DOE/EIS-0380
May 2008

Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

Summary

U.S. Department of Energy

National Nuclear Security Administration

Los Alamos Site Office

Availability of the Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

To submit general questions regarding this EIS, or to request a copy, please contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

Printed with soy ink on recycled paper

COVER SHEET

Responsible Agency: U.S. Department of Energy (DOE)
National Nuclear Security Administration (NNSA)

Title: *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS) (DOE/EIS-0380)

Location: Los Alamos, New Mexico

For additional information or for copies of the SWEIS, contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Telephone: 202-586-4600, or leave a message at 1-800-472-2756

This document is available on the DOE NEPA website (www.eh.doe.gov/nepa) and the NNSA Los Alamos Site Office website (www.doeal.gov/laso/NEPASWEIS.aspx) for viewing and downloading.

***Abstract*:** NNSA proposes to continue operating Los Alamos National Laboratory (LANL), which is located in Los Alamos County in north-central New Mexico. NNSA has identified and assessed three alternatives for continued operation of LANL: (1) No Action, (2) Reduced Operations, and (3) Expanded Operations. Under the No Action Alternative, NNSA would continue the historical mission support activities conducted at LANL at currently approved operational levels. Under the Reduced Operations Alternative, NNSA would eliminate some activities and limit the operations of other activities. Under the Expanded Operations Alternative, NNSA would operate LANL at the highest levels of activity currently foreseeable, including full implementation of mission assignments. Expanded Operations is NNSA's Preferred Alternative. NNSA intends to implement actions necessary to comply with the March 2005 Compliance Order on Consent (Consent Order) to address the investigation and remediation of environmental contamination at LANL, regardless of decisions it makes on other actions analyzed in the SWEIS. Under all of the alternatives, the affected environment is primarily within 50 miles (80 kilometers) of LANL. Analyses indicate little difference in the environmental impacts of the alternatives on many resource areas. The primary discriminators are public risk due to radiation exposure, collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, electrical power and water demand, waste management, and transportation. A classified appendix assesses the potential impacts of terrorist acts.

Public Comments: In preparing the Final SWEIS, NNSA considered comments received during the scoping period (January 19 to February 17, 2005) and during the public comment period on the Draft SWEIS (July 7 to September 20, 2006). Public hearings on the Draft SWEIS were held in Los Alamos, Española, and Santa Fe, New Mexico. Comments on the Draft SWEIS were requested during a period of 75 days following publication of the U.S. Environmental Protection Agency's (EPA's) Notice of Availability in the *Federal Register*. All comments, including any late comments, were considered during preparation of the Final SWEIS.

The Final SWEIS contains revisions and new information based in part on comments received on the Draft SWEIS. Vertical change bars in the margins indicate the locations of these revisions and new information. Volume 3 contains the comments received during the public comment period on the Draft SWEIS and NNSA's responses to the comments. NNSA will use the analysis presented in this Final SWEIS, as well as other information, in preparing the Record(s) of Decision (RODs) regarding the level of continued operations at LANL. NNSA will issue ROD(s) no sooner than 30 days after the EPA publishes a Notice of Availability of this Final SWEIS in the *Federal Register*.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ALARA	as low as reasonably achievable
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
CMR	Chemistry and Metallurgy Research (Building)
CMRR	Chemistry and Metallurgy Research Building Replacement Project
CO	carbon monoxide
Consent Order	Compliance Order on Consent
DD&D	decontamination, decommissioning, and demolition
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
EIS	environmental impact statement
ERPG	Emergency Response Planning Guideline
FR	*Federal Register*
HEPA	high-efficiency particulate air (filter)
LANL	Los Alamos National Laboratory
LANL SWEIS	*Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*
LANSCE	Los Alamos Neutron Science Center
LCF	latent cancer fatality
MDA	material disposal area
MEI	maximally exposed individual
NEPA	National Environmental Policy Act of 1969
NNSA	National Nuclear Security Administration
NOI	Notice of Intent
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
PC	performance category
PCB	polychlorinated biphenyl
petaflops	one quadrillion floating point operations per second
PM_n	particulate matter less than or equal to *n* microns in aerodynamic diameter
RANT	Radioassay and Nondestructive Testing Facility
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RLWTF	Radioactive Liquid Waste Treatment Facility
ROD	Record of Decision
ROI	region of influence
SHEBA	Solution High-Energy Burst Assembly
SO_2	sulfur dioxide
SWEIS	Site-Wide Environmental Impact Statement

TA	technical area
teraflops	one trillion floating point operations per second
TRU	transuranic
USFWS	U.S. Fish and Wildlife Service
WIPP	Waste Isolation Pilot Plant

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

SUMMARY

SUMMARY

The National Nuclear Security Administration (NNSA) has prepared a *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0380) (SWEIS) that evaluates the potential impacts of current and proposed activities at the Los Alamos National Laboratory (LANL) in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations, and the U.S. Department of Energy (DOE) NEPA Implementing Procedures. This Summary is a concise stand-alone version of the main text of the SWEIS, and includes information about the NEPA process as applied to the SWEIS, background information (including a summary of the changes at LANL since the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico [1999 SWEIS]* [DOE/EIS-0238] was prepared), the purpose and need for the agency action, reasonable alternatives, consideration of public comments on the Draft SWEIS, and a comparison of the environmental consequences of the reasonable alternatives. Vertical change bars in the margins indicate the locations of revisions and new information based in part on comments on the Draft SWEIS.

S.1 Background

The NEPA Implementing Procedures of DOE (Title 10 *Code of Federal Regulations* [CFR], 1021.330(c)) require the preparation of a SWEIS, a broad-scoped document that identifies and assesses the individual and cumulative impacts of ongoing and reasonably foreseeable future actions at a DOE site for large multiple-facility sites such as LANL in Los Alamos, New Mexico (see **Figure S–1**). Since 1992, these procedures also require evaluation of a DOE SWEIS at least every 5 years by means of a Supplement Analysis. Based on the Supplement Analysis, DOE determines whether an existing SWEIS remains adequate, or whether to prepare a new SWEIS or supplement the existing SWEIS, as appropriate.

DOE issued the first SWEIS and Record of Decision (ROD) for the operation of LANL (then known as the Los Alamos Scientific Laboratory) in 1979. That environmental impact statement (EIS) was entitled *Final Environmental Impact Statement, Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico* (DOE/EIS-0018). Twenty years later, DOE issued the *1999 SWEIS* and its associated ROD (64 *Federal Register* [FR] 50797).

In early 2004, NNSA[1] undertook the required 5-year evaluation of the *1999 SWEIS* by initiating the preparation of a Supplement Analysis. In mid-2004, shortly into the process of preparing the Supplement Analysis, NNSA determined that the criteria for preparing at least a Supplemental SWEIS had been met. Criteria identified in DOE NEPA Implementing Procedures (10 CFR 1021.314) state that a Supplemental EIS shall be prepared if there are substantial changes to the proposal or significant new circumstances or information relevant to environmental concerns.

[1] *NNSA is a semiautonomous agency within DOE (see the National Nuclear Security Administration Act [Title 32 of the Defense Authorization Act for Fiscal Year 2000, Public Law 106-65]).*

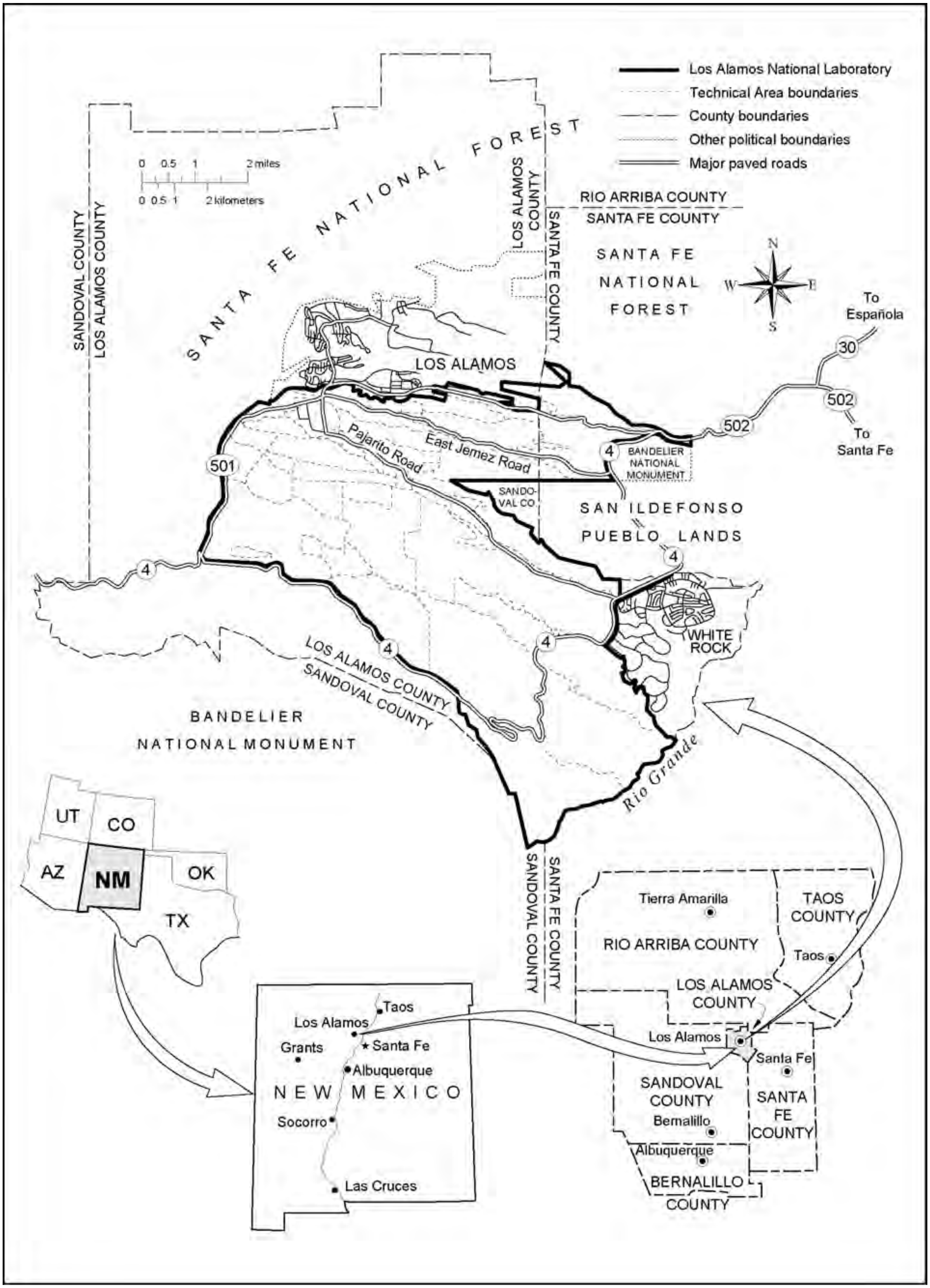


Figure S–1 Location of Los Alamos National Laboratory Site

In January 2005, NNSA published a Notice of Intent (NOI) in the *Federal Register* (70 FR 307) announcing its plan to prepare a Supplemental SWEIS and conduct a public scoping meeting to receive comments. Subsequently, NNSA determined that changes in the LANL environment and proposed new activities warranted preparation of a new SWEIS. Changes to the LANL environment resulted from the 2000 Cerro Grande Fire, which burned a part of LANL, the Los Alamos townsite, and the surrounding forested area; a regional drought; and a massive regional infestation of bark beetles that killed many evergreen trees. Additional information about the LANL environmental setting has become available, as various elements of this setting, particularly the hydrology, have undergone intense investigation by LANL scientists.

Security requirements have evolved in response to changes in recognized threats to facilities and materials at LANL, and DOE and NNSA have finalized several EISs and environmental assessments for LANL operations and activities since issuance of the *1999 SWEIS*. These documents evaluate implementation of new or changed operations and facilities, land conveyances and transfers, and emergency actions taken at LANL in response to the Cerro Grande Fire.

NNSA is considering new actions for initiation at LANL over about the next 5 years that could affect several areas of LANL operations originally analyzed in the *1999 SWEIS*. While consistent with the 1999 ROD, these proposed activities represent potentially substantial changes to some operations. They include the refurbishment or replacement of existing infrastructure so that LANL operations can continue into the future.

Jointly, the activities analyzed in NEPA documents completed since 1999, newly proposed activities for LANL, existing and developing changes to the LANL environmental setting, and changes in site security conditions led NNSA to decide to update the *1999 SWEIS* by preparing a new SWEIS rather than a Supplemental SWEIS. Preparation of a new SWEIS also responds to comments received from the public during the scoping period. The new SWEIS impact analysis tiers from the *1999 SWEIS*, as appropriate, and incorporates information from that document by reference where the information presented in the earlier document remains valid.

Another benefit of preparing a new SWEIS is the reevaluation of cumulative impacts associated with LANL operations. When DOE issued the *1999 SWEIS* and its associated ROD, the analyses considered operational impacts to the northern New Mexico environment of actions that would likely occur over the "foreseeable future" (approximately 10 years for the purposes of that analysis). The new SWEIS considers cumulative impacts associated with ongoing activities at LANL in the context of the new information on the changed environment in the region. For example, a great deal of effort that was not anticipated in 1999 has been expended since the 2000 Cerro Grande Fire to implement forest thinning and watershed protection measures on the Pajarito Plateau.

The following section of this summary describes the purpose and need for continued operation of LANL. Sections S.3 and S.4 explain the scope of the new SWEIS and describe the decisions to be made by NNSA based, in part, on the analyses in the SWEIS, respectively. A description of LANL, as well as terms used in discussing the site and environmental impacts, is presented in Section S.5. The public participation process, including a summary of the major issues raised in the public comments, is provided in Section S.6. Section S.6 also summarizes changes made between the Draft and Final SWEIS. Changes that have occurred at LANL and a comparison to the projected environmental impacts of the *1999 SWEIS* are summarized in Section S.7. Alternatives considered and analyzed in the SWEIS are discussed in Section S.8. The environmental consequences are presented in Section S.9 for the alternatives analyzed in the SWEIS as well as for the individual projects analyzed in appendices of the SWEIS.

S.2 Purpose and Need for Agency Action

The purpose and need for agency action for the new SWEIS remains unchanged from that stated in the *1999 SWEIS*:

> *The purpose of the continued operation of LANL is to provide support for DOE's core missions as directed by the Congress and the President. DOE's need to continue operating LANL is focused on its obligation to ensure a safe and reliable nuclear stockpile. For the foreseeable future, DOE, on behalf of the U.S. Government, will need to continue its nuclear weapons research and development, surveillance, computational analysis, components manufacturing, and nonnuclear aboveground experimentation. Currently, many of these activities are conducted solely at LANL so stopping these activities would run counter to national security policy as established by the Congress.*

With the creation of NNSA in 2000, the President and the Congress reaffirmed the Nation's need for ongoing operations at LANL by assigning administration of LANL to NNSA and by designating LANL as one of three national security laboratories. Further affirmation of the need for continued operations at LANL occurred in 2002, with the creation of the Department of Homeland Security and the subsequent assignment of many of its mission support activities to LANL and other national security laboratories.

On July 13, 2005, a Task Force of the Secretary of Energy Advisory Board issued its report, *Recommendations for the Nuclear Weapons Complex of the Future* (DOE 2005b). This report contains a comprehensive review of the nuclear weapons complex, which includes LANL, and a vision for a modern nuclear weapons complex of the future that would address the needs of the nuclear weapons stockpile. In 2006, NNSA outlined its comprehensive proposal for a smaller, more efficient nuclear weapons complex by the year 2030 that would be better able and more suited to respond to future national security challenges (NNSA 2006b). The proposal included significant dismantling of retired warheads, consolidating special nuclear materials, eliminating duplicative capabilities, consolidating operations, and implementing more efficient and uniform business practices throughout the complex. In an NOI published in the *Federal Register* on October 19, 2006 (71 FR 61731), NNSA announced its intent to prepare a *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement – Complex 2030* (now called the *Complex Transformation Supplemental Programmatic Environmental Impact Statement* [*Complex Transformation SPEIS*]) (DOE/EIS-0236-S4). The NOI outlines alternatives for continued transformation of the nuclear weapons complex to better meet future national security requirements, including a proposal to construct and operate a consolidated plutonium center within the complex. Another proposal, to construct and operate a consolidated nuclear production center, was added as a result of scoping comments. Both of these proposals are analyzed in the Draft *Complex Transformation SPEIS* (DOE 2007b).

On January 31, 2007, NNSA submitted a *Report on the Plan for Transformation of the National Nuclear Security Administration Nuclear Weapons Complex* (NNSA 2007) to the Congressional Defense Committees. The report provides additional discussion of the Complex Transformation vision and the associated transformation plan.

Pending completion of the *Complex Transformation SPEIS*, NNSA is deferring a decision on whether to construct the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. NNSA is continuing with construction of the radiological laboratory, administrative offices and support function building of the new facility and with the design of the nuclear facility portion.

The alternatives in the *Complex Transformation SPEIS* would result in changes to facilities and operations at LANL. In the short term, about the next 5 years, current LANL operations are not expected to change dramatically regardless of the strategy NNSA develops for continuing the transformation of the nuclear weapons complex. However, in recognition of the uncertainties associated with future work assignments to LANL, the "foreseeable future" for the purpose of the Proposed Action in the SWEIS has been changed from the 10 years of LANL operations considered in the *1999 SWEIS* to consideration of proposals regarding LANL operations over about the next 5 years.

S.3 Scope of the New SWEIS

The Proposed Action analyzed in the new SWEIS is the continued operation of LANL to meet DOE's purpose and need. The new SWEIS builds on the descriptions and analyses of operational impacts presented in the *1999 SWEIS*, as well as the information contained in the LANL *SWEIS Yearbooks* prepared since the issuance of the 1999 ROD, and additional documents and data sources. The *SWEIS Yearbooks* are published annually to compare projections in the *1999 SWEIS* with actual operations data. This comparison assists in determining the adequacy of the analysis of environmental consequences in the *1999 SWEIS*. The new SWEIS provides a more focused environmental impact analysis, using the level of operations selected in the ROD of the *1999 SWEIS* as a starting point. In the new SWEIS, the No Action Alternative is the continued implementation of decisions announced in the *1999* ROD together with other activities for which separate NEPA reviews have been completed and decisions made since then. Other alternatives evaluated in the SWEIS include a Reduced Operations Alternative with newly proposed decreases in or elimination of certain activities, and an Expanded Operations Alternative that includes increases in certain ongoing activities and proposed new activities. The proposed new activities are evaluated by means of project-specific analyses contained in appendices of the new SWEIS. **Figure S–2** is a simplified depiction of the alternatives evaluated in the new SWEIS; more detailed descriptions of the alternatives are provided in Section S.8 of this Summary.

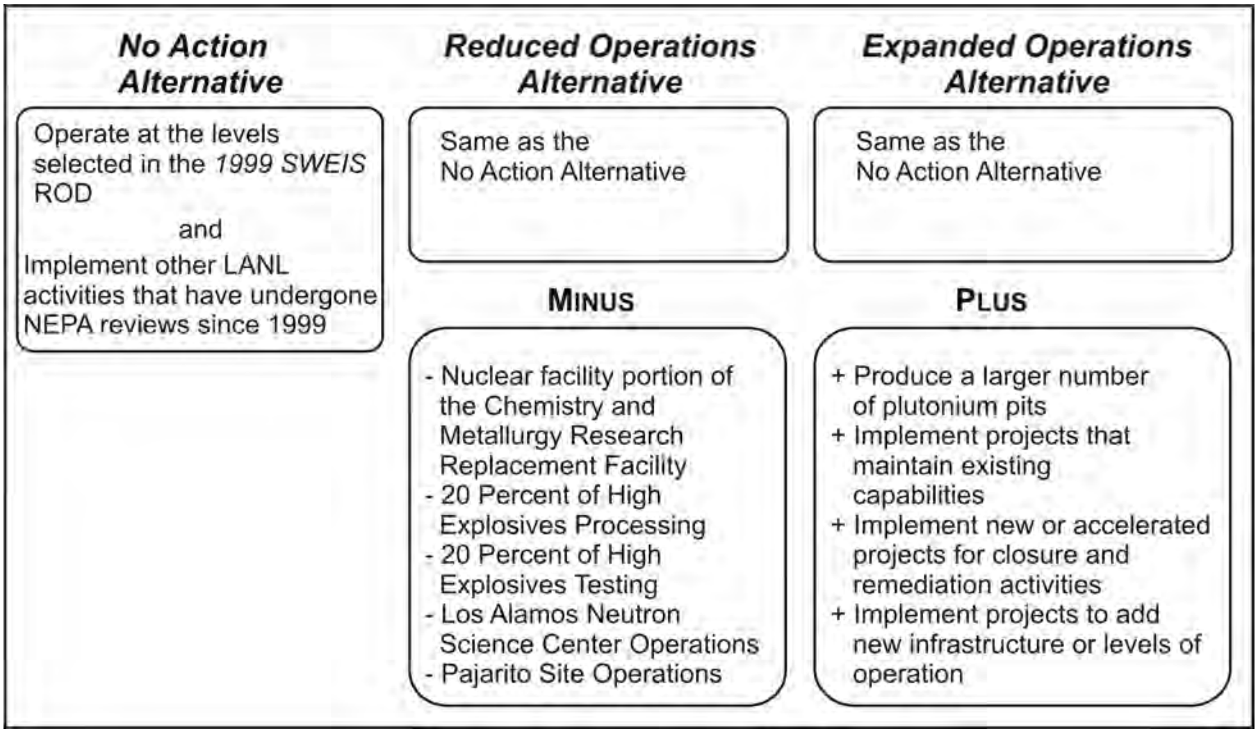


Figure S–2 Summary Comparison of Alternatives Considered in the New Site-Wide Environmental Impact Statement

The new SWEIS also provides an update of current activities at LANL by describing changes that have occurred at the site and presenting a summary of performance compared to *1999 SWEIS* projections. Consistent with the concept of tiering, or building on a previous NEPA document, pertinent information from the *1999 SWEIS* is summarized and incorporated by reference into the new SWEIS. The SWEIS analyzes the potential direct and indirect effects on the human environment under each alternative. Other programmatic decisions currently being considered that might affect LANL and its missions, in combination with activities in the vicinity of LANL, are considered in the cumulative impacts analysis for the new SWEIS.

Appendices of the new SWEIS include specific information and impact analyses for projects that are proposed as part of the Expanded Operations Alternative (project-specific analyses). The project-specific analyses evaluate the potential environmental consequences of projects that are proposed for initiation or implementation prior to 2011. These projects include:

Projects to Maintain Existing LANL Operations and Capabilities – Projects in this group would provide new structures for existing activities at LANL by replacing old and transportable buildings with new modern buildings. This group also includes projects that would provide major refurbishment of selected facilities to maintain capabilities, improve reliability, and prolong operations.

Physical Science Research Complex (formerly the Center for Weapons Physics Research) – provides for the construction and operation of secure and nonsecure facilities in Technical Area (TA) 3.

> **Technical Area (TA)**
>
> Geographically distinct administrative unit established for the control of LANL operations. There are currently 49 active TAs; 47 in the 40 square miles of the LANL site, one at Fenton Hill, west of the main site, and one comprising leased properties in town.

Replacement Office Buildings Project – provides up to 9 office buildings in TA-3 to replace temporary or obsolete buildings.

Radiological Sciences Institute Project (including Phase I – the Institute for Nuclear Nonproliferation Science and Technology) – provides for the consolidation and modernization of radiochemistry capabilities at LANL. Phase I would provide Security Category III and IV laboratories and Security Category I and II training facilities in TA-48 in support of nonproliferation activities.

Radioactive Liquid Waste Treatment Facility (RLWTF) Upgrade Project – provides replacement capabilities in TA-50 for the treatment of radioactive liquids; an auxiliary action provides additional treatment capability that could result in no liquid effluent discharges to the environment.

Los Alamos Neutron Science Center (LANSCE) Refurbishment Project – provides for the replacement of equipment and system refurbishment and improvements at LANSCE in TA-53 to increase the reliability of operations and reduce maintenance costs.

TA-55 Radiography Facility Project – provides radiography capability within the secure area at the TA-55 Plutonium Facility Complex, avoiding the need to transport nuclear components to other locations for examination.

Plutonium Facility Complex Refurbishment Project – provides for a number of subprojects to upgrade electrical, mechanical, safety, and other facility-related systems at the TA-55 Plutonium Facility Complex.

Science Complex Project – provides for the construction of a Science Complex in TA-62 or TA-3. Most bioscience activities currently performed in the Health Research Laboratory would be moved to the new Science Complex.

Remote Warehouse and Truck Inspection Station Project – provides for a warehouse and truck inspection station in TA-72, away from the center portion of LANL.

Projects for Closure and Remediation Actions, including Consent Order Actions – Projects in this group include various actions that would result in the decontamination, decommissioning, and demolition (DD&D) of excess facilities and the remediation of the LANL site. It also includes replacement of waste management capabilities that are displaced as a result of remediation activities.

> **Decontamination, Decommissioning, and Demolition (DD&D)**
>
> DD&D are those actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the building or structure.

TA-18 Closure, including Remaining Operations Relocation and Structure DD&D Project (TA-18 Closure Project) – provides for the relocation of the Security Category III and IV operations currently at the TA-18 Pajarito Site and the DD&D of the structures.

TA-21 Structure DD&D Project – provides for the DD&D of TA-21 structures. Options evaluated include complete and partial removal of structures to support remediation of potential release sites in TA-21.

Waste Management Facilities Transition Project – provides for the retrieval of transuranic waste stored below ground, the removal of the storage domes, and construction and operation of replacement low-level radioactive waste management facilities in TA-54, and construction and operation of a new TRU (Transuranic) Waste Facility (formerly the Transuranic Waste Consolidation Facility). These actions are necessary to support closure of TA-54, material disposal area (MDA) G.[2]

Major Material Disposal Area Remediation, Canyon Cleanups and Other Compliance Order Actions – provides for the implementation of the Compliance Order on Consent (Consent Order) entered into by DOE, the LANL management and operating contractor, and the State of New Mexico in March 2005 (NMED 2005).[3] The analysis evaluates a Capping Option in which barriers are placed over LANL MDAs and a Removal Option in which the MDAs are exhumed.

Implementing the Consent Order

NNSA intends to implement actions necessary to comply with the Compliance Order on Consent (Consent Order) regardless of decisions it makes on other actions analyzed in the LANL SWEIS. Actions associated with implementing the Consent Order are included in the Expanded Operations Alternative; however, their implementation is not contingent on other actions that are part of that alternative.

Projects Associated with New Infrastructure or Levels of Operation – Projects in this group are of two types. One project would provide for changes in the transportation infrastructure within the LANL site. The other projects would provide for increases in activities or capabilities of existing facilities or projects.

Security-Driven Transportation Modifications Project – provides for the construction of parking lots and changes in access along the Pajarito Road corridor to enhance physical security at facilities in TA-35, TA-48, TA-50, TA-55, and TA-63. Proposed auxiliary actions would provide bridges across Mortandad and Sandia Canyons and roadways connecting to TA-3 and East Jemez Road.

Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center) Increase in Level of Operations – provides for the expansion of computing capability at the Metropolis Center.

Increase in the Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project – expands the types and quantities of sealed sources to be managed at LANL to include non-actinide materials routinely used in sealed sources in addition to sources currently approved for management (primarily actinide-bearing sources).

[2] *MDAs are areas used any time between the beginning of LANL operations in the early 1940s and the present for disposing of chemically, radioactively, or chemically and radioactively contaminated material.*
[3] *NNSA is including impacts associated with Consent Order implementation in order to facilitate Consent Order compliance.*

S.4 Decisions NNSA May Make on the Basis of the New SWEIS

The SWEIS updates the *1999 SWEIS* analysis and evaluates the impacts of newly-proposed projects. RODs based on the new SWEIS may supersede previous decisions made in 1999 regarding the level at which LANL operations will be conducted over at least the next 5 years. Analyses in the SWEIS considered levels of operation and new projects proposed for the period 2007 through about 2011, but would also apply to actions beyond 2011 as long as the actions are bounded by the analyses in the SWEIS. The impacts analyses provided in the SWEIS will allow NNSA to reassess the potential impacts of LANL operations on workers, the public, and the environment in light of changes in the environmental setting, changes in the locations at which certain activities are performed, changes in the boundaries of LANL and therefore the locations to be considered for impacts to a member of the public, and changes in guidance for evaluating risk from radiological exposures.

These changes, together with information regarding impact analyses specific to newly proposed projects at LANL that could have overarching effects, will inform NNSA regarding decisions about the continued operation of LANL over about the next 5 years. Focusing on LANL operations over about the next 5 years allows NNSA to make decisions with a reasonable expectation of being able to implement those decisions and associated mitigation measures.

The decisions NNSA may make regarding the operation of LANL are:

- Whether to implement the No Action Alternative for continued LANL operations, either in whole or in part,
- Whether to implement the Reduced Operations Alternative, either in whole or in part, or
- Whether to implement the Expanded Operations Alternative, either in whole or in part.

NNSA could select the level of operations for a Key Facility or whether to implement individual projects from among the Alternatives. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS. NNSA could issue a ROD or RODs to announce its decision regarding the level of operations at LANL or the implementation of a project no sooner than 30 days after the Environmental Protection Agency (EPA) Notice of Availability of the Final SWEIS. In addition to the environmental impact information provided by the SWEIS, other considerations not evaluated through the NEPA process would influence NNSA’s decisions. These include cost estimate information, schedule considerations, safeguards and security concerns, and programmatic considerations.

S.5 Site Description

LANL is located in northern New Mexico within Los Alamos County (see Figure S–1). The two primary residential areas within the county are the Los Alamos townsite and the White Rock residential area, home to about 18,400 people. About 13,500 people work at LANL, of which fewer than half reside within the county.

LANL occupies about 40 square miles (25,600 acres [10,360 hectares]) of land on the eastern flank of the Jemez Mountains along the Pajarito Plateau. The terrain consists of relatively flat mesa tops and canyon bottoms that trend west-to-east toward the Rio Grande. Most of LANL consists of relatively undeveloped forest that serves to provide a buffer for security and safety, as well as space for future expansion.

Activities and potential environmental impacts at LANL are discussed with respect to their location within TAs at the site and whether they are related to those facilities identified as Key Facilities for purposes of the SWEIS. Section S.5.1 describes the TAs at LANL. Section S.5.2 defines the term "Key Facilities" and identifies those facilities at LANL. Section S.5.3 discusses LANL non-Key Facilities.

S.5.1 Technical Areas

LANL operations occupy 49 TAs, including TA-0, the designation given to leased space in the Los Alamos townsite. As shown in **Figure S–3**, there are 47 contiguous TAs; in addition, TA-57 is located approximately 20 miles (32 kilometers) away at Fenton Hill. TAs are geographically discrete areas that are segregated for management, planning, operational, and security purposes. LANL operations occur within the more than 2,000 structures located within these TAs. As of the end of 2005, LANL has approximately 8.6 million square feet (800,000 square meters) under roof on land under the administrative control of NNSA; the total space available for operational use changes frequently as structures are demolished or built. Approximately half of the square footage of buildings at LANL is considered laboratory or production space; the remaining square footage is used for administrative purposes, storage, service, and other space. The number of structures within TAs varies with time, due to frequent addition or removal of temporary structures and miscellaneous buildings. Permanent structures include buildings, meteorological towers, water tanks, manholes, small storage sheds, and electrical transformers, in addition to the specialized facilities that have been built and maintained at LANL over the last 50 years. **Table S–1** provides a brief overview of current activities conducted at each TA.

S.5.2 Key Facilities

Fifteen facilities within LANL were identified in the *1999 SWEIS* as being Key Facilities for the evaluation of potential environmental impacts of operations in the SWEIS. Facilities labeled as "Key" in both the *1999 SWEIS* and the new SWEIS house activities critical to performing mission work assigned to LANL and:

- House operations that have potential to cause significant environmental impacts; or
- Are of most interest or concern to the public based on scoping comments received; or
- Would be most subject to change as a result of programmatic decisions.

The definition of a Key Facility is not limited to a single structure, building, or TA. The number of structures constituting a Key Facility ranges from one (Material Sciences Laboratory) to more than 400 (LANSCE). Key Facilities may exist in more than one TA, as is the case with the High Explosives Processing Key Facilities which consists of structures in six TAs.

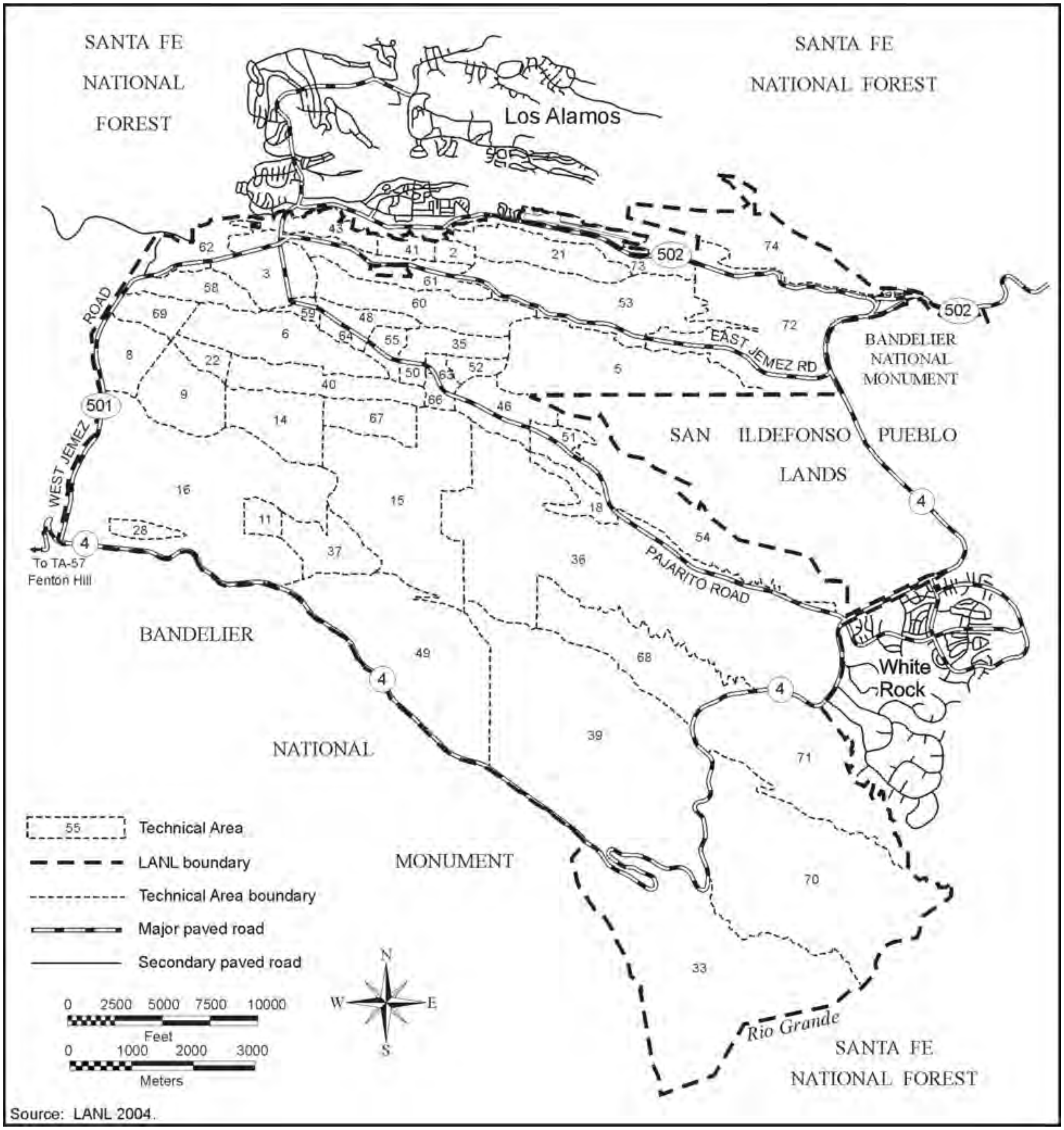


Figure S–3 Technical Areas at Los Alamos National Laboratory

Table S–1 Overview of Los Alamos National Laboratory Technical Areas and Activities

Technical Area [a]	*Activities*
TA-0 (Offsite Facilities)	This TA designation is assigned to structures leased by DOE that are located outside LANL's boundaries in the Los Alamos townsite and White Rock.
TA-2 (Omega Site or Omega West Reactor)	This TA in Los Alamos Canyon was home to the now demolished Omega West Reactor.
TA-3 (Core Area or South Mesa Site)	This TA is LANL's core scientific and administrative area, with approximately half of LANL's employees and total floor space. It is the location of a number of the LANL's Key Facilities, including the Chemistry and Metallurgy Research Building, the Sigma Complex, the Machine Shops, the Material Sciences Laboratory, and the Nicholas C. Metropolis Center for Modeling and Simulation. It is also the location proposed for operating the existing Biosafety Level 3 Facility.
TA-5 (Beta Site)	This TA is largely undeveloped. Located between East Jemez Road and the San Ildefonso Pueblo, it contains physical support facilities, an electrical substation, and test wells.
TA-6 (Two-Mile Mesa Site)	This TA, located in the northwestern part of LANL, is mostly undeveloped. It contains a meteorological tower, gas-cylinder-staging buildings, and aging vacant buildings that are awaiting demolition.
TA-8 (GT-Site [Anchor Site West])	This TA, located along West Jemez Road, is a testing site where nondestructive dynamic testing techniques are used for the purpose of ensuring the quality of materials in items ranging from test weapons components to high-pressure dies and molds. Techniques used include radiography, radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.
TA-9 (Anchor Site East)	This TA is located on the western edge of LANL. Fabrication feasibility and the physical properties of explosives are explored at this TA, and new organic compounds are investigated for possible use as explosives.
TA-11 (K-Site)	This TA is used for testing explosives components and systems, including vibration analysis and drop-testing materials and components under a variety of extreme physical environments. Facilities are arranged so that testing may be controlled and observed remotely, allowing devices that contain explosives, radioactive materials, and nonhazardous materials to be safely tested and observed.
TA-14 (Q-Site)	This TA, located in the northwestern part of LANL, is one of 14 firing areas. Most operations are remotely controlled and involve detonations, certain types of high explosives machining, and permitted burning.
TA-15 (R-Site)	This TA, located in the central portion of LANL, is used for high explosives research, development, and testing, mainly through hydrodynamic testing and dynamic experimentation. TA-15 is the location of two firing sites, the Dual Axis Radiographic Hydrodynamic Test Facility, which has an intense high-resolution, dual-machine radiographic capability, and Building 306, a multipurpose facility where primary diagnostics are performed.
TA-16 (S-Site)	TA-16, in the western part of LANL, is the location of the Weapons Engineering Tritium Facility, a state-of-the-art tritium processing facility. The TA is also the location of high explosives research, development, and testing, and the High Explosives Wastewater Treatment Facility.
TA-18 (Pajarito Site)	This TA, located in Pajarito Canyon, is the location of the Los Alamos Critical Experiment Facility, a general-purpose nuclear experiments facility. It is the location of the Solution High-Energy Burst Assembly and is also used for teaching and training related to criticality safety and applications of radiation detection and instrumentation. In December 2002, NNSA decided to relocate all TA-18 Security Category I and II materials and activities to the Nevada Test Site; this transfer is in process.
TA-21 (DP-Site)	TA-21 is on the northern border of LANL, next to the Los Alamos townsite. In the western part of the TA is the former radioactive materials (including plutonium) processing facility that has been partially decontaminated and decommissioned. In the eastern part of the TA are the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility. Operations from both facilities have been transferred elsewhere as of the end of 2006.
TA-22 (TD-Site)	This TA, located in the northwestern portion of LANL, houses the Los Alamos Detonator Facility. Construction of a new Detonator Production Facility began in 2003. Research, development, and fabrication of high-energy detonators and related devices are conducted at this facility.
TA-28 (Magazine Area A)	TA-28, located near the southern edge of LANL, was an explosives storage area. The TA contains five empty storage magazines that are being decontaminated and decommissioned.
TA-33 (HP-Site)	TA-33 is a remotely-located TA at the southeastern boundary of LANL. The TA is used for experiments that require isolation, but do not require daily oversight. The National Radioastronomy Observatory's Very Long Baseline Array telescope is located at this TA.

Technical Area [a]	***Activities***
TA-35 (Ten Site)	This TA, located in the north central portion of LANL, is used for nuclear safeguards research and development, primarily in the areas of lasers, physics, fusion, materials development, and biochemistry and physical chemistry research and development. The Target Fabrication Facility, located at this TA, conducts precision machining and target fabrication, polymer synthesis, and chemical and physical vapor deposition. Additional activities at TA-35 include research in reactor safety, optical science, and pulsed-power systems, as well as metallurgy, ceramic technology, and chemical plating. Additionally, there are some Biosafety Level 1 and 2 laboratories at TA-35.
TA-36 (Kappa-Site)	TA-36, a remotely-located area in the eastern portion of LANL, has four active firing sites that support explosives testing. The sites are used for a wide variety of nonnuclear ordnance tests.
TA-37 (Magazine Area C)	This TA is used as an explosives storage area. It is located at the eastern perimeter of TA-16.
TA-39 (Ancho Canyon Site)	TA-39 is located at the bottom of Ancho Canyon. This TA is used to study the behavior of nonnuclear weapons (primarily by photographic techniques) and various phenomenological aspects of explosives.
TA-40 (DF-Site)	TA-40, centrally located within LANL, is used for general testing of explosives or other materials and development of special detonators for initiating high explosives systems.
TA-41 (W-Site)	TA-41, located in Los Alamos Canyon, is no longer actively used. Many buildings have been decontaminated and decommissioned; the remaining structures include historic properties.
TA-43 (the Bioscience Facilities, formerly called the Health Research Laboratory)	TA-43 is adjacent to the Los Alamos Medical Center at the northern border of LANL. Two facilities are located within this TA: the Bioscience Facilities (formerly called the Health Research Laboratory) and NNSA's local Site Office. The Bioscience Facilities have Biosafety Level 1 and 2 laboratories and are the focal point of bioscience and biotechnology at LANL. Research performed at the Bioscience Facilities includes structural, molecular, and cellular radiobiology; biophysics; radiobiology; biochemistry; and genetics.
TA-46 (WA-Site)	TA-46, located between Pajarito Road and the San Ildefonso Pueblo, is one of LANL's basic research sites. Activities have focused on applied photochemistry operations and have included development of technologies for laser isotope separation and laser enhancement of chemical processes. The Sanitary Wastewater Systems Plant is also located within this TA.
TA-48 (Radiochemistry Site)	TA-48, located in the north central portion of LANL, supports research and development in nuclear and radiochemistry, geochemistry, production of medical radioisotopes, and chemical synthesis.
TA-49 (Frijoles Mesa Site)	TA-49, located near Bandelier National Monument, is used as a training area and for outdoor tests on materials and equipment components that involve generating and receiving short bursts of high-energy, broad-spectrum microwaves. A fire support building and helipad located near the entrance to the TA are operated by the U.S. Forest Service.
TA-50 (Waste Management Site)	TA-50, located near the center of LANL, is the location of waste management facilities including the Radioactive Liquid Waste Treatment Facility and the Waste Characterization, Reduction, and Repackaging Facility. The Actinide Research and Technology Instruction Center is also located in this TA.
TA-51 (Environmental Research Site)	TA-51, located on Pajarito Road in the eastern portion of LANL, is used for research and experimental studies on the long-term impacts of radioactive materials on the environment. Various types of waste storage and coverings are studied at this TA.
TA-52 (Reactor Development Site)	TA-52 is located in the north central portion of LANL. A wide variety of theoretical and computational research and development activities related to nuclear reactor performance and safety, as well as to several environmental, safety, and health activities, are carried out at this TA.
TA-53 (Los Alamos Neutron Science Center)	TA-53, located in the northern portion of LANL, includes the LANSCE. LANSCE houses one of the largest research linear accelerators in the world and supports both basic and applied research programs. Basic research includes studies of subatomic and particle physics, atomic physics, neutrinos, and the chemistry of subatomic interactions. Applied research includes materials science studies that use neutron spallation and contributes to defense programs. LANSCE has also produced medical isotopes for the past 20 years.
TA-54 (Waste Disposal Site)	TA-54, located on the eastern border of LANL, is one of the largest TAs at LANL. Its primary function is management of solid radioactive and hazardous chemical wastes, including storage, treatment, decontamination, and disposal operations.

Technical Area [a]	***Activities***
TA-55 (Plutonium Facility Complex Site)	TA-55, located in the center of LANL, is the location of the Plutonium Facility Complex and is the chosen location for the Chemistry and Metallurgy Research Building Replacement. The Plutonium Facility provides chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides into many compounds and forms. The Chemistry and Metallurgy Research Building Replacement, currently under construction, will provide chemistry and metallurgy research, actinide chemistry, and materials characterization capabilities.
TA-57 (Fenton Hill Site)	TA-57 is located about 20 miles (32 kilometers) west of LANL on land administered by the U.S. Forest Service. The primary purpose of the TA is observation of astronomical events. TA-57 houses the Milagro Gamma Ray Observatory and a suite of optical telescopes. Drilling technology research is also performed in this TA.
TA-58 (Twomile North Site)	TA-58, located near LANL's northwest border on Twomile Mesa North, is a forested area reserved for future use because of its proximity to TA-3. The TA houses a few LANL-owned storage trailers and a temporary storage area.
TA-59 (Occupational Health Site)	This TA is located on the south side of Pajarito Road adjacent to TA-3. This is the location of staff who provide support services in health physics, risk management, industrial hygiene and safety, policy and program analysis, air quality, water quality and hydrology, hazardous and solid waste analysis, and radiation protection. The Medical Facility at TA-59 includes a clinical laboratory and provides bioassay sample analytical support.
TA-60 (Sigma Mesa)	TA-60 is located southeast of TA-3. The TA is primarily used for physical support and infrastructure activities. The Nevada Test Site Test Fabrication Facility and a test tower are also located here. Due to the moratorium on testing, these buildings have been placed in indefinite safe shutdown mode.
TA-61 (East Jemez Site)	TA-61, located in the northern portion of LANL, contains physical support and infrastructure facilities, including a sanitary landfill operated by Los Alamos County and sewer pump stations.
TA-62 (Northwest Site)	TA-62, located next to TA-3 and West Jemez Road in the northwest corner of LANL, serves as a forested buffer zone. This TA is reserved for future use.
TA-63 (Pajarito Service Area)	TA-63, located in the north central portion of LANL, contains physical support and infrastructure facilities. The facilities at this TA serve as localized storage and office space.
TA-64 (Central Guard Site)	This TA is located in the north central portion of LANL and provides offices and storage space.
TA-66 (Central Technical Support Site)	TA-66 is located on the southeast side of Pajarito Road in the center of LANL. The Advanced Technology Assessment Center, the only facility at this TA, provides office and technical space for technology transfer and other industrial partnership activities.
TA-67 (Pajarito Mesa Site)	TA-67 is a forested buffer zone located in the north central portion of LANL. No operations or facilities are currently located at the TA.
TA-68 (Water Canyon Site)	TA-68, located in the southern portion of LANL, is a testing area for dynamic experiments that also contains environmental study areas.
TA-69 (Anchor North Site)	TA-69, located in the northwestern corner of LANL, serves as a forested buffer area. The new Emergency Operations Center, completed in 2003, is located here.
TA-70 (Rio Grande Site)	TA-70 is located on the southeastern boundary of LANL and borders the Santa Fe National Forest. It is a forested TA that serves as a buffer zone.
TA-71 (Southeast Site)	TA-71 is located on the southeastern boundary of LANL and is adjacent to White Rock to the northeast. It is an undeveloped TA that serves as a buffer zone for the High Explosives Test Area.
TA-72 (East Entry Site)	TA-72, located along East Jemez Road on the northeastern boundary of LANL, is used by protective force personnel for required firearms training and practice purposes.
TA-73 (Airport Site)	TA-73 is located along the northern boundary of LANL, adjacent to Highway 502. The County of Los Alamos manages, operates, and maintains the community airport under a leasing arrangement with DOE. Use of the airport by private individuals is permitted with special restrictions.
TA-74 (Otowi Tract)	TA-74 is a forested area in the northeastern corner of LANL. A large portion of this TA has been conveyed to Los Alamos County or transferred to the Department of the Interior in trust for the Pueblo of San Ildefonso and is no longer part of LANL.

TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] Names in parentheses are common or historical names that are sometimes used to refer to the Technical Areas.

Taken together, the Key Facilities represent the greatest potential for risks of exposure to hazardous materials associated with LANL operations. The *1999 SWEIS* projections and operational experience show that the Key Facilities presented in **Figure S–4** produce:

- More than 99 percent of all radiation doses to the public;
- More than 99 percent of all radiation doses to the LANL workforce;
- More than 90 percent of all radioactive liquid waste generated at LANL; and
- More than 90 percent of all radioactive solid waste generated at LANL.

Nuclear and radiological facilities at LANL are identified by hazard category in accordance with the potential consequences in the event of an accident. At LANL, there are no Hazard Category 1 nuclear facilities; the nuclear facilities are either Hazard Category 2 or Hazard Category 3. Facilities that handle less than Hazard Category 3 threshold quantities of radioactive materials, but require identification as "radiological areas" are designated radiological facilities. All of the nuclear Hazard Category 2 and 3 facilities and most of the radiological facilities at LANL either are Key Facilities in the SWEIS or are MDAs that are being addressed by environmental restoration activities.

Nuclear Facility Hazard Categories

Hazard Category 1: Hazard analysis shows the potential for significant offsite consequences.

Hazard Category 2: Hazard analysis shows the potential for significant onsite consequences.

Hazard Category 3: Hazard analysis shows the potential for only significant localized consequences.

For the impact analysis in the new SWEIS, the identity of the LANL Key Facilities was modified to incorporate decisions DOE made after 1999 that resulted in changes to LANL facilities and operations. As shown in **Table S–2**, most of the Key Facilities in the *1999 SWEIS* are also Key Facilities in the new SWEIS. The only changes to the list are the addition of the Metropolis Center as a new Key Facility, and the removal of the Pajarito Site as a Key Facility for alternatives other than the No Action Alternative.

S.5.3 Non-Key Facilities

The majority of LANL buildings are not Key Facilities, and house operations that are unlikely to cause significant environmental impacts, although some have been designated as radiological or moderate hazard facilities. These buildings and structures, collectively called non-Key Facilities, are located in 30 of the 48 TAs over approximately 14,200 acres (5,750 hectares) of LANL's 25,600 acres (10,360 hectares). Some of these non-Key Facilities are operating, but several are now surplus and awaiting DD&D. Currently, there are no Hazard Category 2 or 3 nuclear facilities among the non-Key Facilities at LANL. The following list provides information about physical changes to non-Key Facilities occurring since the issuance of the *1999 SWEIS* and includes hazard category designation changes where appropriate:

- Various Chlorination Stations (TA-0, Buildings 1109, 1110, 1113, 1114; 16-560; 54-1008; 72-3; 73-9) were designated moderate chemical hazard facilities in the *1999 SWEIS*. Since then, the quantity of chlorine stored at these facilities has been reduced or eliminated, so they are no longer categorized as hazardous facilities. Ownership of several chlorination stations was conveyed to Los Alamos County.

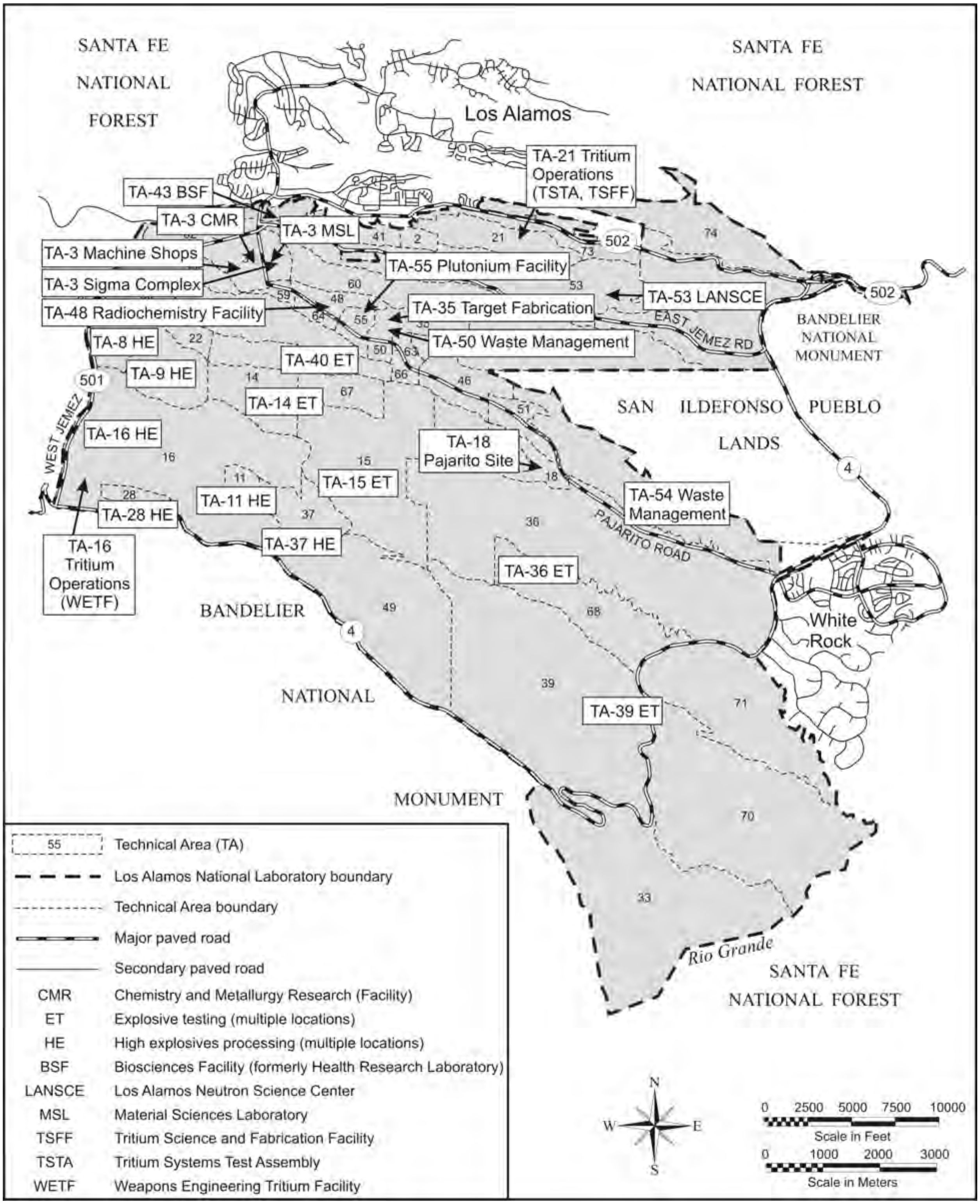


Figure S–4 Locations of Key Facilities

Table S–2 Comparison of Key Facilities Between the *1999 SWEIS* and the New SWEIS

Key Facilities	*1999 SWEIS*	*New SWEIS*
Chemistry and Metallurgy Research Building	✓	✓
Sigma Complex	✓	✓
Machine Shops	✓	✓
Material Sciences Laboratory	✓	✓
Nicholas C. Metropolis Center for Modeling and Simulation		✓
High Explosives Processing Facilities	✓	✓
High Explosives Testing Facilities	✓	✓
Tritium Facilities	✓	✓
Pajarito Site (Los Alamos Critical Experiments Facility)	✓	(a)
Target Fabrication Facility	✓	✓
Bioscience Facilities (previously called Health Research Laboratory)	✓	✓
Radiochemistry Facility	✓	✓
Waste Management Operations: Radioactive Liquid Waste Treatment Facility	✓	✓
Los Alamos Neutron Science Center	✓	✓
Waste Management Operations: Solid Radioactive and Chemical Waste Facilities	✓	✓
Plutonium Facility Complex	✓	✓

[a] The Pajarito Site remains a Key Facility in the No Action Alternative only.

- The Omega West Building (2-1) and reactor were completely decontaminated and demolished in September 2003.

- The Ion Beam Building (3-16) houses an accelerator that is currently in safe-shutdown mode. All radioactive sources have been removed from that building.

- All cryogenics equipment has been removed from the Condensed Matter and Thermal Physics Laboratory (Building 3-34) since 1999 and the Ion Beam M Laboratory now occupies the basement.

- The Health Physics Instrument Calibration facilities, located within the Physics Building (3-40), are no longer designated a Hazard Category 3 nuclear facility. The facilities were relocated to Buildings 36-1 and 36-214, both of which are on the radiological facilities list.

- The Source Storage Building (3-65) has been downgraded from Hazard Category 2 since the *1999 SWEIS*, and removed from the radiological facilities list. It is currently used for storage of materials and test kits.

- The Calibration Building (3-130), designated in the *1999 SWEIS* as a Hazard Category 3 nuclear facility, is being converted into office space with some light-laboratory areas and is no longer on the radiological facilities list.

- The Liquid and Compressed Gas Facility (Building 3-170) was reclassified to a low chemical hazard status. All toxic materials have been removed from this facility since 1999.

- Building 21-5, a laboratory, has been reclassified as a radiological facility since 1999.

- Building 21-150, Molecular Chemistry, has been removed from the radiological facilities list and is now identified as a surplus structure.
- The High Pressure Tritium Facility (Building 33-86) was decommissioned in 2002 prior to its subsequent demolition.
- Nuclear Safeguards Research Facilities (Buildings 35-2 and 35-27) were downgraded to radiological facilities in 2000 from Hazard Category 3 nuclear facilities in the *1999 SWEIS*.
- Central High Pressure Calibration Facility construction (Building 36-214) was completed in October 2001 and categorized as a radiological facility. In addition, Building 36-1, a laboratory and office building, has been categorized as a radiological facility since 1999.
- The Laboratory Building (41-4) was categorized as a radiological facility in the *1999 SWEIS.* Building 41-30 was demolished with a major portion of Building 41-4. The Ice House, Building 41-1, an underground storage vault, is categorized as a radiological facility, although no special nuclear material is now stored in the vault.
- The Sewage Treatment Plants (Building 46-340) no longer use chlorine gas for effluent disinfection, so the designation as moderate chemical hazard facilities prior to 1999 has recently been changed.

S.6 Public Involvement and Issues Identified

The process of preparing an EIS provides opportunities for public involvement (see **Figure S–5**). These opportunities include the scoping process and the public comment period for the EIS. The scoping process is required by 40 CFR 1501.7 while the public comment period is required by 40 CFR 1503.1. Section S.6.1 summarizes the scoping process, major comments received from the public, and changes made by NNSA in response to the public comments. Section S.6.2 summarizes the public comment period process, major comments raised by the public, and NNSA's responses to those comments.

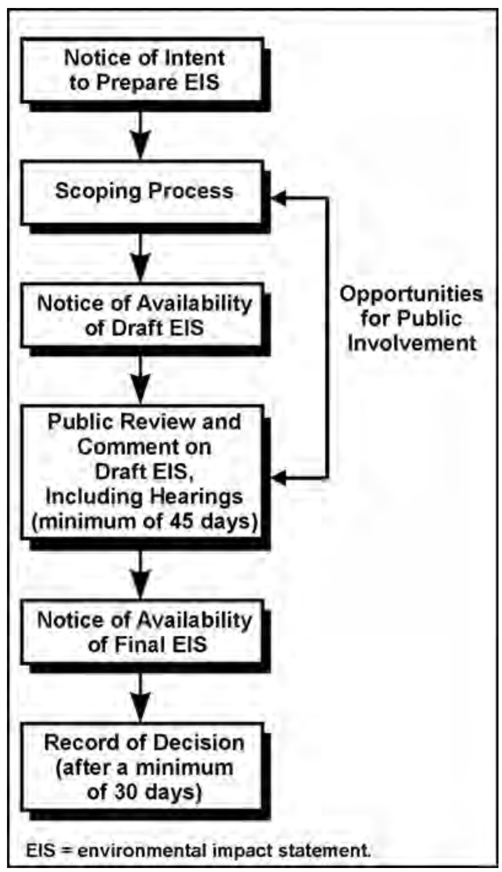


Figure S–5 National Environmental Policy Act Process

S.6.1 Scoping Process

As a preliminary step in the development of an EIS, regulations established by the CEQ (40 CFR 1501.7) and DOE require "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a Proposed Action." The purpose of this scoping process is: (1) to inform the public about a

Proposed Action and the Alternatives being considered, and (2) to identify and clarify issues relevant to the EIS by soliciting public comments.

On January 5, 2005, NNSA published an NOI to prepare a Supplemental SWEIS in the *Federal Register* (70 FR 807). NNSA provided the public an opportunity to participate in the scoping process through a public scoping meeting held on January 19, 2005, in Pojoaque, New Mexico, and through receipt of comments via the U.S. Postal Service, a special DOE Internet address, a toll-free phone line, and a facsimile phone line. The public scoping period ended February 17, 2005. Approximately 225 comments were received from citizens, interested groups, local officials, and representatives of Native American Pueblos in the vicinity of LANL during the scoping process. All comments received were reviewed for consideration by NNSA in proceeding with this NEPA analysis.

Summary of Major Scoping Comments

Multiple comments were made regarding the type of NEPA document that NNSA should prepare. There were comments calling for development of a new SWEIS rather than a supplement to the *1999 SWEIS*. Justifications for a new SWEIS included changes in operations and the environment, issuance of the Consent Order (NMED 2005), concerns about inadequacies of the *1999 SWEIS*, contaminants in the environment, and other reasons. Regarding the scope of the document, comments included the desire to see a Reduced Operations Alternative, a Greener Alternative, and a "true No Action Alternative." In response, NNSA prepared a new SWEIS instead of a Supplemental SWEIS, as originally proposed. The SWEIS includes analysis of a Reduced Operations Alternative to assess the impacts of continued operation of LANL, with certain facilities operating at lower levels. Two alternatives that were suggested for inclusion in the new SWEIS are not analyzed. A "true No Action Alternative," understood to mean a cessation of LANL operations, is not included, nor is a distinct "Greener Alternative." The reasons these alternatives were considered and dismissed from further evaluation are discussed in Section S.8.

Other public comments focused on ensuring that certain facilities, processes, and activities at LANL were included in the SWEIS. In general, all facilities, processes, and other activities at LANL have been included. Operation of the Biosafety Level 3 Facility is being addressed in a separate EIS; however, a summary of the potential impacts is included in the cumulative impacts section of the SWEIS.

A range of comments on environmental changes since the release of the *1999 SWEIS* was also received, including general questions on New Mexico's drought and the impacts of the Cerro Grande Fire. Other comments stressed that the most recent environmental monitoring and hydrological data be incorporated and addressed. The SWEIS summarizes the results of a number of studies performed following the Cerro Grande Fire to determine the impacts the fire had on the movement of contaminants. It also presents a comparison of levels of environmental contamination based on composite samples of groundwater, storm water runoff, sediments, and soil as measured over the years since the Cerro Grande Fire to similar sample results presented in the *1999 SWEIS*. In addition, the most recent publicly available environmental reports have been incorporated into the analyses of the SWEIS.

NNSA received comments from local Native American Tribes that reflected concerns related to LANL operations and human and environmental health problems in their communities. They believe health issues were not properly addressed in the *1999 SWEIS* or ROD and would like to see a more detailed analysis. NNSA believes the SWEIS conforms to the established NEPA requirements and practices for analyzing and presenting these impacts. The text has been revised to provide more information on the analysis of special pathways.

Other concerns identified by commentors in the scoping process were related to analyzing the impacts of reduced air monitoring, improving the air quality and soil analysis, increasing the discussion of cleanup activities, addressing land conveyance and transfer, and questioning the scope of the accident analyses. NNSA addressed all of these topics in the Draft SWEIS and in this Final SWEIS.

Certain groups of comments from the scoping process were not included in the analysis of the SWEIS. These included comments regarding accountability of LANL management, the transfer of LANL management, worker turnover, and worker morale.

S.6.2 Public Comments on the Draft LANL SWEIS

Once the Draft EIS is completed, regulations require that it be issued publicly to obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards; appropriate State and local agencies; Native American Tribal Governments, when the effects may be on a reservation; and the public, which consists of those persons or organizations who may be interested or affected (40 CFR 1503.1).

NNSA issued a notice of availability for the Draft SWEIS in July 2006 (71 FR 38638). The formal public comment period, originally scheduled for 60 days, lasted 75 days, beginning on July 7, 2006 and ending on September 20, 2006. During this comment period, public hearings were held in Los Alamos, Española, and Santa Fe, New Mexico. In addition, Federal agencies, state and local governmental entities, Native American Tribal Governments, and the general public were encouraged to submit comments via the U.S. mail, e-mail, a toll-free telephone number, and a toll-free fax line. Approximately 1,600 comments were received. NNSA considered all comments, including those received after the comment period ended, in evaluating the accuracy and adequacy of the Draft SWEIS and to determine whether its text needed to be corrected, clarified, or otherwise revised.

Upon receipt, all comment documents (e-mail, letter, telefax, transcribed phone messages) were entered into a tracking system for management during the comment response process. The transcript from each public hearing was entered into the system as a comment document. All comment documents are included in the Administrative Record. The text of each comment document is delineated into individual, sequentially numbered comments and responses are developed for each comment, as appropriate. A copy of each comment document, including transcripts, along with NNSA's response to each comment, is included in Volume 3, *Comment Response Document,* of the SWEIS.

Summary of Major Issues

Several topics raised by public comments on the Draft SWEIS are of broad interest or concern, or require a detailed response. The following discussion presents a summary of these major issues and NNSA's responses.

***Opposition to Nuclear Weapons and Pit Production** – Commentors expressed general opposition to nuclear weapons and pit production. Nuclear weapons are seen as unnecessary, immoral, unethical, and violating international nonproliferation treaties, and should be eliminated. Some commentors also called into question the need for pit production because of the apparent long life of plutonium pits.*

NNSA acknowledges that there is wide-spread opposition to the production of nuclear weapons and their components; however, nuclear deterrence will continue to be an important element of national security policy for the foreseeable future. LANL's national security responsibilities are to support NNSA's core mission, which includes ensuring a safe and reliable nuclear stockpile; a cessation of these activities would be counter to national security policy as established by the Congress and the President. Therefore, ending these activities at LANL is not considered in the SWEIS. Maintaining an existing nuclear weapon stockpile for safety and security reasons is not in violation of any current nonproliferation treaty to which the United States is a signatory. Stockpile stewardship capabilities at LANL are currently viewed by the United States as a means to further the Nation's nonproliferation objectives. Continued confidence in the Nation's nuclear stockpile capabilities is likely to remain important in arms control negotiations as the size of the stockpile continues to be reduced in accordance with international treaties. Regarding pit lifetime, NNSA reviewed pit lifetime studies and has concluded that the degradation of plutonium in the majority of nuclear weapons will not affect warhead reliability for a minimum of 85 years; however, the production rate of 80 pits per year analyzed in the SWEIS provides a bounding scenario and would, if implemented, give NNSA flexibility to meet current security needs.

***NEPA Process** – Commentors expressed a variety of concerns related to the implementation of the NEPA process for the LANL SWEIS, including an inadequate scoping process, inadequate time to review the Draft SWEIS, inadequate timing and number of public hearings, lack of availability of references for public review, and the need to include not-yet completed technical studies.*

In implementing the NEPA process, NNSA provides reasonable opportunities for the public to provide input, including a scoping period following issuance of an NOI and a comment period after issuance of the Draft SWEIS. NNSA announced a scoping period and scoping meeting based on the plans to prepare a supplement to the *1999 SWEIS*. Subsequently, NNSA determined that it would prepare a new SWEIS rather than a supplemental SWEIS, consistent with the request expressed in some scoping comments. NNSA believes that the scoping comments apply equally to a supplement to the previous SWEIS or to a new SWEIS. For review of the Draft SWEIS, NNSA originally provided for a 60-day comment period; in response to requests for additional time, the comment period was extended by 15 days for a total of 75 days. The number and location of public hearings was consistent with prior public outreach for LANL NEPA documents; in addition, all public announcements regarding the Draft SWEIS identified a number of other means by which the public could provide comments (U.S. mail, e-mail, fax, or phone message). References used in the Draft SWEIS were available to the public in reading rooms in Los Alamos, Santa Fe, and Albuquerque, New Mexico, also consistent with past practices. Commentors noted that the Draft SWEIS had referenced a draft public health assessment prepared by the Agency for Toxic Substances and Disease Registry; this study has since been finalized and is reflected in the Final SWEIS. Other concerns were that updates to seismic hazards analysis and the TA-54 Area G performance assessment should be included in the SWEIS. To the extent possible, the most recent technical documents, including an update to the seismic hazard analysis, completed in 2007, are considered in the Final SWEIS analyses. Information under development that is not available for use in the Final SWEIS, such as the updated Area G performance assessment, will be considered as it becomes available. In accordance with the NEPA process, the SWEIS impact analyses will be reviewed and supplemented as necessary in response to new information.

***Alternative Missions** – Commentors suggested changing LANL's mission of supporting stockpile stewardship activities to another, non-weapons related mission. Examples of alternative missions suggested by commentors include development of renewable resources including solar, wind, and biomass; development of environmental cleanup technologies; addressing global climate change; development of the use of hydrogen fuel cells; and development of anti-terrorism and nonproliferation tools.*

As indicated above, the purpose of the continued operation of LANL is to provide support for NNSA's core mission as directed by the Congress and the President, which includes maintaining a safe and reliable nuclear weapon stockpile. A cessation of these activities would be counter to national security policy and therefore, is not being considered in the SWEIS. Certain of the research areas identified by commentors are currently performed at LANL and therefore are part of the No Action Alternative. These research activities, including research related to national health issues, waste minimization and environmental issues, and international nuclear safety, would continue to be conducted regardless of the alternative selected.

***Modernization of the Nuclear Weapons Complex** – Commentors requested to delay completion of the LANL SWEIS until the Complex Transformation SPEIS is completed because it has a broader view of the need for, and level of, pit manufacturing. Comments also included requests to address environmental impacts from implementation of the Reliable Replacement Warhead Program in the SWEIS since reliable replacement warheads would be produced at TA-55 within the next 5 years. Commentors also requested the removal of references to a modern pit facility from the SWEIS.*

The LANL SWEIS focuses on continuing site-specific activities and new projects that may be initiated within about 5 years at LANL, whereas the *Complex Transformation SPEIS* addresses programmatic issues of modernization and consolidation of the nuclear weapons complex over a much longer timeframe and across the nuclear weapons complex. As such, the timing of and analyses in the LANL SWEIS are largely independent of the *Complex Transformation SPEIS*. An exception is the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. In conjunction with its Complex Transformation planning, NNSA is reconsidering its previous decision to construct this facility. Regarding the analysis of environmental impacts from producing reliable replacement warheads, the alternatives analyzed in the SWEIS are independent of any decision to produce a reliable replacement warhead. Capabilities such as production of plutonium components are required regardless of such a decision. If a reliable replacement warhead is approved by the President and funded by the Congress as part of a national strategy for providing a nuclear deterrent, it would enable a shift to production that requires fewer hazardous operations. The environmental impacts analyzed in the LANL SWEIS are based on the existing stockpile stewardship program and corresponding life extension programs. Since the reliable replacement warhead design is expected to reduce the use of radioactive and hazardous materials, analysis of the current stockpile should reasonably bound the potential impacts of the reliable replacement warhead if it goes into production.

When NNSA announced its intent to prepare the *Complex Transformation SPEIS*, it also announced cancellation of proposals to construct a modern pit facility. Consequently, analyses in the SWEIS no longer include a modern pit facility in the cumulative impacts analysis.

***Water Resources** – Commentors expressed concern about the impacts of LANL operations on groundwater in the regional aquifer and surface water in the Rio Grande, and consequently, the safety of the drinking water to local and downstream users.*

Monitoring of groundwater has been performed at LANL for many decades and at numerous locations within and around LANL. The locations include springs, drinking water supply wells, shallow monitoring wells, intermediate-depth monitoring wells, and a variety of different monitoring well types for the regional aquifer. LANL, in consultation with the New Mexico Environment Department, will continue a phased approach to determining which wells are needed and in what locations to satisfy long-term monitoring needs. The information presented in the SWEIS relies on the best information available, and primarily on data from the types of wells and screens that have high quality results. Some contaminants are present onsite at levels above applicable standards and guidelines. Elevated levels are investigated to confirm the validity of the results, determine the source and extent of the contamination, and evaluate needed control and cleanup technologies. Confusion regarding the presence of contaminants in samples caused by the presentation of data in the SWEIS has been addressed by better explaining the purpose, development, and use of the data and contrasting them with the data on detected contaminants reported in the annual LANL environmental surveillance reports. There have been concerns regarding neptunium-237 in the regional aquifer. The values of neptunium-237 shown in the SWEIS reflect the conservative statistical interpretation of the analyses. The minimum detectable activity for this radioisotope was found to be greater than the reported values using laboratory gamma spectrometry analytical methods. This indicates that neptunium was not present, and that the results were an artifact of the analytical method. An alternate analytical method, alpha spectrometry, has been shown to have a significantly lower minimum detection level for neptunium-237 and was used to measure groundwater samples in and around LANL in 2006. The results of these environmental sample measurements to date have shown no neptunium-237 present in regional aquifer groundwater. Plutonium-239, plutonium-240, and strontium-90 have been detected in samples from Los Alamos water supply wells taken on only one or two dates, indicating an error by the analytical laboratory. This conclusion was confirmed by reanalysis of numerous samples and contradictory results from field and laboratory duplicate samples.

Remediation of water resources containing or potentially containing contaminants is carried out consistent with DOE and external regulatory requirements. For example, the 2005 Consent Order requires investigations to fully characterize the nature, extent, fate, and transport of contaminants subject to the Consent Order that have been released to surface water, groundwater, and other environmental media. Following the investigations, corrective measures are evaluated, proposed, authorized, and implemented, as needed, to meet quantitative surface water and groundwater cleanup levels prescribed in Section VIII of the Consent Order.

Sampling in 2005 and 2006 indicates that chromium contamination is present in the regional aquifer in a limited area beneath Sandia and Mortandad Canyons and in perched groundwater beneath Mortandad Canyon. Chromium contamination was not detected in water-supply wells. The LANL contractor has prepared an *Interim Measures Work Plan for Chromium Contamination in Groundwater* (LANL 2006b). An interim measures investigation report prepared in 2006 provides a basis for follow-on work. The report found that the main source of hexavalent chromium was chromium-treated cooling water from a TA-3 power plant at the head of Sandia Canyon during its operations between 1956 and 1972. Additional data collection from other regional groundwater monitoring wells is needed to further assess the extent of LANL-derived chromium contamination. Recommendations included additional data collection on chromium and other chemicals for use in risk assessments and the selection of corrective action remedies.

Despite the detection of polychlorinated biphenyls (PCBs) in stormwater runoff within the LANL site boundaries, available data show no discernible impacts on PCB concentrations in the Rio Grande.

Offsite Contamination *– Commentors expressed concern about offsite contamination from past and proposed LANL operations. Some commentors were concerned that increased activities would lead to new contamination. They questioned increasing pit production when LANL had not controlled releases in the past. Other commentors stated concerns that contaminants could appear outside the site boundaries and affect residents of nearby communities or those living down wind or down river from LANL, and others questioned the use of 50 miles as the range for evaluating offsite impacts.*

The SWEIS describes the environmental laws and regulations that apply to LANL operations. LANL operations do result in emissions to the air and discharges of surface water, but all of these emissions and discharges are in accordance with regulations established to protect public health and safety. The LANL contractor demonstrates compliance through environmental monitoring and reporting, which includes statistical analysis and other methods to determine which results are indicative of the actual presence of a contaminant. The SWEIS describes the current environment and presents, for resource areas with annually measurable parameters, recent data that show compliance status with regulations and permits. Compliance status is based on data contained in the annual environmental surveillance reports that are required for DOE sites and are publicly available.

Contamination in Foodstuffs

Because ingestion of foodstuffs constitutes an important pathway by which radionuclides and other contaminants can be transferred to humans, a wide variety of domestically produced edible vegetables, fruits, grains, and animal products is sampled from the area surrounding LANL and analyzed for a variety of radionuclides. These samples are used to compare the levels of radioactive and nonradioactive contaminants in foodstuffs at onsite and perimeter locations to regional levels, to determine trends over time, and to estimate the radiation doses and chemical exposures to individuals who consume them. Foodstuff monitoring in the region regularly shows no contamination resulting from LANL operations.

LANL Impact on the Rio Grande

Waters and sediments along the Rio Grande historically have shown relatively small impacts from LANL operations. All base flow samples from the Rio Grande had pollutant concentrations below drinking water standards and standards for the protection of aquatic life, wildlife habitat, and irrigation. None of the radionuclides commonly associated with LANL operations was detected, except for uranium; uranium concentrations (0.5 to 2 milligrams per liter) were consistent with naturally occurring levels in regional waters and well below the Federal drinking water standard of 30 milligrams per liter. In 2005, radionuclide concentrations in bottom sediments from the Cochiti Reservoir, the first reservoir on the Rio Grande downstream from LANL, were lower than in other post-Cerro Grande Fire years. Plutonium-239, plutonium-240, and cesium-137 concentrations showed increases for 1 to 2 years following the Cerro Grande Fire, but concentrations in 2005 were comparable with pre-fire levels. Plutonium-239 and plutonium-240 concentrations in 2005 were near or below analytical detection limits. Metals concentrations in the bottom sediments were not sufficiently different from background concentrations to warrant discussion. The residual high-explosives organic compound 2, 4-dinitrotoluene was detected in Cochiti Reservoir bottom sediments at an estimated concentration of 2.8 milligrams per kilogram, considerably below the EPA Region VI soil screening level of 120 milligrams per kilogram. This compound was not detected in earlier analyses.

Use of 50-Mile (80-kilometer) Radius Region of Influence

A 50-mile (80-kilometer) radius is commonly used in EISs because this distance has been shown to encompass the significant impacts to the public. Samples measured at varying distances from emissions sources show that the concentration of radionuclides decreases with the distance from the source.

Waste Management – *Commentors were concerned about the large quantities of wastes projected in the SWEIS, particularly for the Expanded Operations Alternative. Commentors questioned the continued generation of waste, particularly when significant legacy waste remains onsite and remediation work is incomplete; where the ultimate disposition of the waste would occur; and the impacts associated with waste storage and disposal, including the impacts from potential accidents. Commentors also questioned the continued practice of onsite disposal of low-level radioactive waste in unlined trenches, citing its impacts on water resources and a general opposition to onsite disposal.*

Although LANL has instituted a pollution prevention and waste minimization program, operation of LANL in support of DOE's core missions will generate radioactive and other wastes. NNSA will continue to manage waste in a manner that minimizes environmental and human health impacts and complies with regulatory requirements and DOE policies and procedures. Mixed low-level radioactive waste and solid and chemical wastes will be shipped to offsite treatment or disposal facilities. Disposal capacity is adequate for these wastes. Low-level radioactive waste may be disposed of onsite or at offsite commercial or DOE disposal facilities, while transuranic waste will be disposed of at the Waste Isolation Pilot Plant (WIPP). Increased pit production, as analyzed in the Expanded Operations Alternative, would not result in a significant increase in the volume of waste. The primary contribution to the large increase in waste volume under this alternative would be from environmental remediation involving complete removal of buried wastes located in MDAs and other contaminated media. In this case, the transuranic waste volume projected from the postulated removal of all MDAs could increase the volume beyond that assumed to come from LANL in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE/EIS-0026-S-2). Decisions about disposal of this transuranic waste, if generated, would be made within the context of the needs of the entire DOE complex. Regarding the use of unlined pits, future use of lined pits rather than unlined pits for low-level radioactive waste disposal at LANL is being evaluated as part of the required review and update of the Area G performance assessment.

Some wastes would be managed at LANL that cannot be accepted at WIPP or other currently operating and authorized disposal facilities, including commercial sealed sources containing radionuclides in concentrations exceeding the Class C limits in 10 CFR Part 61 and DOE sealed sources containing non-defense transuranic isotopes with similar characteristics. These wastes would be safely stored until they can be disposed of pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). DOE has issued an NOI to prepare an *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste* (72 FR 40135). Several options for disposal of this waste and other DOE waste having similar characteristics are being considered, including disposal at LANL.

***Water Use** – Commentors expressed concerns that implementation of the Expanded Operations Alternative would require the use of too much water and could exceed available water rights.*

Total and consumptive water use at LANL have actually decreased since 1999, in part due to water conservation efforts. DOE transferred 70 percent of its water rights for LANL, and leases the remaining 30 percent, to Los Alamos County. DOE is now a county water customer, and is billed and pays for the water it uses in accordance with a water service contract. LANL operational water demands would remain within DOE's water use target ceiling quantity. Water demands at LANL combined with the larger and growing demands of other Los Alamos County users could require up to 98 percent of the currently available water rights.

***Consent Order and Environmental Restoration** – Noting that activities to implement the March 2005 Compliance Order on Consent (Consent Order) were included only in the Expanded Operations Alternative, commentors were concerned that NNSA considered compliance with the Consent Order optional. Commentors doubted that cleanup was being addressed and thought that cleanup should be completed before NNSA contemplated increased pit production or generated additional waste at LANL.*

NNSA does not consider compliance with the Consent Order to be optional and is not linking Consent Order compliance with decisions about pit production, proposed new projects or activities, other increased operational levels, or waste generated from other LANL activities. NNSA could choose to implement the alternatives analyzed in the SWEIS either in whole, in part, or in combinations. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS. The SWEIS summarizes the progress made in environmental restoration since 1999 and analyzes options related to future cleanup actions that could be undertaken.

Depleted Uranium and the Dual Axis Radiographic Hydrodynamic Test Facility – *Commentors expressed concern about open burning of uranium and the effects this would have on air, water, soil, and human health. Some commentors mentioned that large amounts of depleted uranium have been used in the past and might remain in the environment, and that a more comprehensive monitoring program to monitor open burning and detonation sites is needed. Others questioned the use of foam and its effect on emissions.*

There are no experiments or activities at LANL that would involve the burning of depleted uranium. High explosives and explosives-contaminated materials (not including depleted uranium) are burned or detonated in accordance with a Resource Conservation and Recovery Act (RCRA) permit as a hazardous waste treatment to render the materials safe for disposal. The State of New Mexico open burning permits that would allow a variety of experiments and testing have been withdrawn. Experiments at the Dual Axis Radiographic Hydrodynamic Test Facility are subject to specific monitoring requirements. Sampling is performed to better understand the levels of contamination at the firing sites, the success of decontamination efforts, and the success of mitigation techniques that are applied to specific experiments. LANL monitoring programs are regularly reviewed and adjusted to take into account the latest trends in results. Past emission levels analyzed through the existing LANL monitoring programs and those projected in the SWEIS would not be expected to cause adverse impacts on human health or the environment. The use of aqueous foam was implemented at the Dual Axis Radiographic Hydrodynamic Test Facility to reduce the amount of particulates released. The use of foam is estimated to reduce fine particulates by 50 to 95 percent depending on the individual shot. The foam breaks down and is rinsed to a sump from which it is pumped and sent to the Radioactive Liquid Waste Treatment Facility for treatment. This additional, nonhazardous waste was included in the waste analysis in the SWEIS.

Environmental Justice – *Commentors expressed concerns about the adequacy of the Environmental Justice analysis in the SWEIS, indicating that it does not meet the requirements of Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. They also were concerned that environmental justice was not properly addressed in cumulative impacts and that the special pathways were not adequately analyzed. Some commentors took exception to statements in the SWEIS that there are no disproportionately high and adverse impacts to low-income and minority populations.*

NNSA acknowledges that different approaches can be used to assess the environmental justice impacts from continuing to operate LANL. NNSA has met the objectives of Executive Order 12898 to investigate environmental justice impacts that would be potentially high and adverse and would disproportionately affect one group over another. In response to comments on the Draft LANL SWEIS, NNSA added additional discussion to address the potential for environmental justice cumulative impacts. An analysis of the radiological doses from emissions associated with normal operations at LANL to minority and low-income populations and individuals was added to the Environmental Justice impacts section of the SWEIS. Under all of the alternatives the doses to members of minority populations or low-income populations were slightly less than for the members of the population that do not belong to these groups. NNSA looked at potential exposure through special pathways as part of the human health impacts analysis in the SWEIS. The special pathways analysis considers ingestion of native vegetation (pinyon nuts and Indian Tea [Cota]), locally grown produce and farm products, groundwater, surface water, fish (game and nongame), game animals, other foodstuffs and incidental consumption of soils and sediments (on produce, in surface water, and ingestion of inhaled dust); adsorption of contaminants in sediments through the skin; and inhalation of plant materials. Even considering these special pathways, NNSA did not find disproportionately high and adverse health impacts to minority or low-income populations. While NNSA recognizes commentors' objections to the conclusions that the analysis in the SWEIS has not identified any disproportionately high and adverse human health or environmental impacts on minority or low-income populations under any of the actions or alternatives analyzed in the SWEIS, NNSA believes this is the correct conclusion. The SWEIS has been revised to include more detailed discussion of the environmental justice analysis.

Comparison to Rocky Flats Plant – *Commentors oppose continued or expanded levels of pit production and associated activities at LANL, concerned that these activities would result in health and safety problems. Commentors cited past performance at the Rocky Flats Plant as being indicative of NNSA's continued and future operations, inferring that similar activities at LANL would result in similar environmental contamination and human health effects.*

A number of factors including much lower pit production levels, a heightened awareness of safety and environmental issues, newer facilities and technologies, more stringent environmental and nuclear safety regulations, a higher level of scrutiny by regulators and independent oversight organizations, and more controlled operational and management practices support the conclusion that LANL operations are not comparable to operations at the Rocky Flats Plant. The Rocky Flats Plant produced thousands of pits per year until it ceased operation in 1989. Under the SWEIS Expanded Operations Alternative, LANL would produce a maximum of 80 pits per year.

The Plutonium Facility in TA-55 is a newer facility than those at the Rocky Flats Plant. The Plutonium Facility has increased safety margins, stronger structural components, firebreaks and automatic fire suppression systems, and more automatic alarms and process controls. Specifically with respect to filtration of process emissions and the problems with the Rocky Flats design, the Plutonium Facility has implemented structural designs for fire containments, multiple stages of high-efficiency particulate air (HEPA) filtration, and firebreaks to prevent, isolate, and confine potential fires from spreading through air filtration systems, thus minimizing potential releases to the environment. Additional upgrades, repairs, and replacements of equipment and components are proposed under the TA-55 Refurbishment Project as part of the SWEIS Expanded Operations Alternative to ensure the facility safety envelope is maintained as the facility and its systems and components age.

Recommendations of the Defense Nuclear Facilities Safety Board (DNFSB) – *Commentors expressed their opinion that LANL is not in compliance with DOE and DNFSB safety regulations and recommendations; some commentors claimed that some LANL facilities are up to 6 years behind on preparing and submitting their safety documentation to DOE; and certain commentors stated that such lack of compliance poses an unacceptable risk to workers, the public and the environment. Commentors stated that the Draft SWEIS should fully incorporate, analyze, consider, and resolve the serious safety issues raised by the DNFSB.*

The DNFSB was created by the Congress in 1988 as an independent oversight organization within the Executive Branch to provide advice and recommendations to the Secretary of Energy regarding protection of public health and safety at defense nuclear facilities. As such, the DNFSB independently oversees activities affecting nuclear safety within the nuclear weapons complex. DNFSB reviews safety issues and formally reports its findings and recommendations to the highest levels of NNSA regarding the safety of nuclear weapons complex facilities. Procedures are in place for NNSA to review and respond to DNFSB recommendations, and to implement recommendations at the sites as appropriate. NNSA and the LANL contractor have reviewed DNFSB reports and responded with commitments to update and improve safety basis documentation. The Los Alamos Site Office Safety Authorization Basis Team assures the development and approval of adequate controls to support operations at LANL in a safe manner. LANL nuclear facility operations are authorized and approved by NNSA based on its evaluation of the acceptability of existing relevant safety documentation.

The environmental impacts of potential accident scenarios, including accidents caused by human error during the performance of high hazard operations, as well as from other types of initiating events, are analyzed in the SWEIS. Safe operation is an intrinsic part of the activities proposed and analyzed in the SWEIS. Nonetheless, NNSA identifies possible operational accidents, natural events, or intentional destructive acts and analyzes their impacts as part of the NEPA process so that this information is available to NNSA in deciding whether to proceed with a proposed action. NNSA has recently revised its oversight practices relative to LANL to increase the focus of its resources on nuclear safety and security.

Plutonium Inventory Discrepancies – *During the scoping process and again during the review of the Draft LANL SWEIS, commentors contended that there were historical differences in plutonium inventories, leading to the conclusion that there was a loss of control of the plutonium materials and that inventory systems were inaccurate.*

The issue of historical differences in the plutonium inventories has been raised previously. DOE addressed this issue in a 1996 report that notes there are differences in the quantity of plutonium according to the accounting books and the quantity measured by a physical inventory.[4] The report explains that inventory differences are primarily due to various measurement uncertainties

[4] *In 1996 DOE issued the report Plutonium: The First 50 Years. This report notes that there are differences in the quantity of plutonium according to the accounting books and the quantity measured by a physical inventory. It explains that "inventory differences are not explained as losses but are explained as follows: (1) high measurement uncertainty of plant holdup (plutonium materials remaining in process tanks, piping, drains, ventilation ducts, and other locations); (2) measurement uncertainties because of the wide variations of material matrix; (3) measurement uncertainties due to statistical variations in the measurement; (4) lack of measurement technology to accurately measure material; (5) measurement uncertainties associated with waste due to material concentration and matrix factors; (6) unmeasured material associated with accidental spills; and (7) recording, reporting, and rounding errors."*

(DOE 1996). More recently, NNSA addressed allegations of plutonium discrepancies at LANL. The letter responding to this issue states that "the apparent discrepancy is related to the different tracking and reporting procedures for site security and waste management organizations." The letter concludes that "because of the differences between the tracking and reporting of the site security and waste management organizations, comparisons of the information contained in these two systems cannot be used to draw conclusions concerning the control and accountability of special nuclear material" (NNSA 2006a).

S.6.3 Changes from the Draft Environmental Impact Statement

In preparing the Final LANL SWEIS, NNSA made revisions in response to comments received from other federal agencies, state and local government entities, Native American Pueblos, and the public. In addition, the SWEIS was changed to provide additional environmental baseline information, include additional analyses, correct inaccuracies and make editorial corrections, and clarify text. NNSA also updated information due to events or notifications made in other documents since the Draft SWEIS was provided for public comment in July 2006. The following summarizes the more important changes made to the SWEIS.

Incorporation of the Updated Environmental and Other Information

Information was updated in the Final SWEIS to reflect the most recent environmental data from *Environmental Surveillance at Los Alamos during 2005* (LANL 2006d) and information from the 2005 *SWEIS Yearbook* (LANL 2006c). Resource areas most affected include air emissions and water discharges, human health, infrastructure (including electrical and water usage), and waste management. Other new information incorporated into the SWEIS analyses include a biological assessment; an updated seismic hazard analysis, and new New Mexico Environment Department stream water quality standards.

The SWEIS was revised to more clearly indicate the purpose and use of the environmental contamination data included and how they relate to the information reported in annual environmental surveillance reports. The data provide perspective relative to similar data presented in the *1999 SWEIS* and in SWEIS impacts analyses. Affirmed detection of contaminants in the environment is presented in the LANL environmental surveillance reports. In addition, the SWEIS was updated to discuss the monitoring results for nonradiological chemicals that are part of the LANL environmental surveillance program. Information on nonradiological contaminants for the period of 2001 through 2005 has been provided for hexavalent chromium, 1,4-dioxane, and PCBs. In addition, the perchlorate environmental surveillance information was updated to include the results from the most recent year of reporting.

The SWEIS was updated to include 2005 water use data in the trend analysis. The projected demand on available water rights administered by Los Alamos County decreased from 101 percent to 98 percent, leading to the conclusion in the Final SWEIS that the water rights would not be exceeded if the Expanded Operations Alternative were implemented.

Presentation of Impacts from Consent Order Activities

The summary of impacts has been revised to more readily show the impacts associated with activities necessary to comply with the Consent Order. Under the Expanded Operations Alternative, in addition to showing the impacts for the entire alternative, where practical, the impacts from implementing the Consent Order have been shown separately and could be added to any alternative; the impacts for the balance of the Expanded Operations Alternative are also shown. This presentation of the impacts makes it possible for a reader to see how alternatives compare without the influence of Consent Order activities and reinforces the idea that NNSA can select all or part of the Expanded Operations Alternative; however, NNSA does not consider compliance with the Consent Order to be optional.

Environmental Justice

The Environmental Justice analyses were expanded to include radiological doses from LANL operations for the following populations within 50 miles (80 kilometers) of LANL: white (non-Hispanic), all (total) minorities, American Indians, Hispanic of any race, and low-income populations. These data show that the total minority, American Indian, Hispanic, and low-income populations would not be subjected to disproportionately high and adverse dose impacts from operations at LANL.

Removal of References to a Modern Pit Facility

References to a modern pit facility in the Draft LANL SWEIS were made in the context of ensuring that reasonably foreseeable future actions were addressed in accordance with the CEQ NEPA regulations regarding cumulative impacts. In October 2006, NNSA issued an NOI to prepare the *Complex Transformation SPEIS*. In addition to announcing its intent to prepare an assessment of the environmental impacts from the continued transformation of the nuclear weapons complex, NNSA announced cancellation of the previously planned *Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (DOE/EIS-236-S2). Therefore, the Final LANL SWEIS does not include a modern pit facility in the discussion of cumulative impacts.

Accident Analyses

The accident analysis has been revised to account for 2006 updates to accident scenarios for certain nuclear facilities that resulted in higher consequences and risks than the previous scenarios. Revising the accident analysis also addressed a comment received regarding an accident scenario involving a fire in the Plutonium Facility Complex. The new accident scenarios were for the Radioassay and Nondestructive Testing Facility, the Waste Characterization, Reduction, and Repackaging Facility, and the Plutonium Facility Complex. The new accident scenarios included one scenario for each of the individual facilities, two scenarios involving the Waste Characterization, Reduction, and Repackaging Facility and the Plutonium Facility Complex during a seismic event, and one scenario involving the Waste Characterization, Reduction, and Repackaging Facility in the event of a wildfire.

The discussion of the site-wide seismic accidents was revised to account for new information from the updated seismic hazard analysis (LANL 2007). The new study indicates that the seismic hazard is higher than previously understood; that is, the likelihood of earthquakes capable of producing strong ground shaking at the LANL site is greater than previously estimated. This would result in changes to the maximum risks of a latent cancer fatality (LCF) for the maximally exposed individual (MEI), the noninvolved worker, and the offsite population under the two seismic accidents.

Terrorism

The SWEIS has been revised to more fully address the issue of terrorism. A description of the safeguards and security that are in place at LANL to protect facilities and special nuclear materials from malevolent acts has been expanded. It also has been revised to include a discussion of the process of assessing vulnerabilities of facilities to hostile acts. These vulnerability assessments guide the enhancement of safeguards and security at the site. A classified appendix to the SWEIS assesses the potential impacts of terrorist acts.

Transportation Analysis

The transportation analysis was revised to address three specific areas. Responding to comments expressing concerns regarding increased pit production, the SWEIS transportation analysis was revised to provide a clearer distinction between the shipment requirements for production rates of 20 and 80 pits per year. In addition, the impact analysis was revised to bound the impacts of transporting uranium-233 between Oak Ridge National Laboratory and LANL and between LANL and the Nevada Test Site in support of the criticality safety program. A unit basis transportation impacts assessment was also included to provide a basis for assessing impacts of the future transport of sealed sources to LANL in support of the Off-Site Source Recovery Project.

Alternatives for Upgrading the Radiography Facility

The project-specific analysis for providing a radiography facility in TA-55 has been revised to remove any options that considered use of all or part of the previous Nuclear Materials Storage Facility (Building 55-41). Based on evaluations of the structure of Building 55-41, a determination was made that extensive and costly structural upgrades to the building to bring it into compliance with requirements for managing special nuclear material would be needed – roof panel members would need to be replaced and other structural components would need to be repaired, replaced, or reconfigured. This structure was never used for storage of nuclear materials and a determination was made in 2006 to demolish the structure. As an uncontaminated structure, the resulting demolition debris could be reused as fill or sent to a solid waste landfill.

Location of the Proposed TRU Waste Facility

The impacts analysis included for Waste Management Facilities Transition has been revised with respect to the TRU Waste Facility. The function of the facility would primarily be to support operations at the Plutonium Facility Complex, including managing transuranic waste from the Radioactive Liquid Waste Treatment Facility. Therefore, a number of locations along the west end of the Pajarito Road corridor near the waste-producing facilities are being considered. The analysis has been revised to evaluate the impacts of a range of locations in the TAs along Pajarito

Road. For certain resource areas, such as human health impacts, release from normal operations and facility accident impacts, analyses account for the largest impacts that would be expected. For other impacts that would be more site specific such as land use, visual impacts, and effects on cultural resources and ecology, the analyses distinguish among the group of TAs being considered.

Revision of the Reduced Operations Alternative

The Reduced Operations Alternative and impacts analysis were revised to include a possible reduction in scope of the Chemistry and Metallurgy Research Replacement Facility as described in the *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0350) and NNSA's subsequent 2004 ROD (69 FR 6967). The Chemistry and Metallurgy Research Replacement Facility would be limited to the construction and operation of the radiological laboratory, administrative offices, and support facility building. The decision whether to construct the nuclear facility portion will be postponed until completion of the *Complex Transformation SPEIS*. Under this scenario the existing Chemistry and Metallurgy Research Building would continue to operate beyond 2010 to provide analytical chemistry and materials characterization research and development activities.

S.7 Changes at Los Alamos National Laboratory since the *1999 SWEIS*

For the most part, operations at LANL remained within the projections made in the *1999 SWEIS*. Operations that exceeded projections produced a beneficial or neutral impact on northern New Mexico. For example, a larger number of employees than projected increased the tax base and resulted in a higher level of economic activity. Although the amount of chemical waste generation was higher, thereby increasing the amount of offsite transportation, it was managed without adverse impact to the LANL waste management infrastructure, and the waste was treated and disposed of in accordance with applicable regulations. Overall, data on operations during the period 1999 through 2005 indicate that LANL was still approaching the operation levels of the Expanded Operations Alternative in the *1999 SWEIS*, as modified for a lower level of pit production.

Table S–3 presents a summary of the actual impacts and performance changes by resource or impact area from 1999 through 2005 compared to the projected impacts for the modified Expanded Operations Alternative in the *1999 SWEIS*. The first column lists the resource or environmental impact areas. For each resource or impact area, the next column provides a summary description of the projected impact for the Expanded Operations Alternative as presented in the *1999 SWEIS*. The third column summarizes the actual impacts for the years 1999 through 2005 as reported in the LANL *SWEIS Yearbooks*. The final column presents an assessment of performance at the site compared to the projected performance in the *1999 SWEIS*. This comparison shows that, in general, LANL operated within the bounds projected in the *1999 SWEIS*.

Table S–3 Summary Comparison of *1999 SWEIS* [a] Projected Impacts and Actual Changes and Performance (1999 through 2005)

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Land Resources	LANL covered 43 square miles (111 square kilometers), with about 5 percent of the site developed. It was divided into 6 land use categories and contained 944 permanent buildings, 512 temporary structures, and 806 miscellaneous buildings. Changes to land use included TA-67, where 60 acres (24 hectares) of forested land would be cleared for a road and the land use category changed from "Explosives" to "Explosives and Waste Disposal." Area G expansion was estimated to disturb 41 acres (16.6 hectares) of approximately 72 acres designated for waste disposal. The *1999 SWEIS* predicted limited land disturbance (about 100 acres [40 hectares] of previously undisturbed land) from new construction.	LANL now covers 40 square miles (104 square kilometers). Land use categories have increased from 6 to 10. The number of structures, which change often, now includes 952 permanent buildings, 373 temporary structures, and 897 miscellaneous buildings. Major projects have occupied more land than predicted. Forty-four acres (18 hectares) were leased to Los Alamos County for a research park. Environmental restoration activities have not substantially added to available land. About 4,078 acres (1,650 hectares) have been designated for conveyance to Los Alamos County and the New Mexico Department of Transportation, and transfer to the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso), of which 2,259 acres (914 hectares) have been turned over (as of the end of 2006), including all lands to be transferred to the Department of the Interior (in trust for the Pueblo of San Ildefonso). In 2000, the Cerro Grande Fire burned 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) at LANL. Direct impacts on land use included damage to or loss of 332 structures. Fire mitigation work, such as flood retention structures, affected about 50 acres (20 hectares) of undeveloped land.	Land use changes were slightly greater than those projected in the *1999 SWEIS*. Actions undertaken at LANL that were either not addressed or predicted in the *1999 SWEIS* include the conveyance of land to Los Alamos County and the New Mexico Department of Transportation, and the transfer of land to the Pueblo of San Ildefonso; and several projects that could disturb up to 245 more acres (99 hectares) of greenfield sites than predicted in the *1999 SWEIS*. These actions, however, were addressed in separate NEPA review documents. Land use changes related to the number of buildings at LANL were within the range of impacts evaluated within the *1999 SWEIS*.
Visual Resources	LANL is primarily distinguishable in the daytime by views of its water storage towers, emission stacks, and occasional glimpses of older buildings. At elevations above LANL, the view is primarily of scattered austere buildings and groupings of several-storied buildings. LANL has relatively few nighttime security light sources compared to the nearby communities; the distinction between LANL and the nearby communities is lost to the casual observer.	In many cases, new construction has reduced visually incompatible building styles and allowed for the removal of some of the more austere buildings. One new building has been built at the Los Alamos Research Park. Radio towers have been erected, but have been painted to blend with the background. The water tower at the new Emergency Operations Center has also been painted to blend with the background. Two domes have been added at TA-54, which contrast with the natural landscape and can be seen from the Pueblo of San Ildefonso sacred area, the Nambe-Española area, and areas in western and southern Santa Fe County.	Visual impacts resulting from continuing operations at LANL slightly exceeded those projected in the *1999 SWEIS*. Actions undertaken at LANL that either were not fully addressed or occurred since the *1999 SWEIS* was published include the construction of domes at TA-54, construction of new facilities (especially those that extend above the tree line), and forest thinning. Activities associated with each of these areas were addressed in separate NEPA actions.

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
	Projected temporary and minor impacts included changes resulting from construction and environmental restoration activities.	The Cerro Grande Fire altered views and made site facilities more visible. Since 2000, wildfire prevention activities, such as forest thinning, have reduced tree density on 7,700 acres (3,110 hectares) resulting in a more open, park-like forest, increasing the visibility of some facilities. Bark beetles have killed thousands of evergreen trees, opening the forest and making LANL facilities more visible.	The Cerro Grande Fire and bark beetle infestation altered the viewscape beyond that analyzed in the *1999 SWEIS* or other subsequent NEPA review documents.
Geology and Soils			
- Geology	The *1999 SWEIS* identified major seismic features at LANL. Some sections of faults at LANL constitute active and capable faults under the Nuclear Regulatory Commission nuclear facility criteria. Surface rupture from faulting in TA-3 was identified and concern regarding seismic risk to the Chemistry and Metallurgy Research Building was identified.	LANL operations have not affected seismicity concerns. Most construction was conducted at a distance from mapped faults and injection wells were not operated. Based on the seismic risk at TA-3 identified in the *1999 SWEIS*, LANL decided to move the Chemistry and Metallurgy Research Building operations to TA-55, an area of no observed seismic faulting.	Impacts at LANL were within those projected in the *1999 SWEIS*.
- Soils	The *1999 SWEIS* identified canyon walls as areas of potential slope instability and indicated that disturbed or unvegetated soils have a greater potential for erosion. Small quantities of contaminants from facility operations would impact LANL soils, and that contaminated soil would be excavated from LANL.	LANL operations have not substantially affected slope instability or soil erosion. Construction activities were set back from canyon walls, and although localized erosion due to disturbed soils occurred at construction sites, it was mitigated by standard construction best management practices such as silt fences and flow barriers. The Cerro Grande Fire increased soil erosion at LANL. Releases from facility operations causing soil contamination have been below *1999 SWEIS* projections due to improvements in facility operating procedures.	Impacts were fewer than those projected in the *1999 SWEIS*, in part due to the removal of contaminated soils through environmental restoration activities and continued use of engineering controls at construction sites. While the Cerro Grande Fire increased soil erosion, the overall effects were mitigated through various actions such that *1999 SWEIS* projections were not exceeded.
Surface Water			
- NPDES Outfall Volumes	Total of 61 NPDES-permitted outfalls. Total projected discharge volumes through permitted outfalls: • 278 million gallons per year (1,052 million liters per year). • 136 million gallons per year (515 million liters) from Key Facilities. • 142 million gallons (538 million liters) per year from non-Key Facilities.	NPDES-permitted outfalls decreased to 21 – including 20 industrial outfalls and 1 sanitary outfall. The total flow from all NPDES outfalls was below *1999 SWEIS* projections for 6 of 7 years; in 1999, the flow exceeded *1999 SWEIS* projections by 14 percent. Key facilities: Combined volumes have been less than *1999 SWEIS* projections; however, discharges from four Key Facilities exceeded their individual 1999 projections. • Tritium Facilities: discharges exceeded annual projections each year, ranging from 0.4 to 33 million gallons per year (1.5 to 125 million liters per year), compared to *1999 SWEIS* projection of 0.3 million gallons (1.1 million liters) per year.	The number of NPDES outfalls was within the *1999 SWEIS* projections. The number of permitted NPDES outfalls and the total flow were consistent with or below *1999 SWEIS* projections. The distribution of flow from individual Key and non-Key Facilities, however, has changed from that projected in the *1999 SWEIS*. Although there appears to be a decrease in total flow from NPDES outfalls, it is largely due to a change in how flow is measured and reported. The current method adopted in 2001 uses actual flow meters in many (but not all)

Resource or Impact Area	***1999 SWEIS Projected Impacts***	***Actual Impacts and Performance Changes (1999 to 2005)***	***Assessment***
		• Chemistry and Metallurgy Research Building discharges exceeded projections 6 of 7 years, ranging from 0.02 to 4.5 million gallons (0.08 to 17 million liters) per year, compared to *1999 SWEIS* projection of 0.5 million gallons (1.9 million liters) per year. • High Explosives Testing Facilities discharges exceeded projections 3 years, ranging from 9 to 16.1 million gallons (34 to 61 million liters) per year in 1999 through 2001, compared to *1999 SWEIS* projection of 3.6 million gallons (14 million liters) per year. • Sigma Complex discharges exceeded projections in 2003 with 7.6 million gallons (29 million liters) compared to the *1999 SWEIS* projection of 7.3 million gallons (28 million liters) per year. Non-Key Facilities: Total flow exceeded *1999 SWEIS* projections 3 out of 7 years, in part due to extrapolation from instantaneous flow measurements.	outfalls and measuring stations, providing more accurate information.
- NPDES Outfall Quality	The implied measure of performance is compliance with NPDES permit levels, the New Mexico Water Quality Control Commission stream standards, and DOE Derived Concentration Guides for radionuclides. As described in the *1999 SWEIS*, RLWTF would be modified and the High Explosives Waste Treatment Facility would be constructed to improve effluent quality.	NPDES effluent quality met permitted levels for 99.75 percent of samples since 2000; number of events where permit levels were exceeded ranged from 0 to 14 (of about 1,100 samples) per year. Exceedances resulted in preparation and implementation of corrective action plans. RLWTF has improved the quality of effluent, reducing annual levels of nitrates and radionuclides. Since 1999, radionuclides activities have been well below the Derived Concentration Guides levels, and nitrates and fluorides concentrations were well below the standards. Volumes of effluent discharged from the High Explosives Wastewater Treatment Facility outfall have been below *1999 SWEIS* projections since 1999.	Surface water quality impacts are consistent with or less than those projected in the *1999 SWEIS*. Overall quality and volume of effluents were within the levels projected in the *1999 SWEIS*.
- Water Quality Impacts from Stormwater and Construction Sources	Water quality was projected to be similar or better than recent experience. The following LANL operations were identified in the *1999 SWEIS* as impacting surface water quality: • Stormwater discharges from industrial activities, with 76 industrial facilities identified on LANL site. • Construction activities disturbing greater than 5 acres (2 hectares). • Excavation or dredge and fill activities, which are permitted by the Corps of Engineers and the New Mexico Environment Department (Section 404 and 401 permits).	LANL still requires Stormwater Pollution Prevention Plans and best management practices to protect surface waters from pollutants from industrial stormwater sources and construction projects. The number of industrial activities requiring individual Stormwater Pollution Prevention Plans has ranged from 15 to 22. Stormwater Pollution Prevention Plans and best management practices are now required for all projects disturbing greater than 1 acre (0.4 hectares) of land. An increase in construction projects and dredge and fill projects was seen following the Cerro Grande Fire; however, each project was required to implement Stormwater Pollution Prevention Plans and meet 404 and 401 permit conditions to protect surface waters.	Impacts from storm flows and construction or excavation projects were within *1999 SWEIS* projections.

Resource or Impact Area	***1999 SWEIS Projected Impacts***	***Actual Impacts and Performance Changes (1999 to 2005)***	***Assessment***
- Contaminant Transport	Small increases in outfall flows to watersheds were not expected to result in substantial contaminant transport offsite. Outfall discharge volumes per watershed were projected. Storm flow and sediment transport were identified as primary mechanisms for potential contaminant transport beyond LANL boundaries. The *1999 SWEIS* discussed watershed monitoring activities to track the extent of offsite contaminant movement in sediments and surface waters, including monitoring for radionuclides, metals, organics, PCBs, and high explosives residue.	Several actions and best management practices were implemented to manage, control, and minimize stormwater and sediment transport. On average, outflows to individual watersheds have been within projections, and trends show that outfall flows per watershed have been declining, thereby reducing the potential for contaminant transport. The number of watersheds receiving outfall flow has been reduced from 8 to 5. The annual flow discharged to the individual watersheds exceeded *1999 SWEIS* projections 5 times from 1999 to 2000 and 1 time since 2000. While radionuclides at or above background levels have been detected in sediments on- and offsite, the overall pattern of radioactivity in sediments has not greatly changed since the *1999 SWEIS*. Concentrations of metals, radionuclides, PCBs, and high explosives residue above water quality standards have been detected during storm flows; however, these events are infrequent and short-lived. As a direct result of the Cerro Grande Fire, stormwater runoff increased (2 to 4 times for average flow, and 10 to 1,000 times for peak flows), increasing the potential for contaminant transport. Storm events in 2001 and 2002 were found to accelerate the transport of legacy contamination (radionuclides) from Pueblo Canyon into lower watersheds and canyons.	Contaminant transport impacts were consistent with the *1999 SWEIS*, due to LANL programs and best management practices that manage and control storm flow and sediment transport. Increased or accelerated transport of contaminants that occurred from postfire storm flows are considered to be short-lived events that are being controlled and will diminish within the next few years.
Groundwater			
- Water Use	The projected effect of water use over the next 10 years (extracted from the main aquifer) is an average drop in DOE well fields of up to 15 feet (4.6 meters).	The drop in the Los Alamos County (previously DOE) well fields has continued to be 1 to 2 feet (0.3 to 0.6 meters) per year, per the *Water Supply at Los Alamos 1998 – 2001* report (LANL 2003).	Impacts of LANL water use on the regional aquifer continue to be bounded by the impacts analyzed in the *1999 SWEIS*.
- Quantity	No substantial changes to groundwater quantities were expected based on recent experience with LANL discharges that had little effect on groundwater quantities.	LANL discharges have had little effect on groundwater quantities in the last 6 years.	Impacts of LANL discharges on groundwater quantities continue to be bounded by the impacts analyzed in the *1999 SWEIS*.
- Quality	Because mechanisms for recharge to groundwater are highly uncertain, it is possible that discharges under any of the alternatives in the *1999 SWEIS* could result in contaminant transport in groundwater and off the site.	Regional groundwater samples taken in 2005 and 2006 show the presence of hexavalent chromium. Other contaminants detected included perchlorate in all groundwater zones in Mortandad Canyon, in the regional aquifer in Pueblo Canyon, and in alluvial groundwater in Cañon de Valle; and 1,4-dioxane in perched groundwater in Mortandad Canyon.	Hexavalent chromium has not been detected in offsite regional groundwater or in water supply wells. Production well Otowi-1 in Pueblo Canyon was taken permanently off-line because it had one tenth of the risk level of 24.5 micrograms per liter of perchlorate. There is no Federal or State standard for 1,4-dioxane.

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Air Quality			
- Nonradiological Criteria Pollutants	Ambient standards would be met. Annual emissions of criteria pollutants (tons per year): CO = 58 NO_x = 201 PM = 11 SO_2 = 0.98	Ambient standards have been met. Annual emissions for highest year, excluding years of the Cerro Grande Fire and fire mitigation activities (tons per year): CO = 35 NO_x = 93.8 PM = 5.5 SO_2 = 1.9	Annual emissions of criteria pollutants from LANL operations reported in the *Annual Emissions Inventories Through 2005* were within *1999 SWEIS* projections. As of 2004, revised reporting methods for the Title V Operating Permit Emissions Report include small exempt boilers and stand-by emergency generators in the emissions calculations; their inclusion results in SO_2 emissions higher than projected in the *1999 SWEIS*. Cerro Grande Fire and fire mitigation activities caused a temporary increase in CO, PM_{10} and SO_2 emissions above the levels analyzed in the *1999 SWEIS*.
- Other Nonradiological Pollutants	A screening analysis of toxic and hazardous pollutants indicated that levels of potential consequence to the public would not be exceeded for most air pollutants. Further detailed analysis demonstrated that concentrations of other pollutants would be below guideline values. For carcinogens, the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs was estimated. Major contributors to the combined cancer risk values included chloroform, formaldehyde, and trichloroethylene from TA-43 (Bioscience Facilities). The cancer risk to the public of less than 7.4×10^{-7} was dominated by the contribution from chloroform. Although annual emissions of chemical pollutants were not reported in detail for all facilities, the details presented for TA-3, for example, indicate emissions of 153 toxic pollutants. The *1999 SWEIS* did not address toxic and hazardous emissions from combustion sources.	Reported toxic and hazardous pollutant emissions generally have been less than guideline values. Carcinogenic emissions generally have been less than the *1999 SWEIS* projections. Chloroform emissions were less than 30 percent of the *1999 SWEIS* projections. TA-3 peak emissions data show that 21 additional pollutants were emitted and emissions of 39 pollutants exceeded *1999 SWEIS* projections. Seventy-five pollutants were not emitted that were projected.	The amounts of chemicals used and the amounts emitted to the air continue to show considerable variation. Although the actual quantities and chemicals vary from those analyzed in the *1999 SWEIS*, the concentrations to which the public is exposed continue to be below levels of potential consequence.

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
- Nonradiological Construction Activities	Air quality impacts of construction activities were not quantified in the *1999 SWEIS*. The *1999 SWEIS*, however, indicated that construction activities were planned in various areas and would include land disturbance. These activities would result in emissions from disturbed areas and from equipment.	Construction of new facilities, demolition, and remediation activities have resulted in short-term increases in air pollutant concentrations. These activities were mitigated as appropriate to prevent exceedance of the ambient standards.	Construction at LANL is an ongoing activity with temporary and localized air quality impacts.
- Radiological	*Annual Average (curies per year)* *Actinides* 0.000798 *Fission Products* 0.00014 *Activation Products* 16,000 *Tritium (water vapor)* 1,260 *Tritium (gas)* 1,920 *Argon-41* 870 *Other Noble Gases* 1,640 *Uranium* 0.152	*Annual Average (curies per year)* / *Peak Year (curies)* *Actinides*: 0.0000113 / 0.0000302 *Fission Products*: Not reported / Not reported *Activation Products*: 5,070 / 18,900 *Tritium (water vapor)*: 815 / 1,200 *Tritium (gas)*: 1,770 / 8,740 *Argon-41*: 22.7 / 49.8 *Other Noble Gases*: Not detected / Not detected *Uranium*: 0.00836 / 0.02	Annual average air emissions continue to be below levels projected in the *1999 SWEIS*. The exceptions for peak years were due to deactivation activities at TA-21 and a single event at the Weapons Engineering Tritium Facility (TA-16) for tritium and the hours of operation and a failed valve at LANSCE for activation products.
Noise	There would be little change in noise impacts to the public from traffic or site activities, although sudden loud noises associated with explosives testing may occasionally startle members of the public and workers. There would be some increase in the frequency of impulsive noise, but these noises would be occasional and not prolonged or unusual to the community.	Construction activities at LANL are common and generally have not altered noise conditions to levels that annoy the public. The increase in workforce has not resulted in any noticeable increase in traffic noise.	Noise impacts from construction and operation were similar to those discussed in the *1999 SWEIS*.
Ecological Resources	Only 5 percent of LANL was determined to be unavailable to wildlife. There were 900 species of vascular plants and 294 species of animals in the area. There were 50 acres (20 hectares) of wetlands, 13 acres (5 hectares) of which were created or enhanced by wastewater from 38 outfalls. The site is home to 3 federally listed endangered species, 2 federally listed threatened species, 18 species of concern, and numerous state-listed species. Areas of Environmental Interest were established at LANL to protect threatened and endangered species.	In total, major projects used slightly less acreage of undeveloped land than predicted in the *1999 SWEIS*. About 5 acres (2 hectares) of the Los Alamos Research Park have been cleared, resulting in the loss of habitat. The reduction in permitted outfalls to 21 by 2003 has reduced the amount of wetlands supported by such flows. Approximately 34 acres (14 hectares) of wetlands occur at LANL. Impacts to ecological resources from land conveyance and transfer have resulted in a reduction in potential onsite habitat and the loss of DOE protection for threatened and endangered species, including areas of core and buffer zones within the Areas of Environmental Interests.	Impacts to biological resources were somewhat greater than those predicted in the *1999 SWEIS*. The *1999 SWEIS* did not account for certain events that occurred after 1999, including the land conveyance and transfer. Activities associated with each of these areas were addressed in separate NEPA documents. The Cerro Grande Fire and bark beetle infestation have altered the ecology of the site. The bark beetle infestation could impact runoff, herbaceous growth, and wildlife populations, as well as increase the potential fire hazard.

Resource or Impact Area	1999 SWEIS Projected Impacts	Actual Impacts and Performance Changes (1999 to 2005)	Assessment
	As discussed in the *1999 SWEIS*, about 100 acres (40 hectares) of undeveloped land at LANL were predicted to be disturbed by construction projects, resulting in some habitat loss. The closure of 27 outfalls was predicted to reduce wetland acreage by 8.6 acres (3.5 hectares). About 25 acres (10 hectares) of the core zone of the Areas of Environmental Interest and 38 acres (15 hectares) of buffer zone could be affected by new projects (some of which would be completed in the future).	The Cerro Grande Fire burned 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) of LANL. Direct impacts to ecological resources included a reduction in habitat and the loss of wildlife. Fire mitigation work, such as flood retention structures, affected about 50 acres (20 hectares) of undeveloped land. Additionally, between 1997 and 2004, 8,233 acres (3,332 hectares) of forest were thinned to reduce potential wildfire. Thinning has both positive and negative effects on wildlife. An infestation of bark beetles resulted in a 12 to 100 percent mortality of pine and fir trees across LANL.	Forest thinning creates a forest that appears more park-like and increases the diversity of shrubs, herbs, and grasses in the understory.
Offsite Radiological Impacts			
- Offsite Population	Affected population within 50 miles (80 kilometers) of LANL.	Population within 50 miles (80 kilometers) of LANL grew by 14 percent between 1995 and 2000.	Lower emissions than those projected in the *1999 SWEIS* resulted in lower population dose and risk.
Dose (per year)	33.09 person-rem	2.5 person-rem in peak year (2005)	
Risk (per year)	0.0165 latent cancer fatalities	0.0015 latent cancer fatalities in peak year (2005)	
- MEI	LANL site MEI located north-northeast of LANSCE.	No change in location for the LANL site MEI.	Average dose to MEI continues to be bounded by projections in the *1999 SWEIS*. Higher emissions in 2005, resulting in a higher MEI dose, were due to a failed valve at LANSCE. The peak year dose is below the 10 millirem annual public exposure limit.
Dose (per year)	5.44 millirem	6.5 millirem in peak year (2005)	
Risk (per year)	2.72×10^{-6} latent cancer fatalities	3.9×10^{-6} latent cancer fatalities in peak year (2005)	
Worker Health			
- Average Measurable Dose			Average dose to workers continues to be bounded by projections in the *1999 SWEIS*.
Dose (per year)	198 millirem	149 millirem in peak year (2000)	
Risk (per year)	7.92×10^{-5} latent cancer fatalities	8.9×10^{-5} latent cancer fatalities in peak year (2000)	
- Collective Dose			Collective dose to the worker population continues to be bounded by projections in the *1999 SWEIS*.
Dose (per year)	704 person-rem	241 person-rem in peak year (2003)	
Risk (per year)	0.281 latent cancer fatalities	0.145 latent cancer fatalities in peak year (2003)	
	Factor used to estimate risk of latent cancer fatalities per rem was 0.0004 in 1999.	Dose-to-risk factor for workers increased from 0.0004 to 0.0006 latent cancer fatalities per rem.	

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Environmental Justice	There would be no disproportionately high and adverse impacts to minority or low-income populations from LANL activities. Consultations would continue to provide opportunities for avoiding or minimizing adverse impacts to traditional cultural properties at LANL. Human health impacts associated with special pathways would not present disproportionately high and adverse impacts to minority and low-income populations.	There were no disproportionately high and adverse impacts to minority or low-income populations from LANL activities during this period. Potential impacts to sacred lands adjacent to LANL from activities at TA-54 have been of concern to the San Ildefonso Pueblo. The amount of radiological material released to the environment (curies per year) has been well within the amount projected in the *1999 SWEIS*.	Impacts have not exceeded any health, safety, and environmental regulation, standard, or guideline; nor have they been high or adverse to minority and low-income populations. Ongoing consultations with representatives of the San Ildefonso Pueblo address concerns that activities at LANL and at TA-54 could affect sacred lands. Human health impacts associated with special pathways remained below the levels projected in the *1999 SWEIS*.
Cultural Resources	Cultural resources at LANL were categorized as prehistoric, historic, and traditional cultural properties. As discussed in the *1999 SWEIS*, about 75 percent of LANL was surveyed for cultural resources. Surveys identified 1,295 prehistoric sites, 2,319 historic sites, and 54 traditional cultural properties on or near LANL. As predicted in the *1999 SWEIS*, 15 prehistoric sites associated with the expansion of Area G could be impacted. No impacts to historic sites were expected. Impacts to traditional cultural properties were not fully predictable due to the lack of information on their specific locations and nature; however, impacts could result from changes in hydrology, explosives, hazardous materials, and security measures. It was noted that consultation with affected Pueblos would accompany any potential expansion in Area G or enhancement of pit manufacturing.	The percentage of LANL surveyed for cultural resources increased to 90 percent in 2005, and the number of known cultural resource sites increased as well. Conveyance and transfer of land resulted in the removal of cultural resources from the responsibility and protection of DOE, including resources eligible for listing on the National Register of Historic Places and American Indian sacred sites, remains, and traditional religious sites. A data recovery plan has been written to resolve adverse effects on tracts conveyed to the County of Los Alamos; transferred land would be held in trust by the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) and so would remain under Federal protection. Following the Cerro Grande Fire, an assessment determined that about 400 archaeological sites and historic buildings and structures were impacted by the fire. Impacts included direct loss, soot staining, spalling and cracking of stone masonry walls, and the exposure of artifacts from erosion. Additionally, the fire and the tree thinning measures taken to reduce wildfire hazard resulted in the discovery of 447 new archaeological sites.	Impacts to cultural resources at LANL exceeded the level predicted in the *1999 SWEIS*, which did not account for events such as land conveyance and transfer. Certain activities associated with the development of new sites and land conveyance and transfer were addressed in separate NEPA documents. The Cerro Grande Fire caused extensive damage to cultural resources at LANL.
Socioeconomics	The *1999 SWEIS* projected the need for 11,351 full-time equivalent LANL-affiliated employees. Changes in employment at LANL would change regional population, employment, personal income, and other socioeconomic measures.	By 2005, there were 13,504 LANL-affiliated employees.	Socioeconomic impacts from continued operations at LANL between 1998 and 2005 have exceeded the socioeconomic impacts projected in the *1999 SWEIS* due to the larger number of employees.

Resource or Impact Area	1999 SWEIS Projected Impacts	Actual Impacts and Performance Changes (1999 to 2005)	Assessment
Infrastructure			
- Electricity	LANL was projected to require 782,000 megawatt-hours of electricity per year, with a peak load demand of 113 megawatts.	Average annual usage: 391,096 megawatt-hours per year, with peak usage of 421,413 megawatt-hours in 2005. Average peak load demand: 68.8 megawatts, with a peak of 70.9 megawatts in 2001 and 2003.	Annual electricity usage at LANL remained below the levels projected in the *1999 SWEIS*. Electrical usage has not exceeded the annual 963,600 megawatt-hour system capacity, or the physical transmission capability (thermal rating) of 110 megawatts.
- Fuel	LANL was projected to require 1.84 million decatherms (52.1 million cubic meters) of natural gas per year. Note: A decatherm is equivalent to 1,000 cubic feet.	Average annual usage: 1.32 million decatherms (37.4 million cubic meters) per year. Peak year usage: 1.49 billion cubic feet (42.2 million cubic meters) (2001).	Annual natural gas usage at LANL remained below the level projected in the *1999 SWEIS*. Demand for natural gas has not exceeded the contractually limited capacity of 8.07 million decatherms (229 million cubic meters) per year.
- Water	LANL was projected to require 759 million gallons (2.87 million liters) of water per year.	Average annual usage: 385 million gallons (1.46 billion liters) per year. Peak year usage: 453 million gallons (1.71 billion liters) (1999).	Annual water usage at LANL remained below the level projected in the *1999 SWEIS*. Demand for water has not exceeded the ceiling quantity of approximately 542 million gallons (2 billion liters) per year.
Environmental Restoration	The *1999 SWEIS* evaluated Environmental Restoration Program impacts in the ecological and human health risk assessments and in analyses related to the transport, treatment, storage, and disposal of waste. Other environmental restoration–related impacts addressed qualitatively in the *1999 SWEIS* included fugitive dust, surface runoff, soil and sediment erosion, and worker health and safety risks.	The environmental restoration project originally identified 2,124 potential release sites, including 1,099 regulated by the New Mexico Environment Department under RCRA and 1,025 regulated by DOE. At the end of 2005, 829 potential release sites remained to be investigated or remediated. Cleanup activities have been completed at many sites. No further action determinations have been made for 774 units, and 146 units have been removed from LANL's RCRA Permit. Major unplanned environmental restoration activities were undertaken in response to the Cerro Grande Fire that reduced long-term exposures to legacy contaminants. The large quantities of waste generated by cleanup were sent to offsite facilities.	The overall impacts of environmental restoration activities and waste generated by activities at LANL remained within the qualitative projections presented in the *1999 SWEIS*.

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Waste Management and Pollution Prevention	Waste management impacts were projected in the *1999 SWEIS* for five categories of waste (low-level radioactive waste, mixed low-level radioactive waste, transuranic waste, mixed transuranic waste, and chemical waste). Liquid radioactive wastes were evaluated separately and subcategory (sludge) quantities were projected. For low-level radioactive waste disposal at TA-54, the *1999 SWEIS* and ROD selected the preferred option of expansion into Zones 4 and 6, providing an additional 72 acres (29 hectares) of low-level radioactive waste disposal area, of which 41 acres (16.6 hectares) would actually be disturbed by waste disposal.	In general, quantities of radioactive waste were below *1999 SWEIS* projections for all categories. Overall low-level radioactive waste generation was well below the projected level up until 2004, when the projection was exceeded due to heightened activities and new construction at non-Key Facilities. Mixed low-level radioactive waste remained within the *1999 SWEIS* projection. For transuranic waste, the quantities were within the *1999 SWEIS* projection for 6 of the 7 years; in 2003, the transuranic waste projection was exceeded due to repackaging of legacy waste for shipment to WIPP and the receipt and storage of sealed sources by the Off-Site Source Recovery Program. Generation of mixed transuranic waste by the waste repackaging effort in 2003 exceeded the *1999 SWEIS* projection, the only exceedance for this category. The chemical waste projection was exceeded for the years 1999 through 2001 due to environmental restoration cleanups. Numerous facility-specific variances to the *1999 SWEIS* chemical waste projections occurred over the timeframe, mostly due to one-time events such as chemical cleanouts or maintenance activities. For liquid radioactive wastes, quantities treated were within *1999 SWEIS* projections; some sludge exceeded *1999 SWEIS* projections, but was within the low-level radioactive waste management capacity. Low-level radioactive waste operations at TA-54 were conducted within the existing footprint.	The amount of waste managed at LANL was within *1999 SWEIS* projections for all waste categories with a few exceptions. Although sporadic exceedances took place, the quantities generated were within the capacity of the existing LANL waste management infrastructure. Liquid radioactive waste treatment quantities remained within *1999 SWEIS* projections.
Emergency Preparedness and Security	LANL's Comprehensive Emergency Management and Response Program, which includes specialized response teams, specialized training, and response agreements in cooperation with local government response agencies was described in the *1999 SWEIS*. In addition, DOE was studying a variety of options for the renovation of the emergency preparedness and security infrastructure at LANL that included replacing a number of aging structures individually or as part of a multi-building effort.	Until 2003, the LANL Emergency Operations Center was located within TA-59. A new Emergency Operations Center located at TA-69 was completed and began operations in 2003.	Impacts were consistent with those described in the *1999 SWEIS*, except for measures taken in response to enhanced national security concerns after the attacks of September 11, 2001.

TA = technical area, NEPA = National Environmental Policy Act, NPDES = National Pollutant Discharge Elimination System, CO = carbon monoxide, NO_x = nitrogen oxide, PM = particulate matter, SO_2 = sulfur dioxide, rem = roentgen equivalent man, PCBs = polychlorinated biphenyls, MEI = maximally exposed individual, RLWTF = Radioactive Liquid Waste Treatment Facility, LANSCE = Los Alamos Neutron Science Center, RCRA = Resource Conservation and Recovery Act, ROD = Record of Decision, WIPP = Waste Isolation Pilot Plant.

[a] Based on the Expanded Operations Alternative as defined in the *1999 SWEIS* and ROD (64 FR 50797).

S.8 Description of the Alternatives

The alternatives considered in the new SWEIS are the No Action Alternative, a Reduced Operations Alternative, and an Expanded Operations Alternative. Under the **No Action Alternative**, LANL would continue to implement decisions made in the *1999 SWEIS* ROD, as well as decisions based on NEPA analyses completed since 1999. For purposes of the SWEIS, the construction and operation of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility is included in the No Action Alternative in keeping with the bounding approach for impact analysis. However, NNSA is engaged in a programmatic review process that includes a reconsideration of its 2004 decision regarding that portion of the Chemistry and Metallurgy Research Replacement Facility through preparation of the *Complex Transformation SPEIS*.

Under the **Reduced Operations Alternative**, many activities would remain unchanged, but others would be eliminated or reduced. Projects that have been approved based on completed NEPA analyses would go forward under this alternative; however, the scope of the Chemistry and Metallurgy Research Replacement Facility would be reduced. Only the radiological laboratory, administrative office, and support functions building would be constructed and operated; the nuclear facility portion would not be constructed, and the existing Chemistry and Metallurgy Research Building would operate beyond its previously identified closure date of 2010.

Alternatives for Continued Operation of Los Alamos National Laboratory

No Action Alternative—Operations would continue at current levels consistent with previous decisions such as those announced in the *1999 SWEIS* ROD.

Reduced Operations Alternative—The nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility would not be constructed. Operations would be reduced at High Explosive Processing and Testing Facilities and eliminated at LANSCE and Pajarito Site.

Expanded Operations Alternative (Preferred Alternative)—Actions would be implemented to upgrade or replace aging facilities and systems, improve security, and remediate obsolete buildings and contaminated lands. Selected operations would increase, including plutonium pit production.

The **Expanded Operations Alternative** analyzed in the SWEIS, which NNSA has selected as its Preferred Alternative, reflects proposals to expand overall operational levels at LANL above those analyzed in the No Action Alternative. This alternative includes the expansion of operations at certain Key Facilities and the construction of new facilities. This alternative also includes the actions required to support implementation of the Consent Order. Three types of new projects are addressed in the SWEIS under the Expanded Operations Alternative: projects that maintain existing capabilities at LANL, projects that support the cleanup of LANL including the DD&D of excess buildings and implementation of the Consent Order[5] (NMED 2005); and projects that add new or expand existing capabilities at LANL.

[5] *NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.*

The greatest change at a Key Facility would occur at the Plutonium Facility Complex. The *1999 SWEIS* analyzed a production level of "80 plutonium pits per year in multiple shift operations (up to 50 pits per year in single-shift operations)" as part of its Expanded Operations Alternative (DOE 1999). However, DOE decided in 1999 to manufacture a nominal 20 pits per year, and announced that decision in the *1999 SWEIS* ROD. The annual production of 20 pits was identified in the Final *1999 SWEIS* as part of the Preferred Alternative, and the analysis of impacts for this alternative was developed by scaling the impacts identified for the *1999 SWEIS* Expanded Operations Alternative (which was based on an annual production rate of 80 pits) to a production rate of 20 pits per year.[6]

While recent studies suggest that the lifetime of the plutonium pit in the majority of nuclear weapons may be longer than originally thought, NNSA needs the flexibility provided by increased pit production for two reasons: First, even with longer pit lifetimes, NNSA will need to replace pits in stockpiled warheads as the stockpile ages. Second, at significantly smaller stockpile levels than today, NNSA must anticipate an adverse change in the geopolitical threat environment, or a technical problem with warheads in the operationally deployed force, either of which could require the United States to manufacture and deploy additional warheads on a relatively rapid schedule (NNSA 2006b, 2007).

NNSA proposes to increase the annual manufacturing rate from 20 pits per year (the rate assumed for the No Action Alternative in the SWEIS) to an annual rate of up to 80 pits under the Expanded Operations Alternative. The production of pits includes the activities needed to fabricate new pits, to modify the internal features of existing pits, and to certify new pits or requalify existing pits. Some of the pits produced by these processes may not be certified or requalified. NNSA needs to produce about 50 certified pits annually to meet the immediate requirements of the Stockpile Stewardship Program (although the number of certified pits needed may change in the future), and may need to produce more than 50 pits in order to obtain 50 certified pits. The Expanded Operations Alternative for the SWEIS is based on an annual production rate of 80 pits per year in order to provide NNSA with some flexibility in obtaining the appropriate number of certified pits. The annual production rate of 80 pits analyzed in the Expanded Operations Alternative is the upper limit of the annual production rate at LANL. Although NNSA has proposed further transformations of the nuclear weapons complex to meet future national security needs, NNSA has not completed the *Complex Transformation SPEIS* and therefore has not made a decision on the configuration of the future complex, including decisions regarding whether to increase the pit production capabilities above 80 pits per year at LANL or another NNSA site. Any decision to increase pit production beyond 20 pits per year would be made after NNSA issues the Final *Complex Transformation SPEIS*; such a decision would be based on the analyses in the *Complex Transformation SPEIS*, the SWEIS, and other information, including cost studies, budget projections, and national security requirements.

A decision to increase pit production significantly above 20 pits annually would require NNSA to issue a new or revised ROD. Work continues toward implementing the decision to produce 20 pits per year announced in the *1999 SWEIS* ROD. The current proposal to produce up to

[6] *As part of this scaling process, the 1999 SWEIS provided quantitative adjustments of important impacts where possible to reflect the differences between an annual production rate of 80 pits (the rate used for that SWEIS's Expanded Operations Alternative) and an annual rate of 20 pits (the rate used for the Preferred Alternative and selected by the 1999 ROD). Where quantitative adjustments were not possible, a qualitative discussion of the important differences in impacts was provided.*

80 pits per year involves reorganizing operations within the Plutonium Facility such that no new building or other addition to the "footprint" of the facility would be required. Available production space within the facility would be used more efficiently, and process efficiencies identified since 1999 would be employed. Some modifications to equipment arrangements in the Plutonium Facility might also be necessary. This approach – using only existing floor space – is not the same as the approaches analyzed in the *1999 SWEIS*, each of which would have required addition of floor space to the Plutonium Facility. In the new SWEIS, NNSA is reanalyzing the potential environmental impacts of using this new approach to produce up to 80 pits per year as outlined in the Expanded Operations Alternative. As was the case for the impact analysis used in the Expanded Operations Alternative in the *1999 SWEIS*, the new SWEIS bases the analysis of impacts for its Expanded Operations Alternative on a maximum annual production rate of 80 pits. The No Action Alternative for the SWEIS uses the same scaling process used to develop the Preferred Alternative for the *1999 SWEIS*.

NNSA has selected the Expanded Operations Alternative as its **Preferred Alternative** for the continued operation of LANL. This alternative includes fabrication of up to 80 pits per year at the Plutonium Facility Complex in TA-55, as well as increased activity levels at certain other Key Facilities (such as the Chemistry and Metallurgy Research Replacement Facility) to support this level of pit production. Proposed increases in activity levels would be implemented and new capabilities would be added to existing Key Facilities. Capabilities, activity levels, and projects identified under the No Action Alternative that remain unchanged under the Expanded Operations Alternative would continue as described. NNSA would undertake activities to facilitate compliance with the Consent Order and remediation of the MDAs, as well as other closure and DD&D projects. The proposed projects discussed in Section S.3 of this Summary would proceed, commensurate with funding.

However, full implementation of the Preferred Alternative may be affected by future programmatic decisions. NNSA is reconsidering its decision to construct and operate the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility at LANL pending decisions related to its Complex Transformation proposal for the nuclear weapons complex. NNSA is deferring a decision on how to provide the necessary long-term analytical chemistry, materials characterization, and research and development capabilities that would be provided by the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. NNSA may ultimately choose to implement only part of the Expanded Operations Alternative contingent on the Complex Transformation strategy.

Given the uncertainty regarding the nuclear weapons work that will be assigned to LANL in the future, NNSA expects to issue two or more RODs to implement its decisions. Decisions relating to site remediation and to DD&D of facilities are expected to be in the first ROD based on the SWEIS. Specifically, this includes activities that would facilitate remediation of MDAs and other contaminated sites as required by the Consent Order.

Table S–4 provides a comparison of the principal activities associated with each alternative. The table is divided into three sections to reflect whether the proposed activities involve implementation at a site-wide (not associated with a single TA or Key Facility) or TA level, or are specific to a Key Facility. The projects that are the subject of project-specific analyses in the SWEIS could occur at any of these levels, and appear in *italics* in the table to aid in identification.

Table S–4 Summary of Actions Under Proposed Alternatives [a]

Project/Facility	Location	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative
Site-Wide Activities and Projects				
Security Needs	Site-wide	Complete project related to access control stations and realign roadways around TA-3. Upgrade and replace existing physical security system. Implement Nuclear Materials Safeguards and Security Upgrades Project, Phase II.	Same as No Action Alternative	Same as No Action Alternative, plus: Implement *Security-Driven Traffic Modifications Project* – limit access along Pajarito Corridor West; provide commuter bus parking lots, shuttle bus service, and pedestrian and vehicle bridges between TA-63 and TA-35. Auxiliary actions include constructing 2 more vehicle bridges from TA-35 to TA-60 and TA-60 to TA-61.
Remediation and Closure Activities	Site-wide	Continue remediation of potential release sites. Remediate MDA H.	Same as No Action Alternative	*Major Material Disposal Area Remediation, Canyon Cleanups and Other Consent Order Activities*: Investigate and remediate potential release sites, including MDAs as required by the Consent Order. Perform environmental monitoring as needed to support Los Alamos County Landfill closure.
Land Conveyance and Transfer	Site-wide	Transfer previously identified parcels of LANL land to the Department of the Interior in trust for San Ildefonso Pueblo, or convey to Los Alamos County and New Mexico Department of Transportation.	Same as No Action Alternative	Same as No Action Alternative
Electrical Power System Upgrade	Site-wide	Construct or modify 2 substations. Construct or modify 2 power lines.	Same as No Action Alternative	Same as No Action Alternative
Wildfire Hazard Reduction	Site-wide	Implement ecosystem-based management program for approximately 10,000 acres (4,000 hectares) through forest thinning, construction of access roads and fuel breaks, and use of prescribed fire.	Same as No Action Alternative	Same as No Action Alternative
Flood and Sediment Retention Structures	Site-wide	Remove aboveground portions of the Pajarito Canyon flood retention structure and TA-18 steel diversion wall. Grade streambed and reseed banks.	Same as No Action Alternative	Same as No Action Alternative
Trails Management Program	Site-wide	Repair, maintain, improve or close, as necessary, publicly used trails on LANL property.	Same as No Action Alternative	Same as No Action Alternative
Off-Site Source Recovery Project	TA-3, TA-18, TA-54, TA-55	Continue to receive and store excess sealed radiological sources.	Same as No Action Alternative	Same as No Action Alternative, plus: *Increase Type and Quantities of Sealed Sources Accepted for Management.*
Management of Construction Soils	TA-16, TA-61	Transport and store up to 150,000 cubic yards of soil excavated from Chemistry and Metallurgy Research Replacement Facility Project, and other construction projects at TA-16 or TA-61 borrow areas.	Same as No Action Alternative	Same as No Action Alternative

Project/Facility	***Location***	***No Action Alternative***	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Technical Area Activities and Projects				
Combustion Turbine Generators	TA-3	Install two 20-megawatt combustion turbine generators.	Same as No Action Alternative	Same as No Action Alternative
Physical Science Research Complex	TA-3	No activity	No activity	Construct a new *Physical Science Research Complex*.
Replacement Office Buildings	TA-3	Construct 3 office buildings.	Same as No Action Alternative	Construct up to 9 additional *Replacement Office Buildings*.
Administration Building	TA-3	Demolish building.	Same as No Action Alternative	Same as No Action Alternative
TA-21 DD&D	TA-21	Deactivate tritium facilities followed by surveillance and maintenance.	Same as No Action Alternative	Implement *TA-21 Structure Decontamination, Decommissioning, and Demolition Project.*
Science Complex	TA-62 or TA-3 or Research Park	No activity	No activity	Construct and operate a new *Science Complex.*
Remote Warehouse and Truck Inspection Station	TA-72	No activity	No activity	Construct and operate a new *Remote Warehouse and Truck Inspection Station.*
Key Facility Activities and Projects				
Chemistry and Metallurgy Research Building	TA-3	Continue actinide research and processing activities, characterization, analysis, testing, and fabrication. Conduct nonproliferation training. Recover, process, and store LANL's highly enriched uranium inventory. Complete construction of CMR Replacement Facility at TA-55.	Same as No Action Alternative except: Nuclear facility portion of CMR Replacement Facility would not be constructed.	Same as No Action Alternative, plus: Expand and develop new actinide processing and analysis capabilities. Increase support to the Off-Site Source Recovery Program.
Sigma Complex	TA-3	Conduct research, development, and characterization on materials fabrication from metals, ceramics, salts, beryllium, enriched uranium, depleted uranium, and other uranium isotope mixtures. Analyze and fabricate tritium reservoirs. Fabricate nonnuclear components in support of research and development: 100 hydrotests and 50 joint test assemblies. Fabricate components for up to 80 pits and 50 secondary assemblies per year.	Same as No Action Alternative	Same as No Action Alternative
Machine Shops	TA-3	Machine, weld, and assemble various materials in support of major LANL programs and projects, principally related to weapons manufacturing.	Same as No Action Alternative	Same as No Action Alternative
Material Sciences Laboratory	TA-3	Develop and improve materials formulation and chemical processing technologies, mechanical testing, research, synthesis, and characterization.	Same as No Action Alternative	Same as No Action Alternative
Nicholas C. Metropolis Center for Modeling and Simulation	TA-3	Conduct high-performance, complex computing operations at up to 50 teraflops, using no more than 7.2 megawatts of electricity.	Same as No Action Alternative	Same as No Action Alternative, plus: Implement *Nicholas C. Metropolis Center for Modeling and Simulation Increase in Level of Operations*, using up to 15 megawatts of electricity and 51 million gallons (193 million liters) of water per year.

Project/Facility	***Location***	***No Action Alternative***	***Reduced Operations Alternative***	***Expanded Operations Alternative***
High Explosives Processing Facilities	TA-8, TA-9, TA-11, TA-16, TA-22, TA-37	High explosives processing activities using approximately 82,700 pounds (37,500 kilograms) of explosives and 2,910 pounds (1,320 kilograms) of mock explosives annually. Evaluate stockpile returns, develop and characterize new materials, and research waste treatment methods. Fabricate materials and parts. Conduct up to 15 safety and mechanical tests and support about 100 major hydrodynamic tests annually. Complete construction of TA-16 Engineering Complex and remove or demolish vacated structures.	Twenty percent reduction in activities and materials from the No Action Alternative	Same as No Action Alternative, plus: Increase use to 5,000 pounds (2,270 kilograms) of mock explosives, and conduct up to 500 safety and mechanical tests annually.
High Explosives Testing Facilities	TA-15 with firing sites in TA-14, TA-15, TA-36, TA-39, TA-40	Conduct approximately 1,800 experiments per year using up to 6,900 pounds (3,130 kilograms) of depleted uranium. Conduct explosives experiments and studies, dynamic experiments, and 100 major hydrodynamic tests annually. Install dynamic experimentation structure at TA-15. Complete construction of 15 to 25 new structures to replace about 59 structures currently used; remove or demolish vacated structures.	Twenty percent reduction in activities and materials from the No Action Alternative	Same as No Action Alternative
Tritium Facility	TA-16, TA-21	Perform high-pressure gas fills and processing operations for research and development and nuclear weapons systems. Perform ongoing maintenance, testing, research and development to maintain safety and reliability of gas boost systems for nuclear weapons. Tritium storage of about 35 ounces (1,000 grams). Phase out and move tritium activities from TA-21; decontaminate buildings.	Same as No Action Alternative	Same as No Action Alternative, plus: Implement *TA-21 Structure Decontamination, Decommissioning & Demolition Project.*
Pajarito Site	TA-18	Perform criticality experiments and provide training courses. Continue Security Category III and IV nuclear activities. Operate SHEBA in its security Category III configuration. Develop safeguard instrumentation and perform research and development for nuclear materials. Conduct experiments and activities to support NNSA's Second Line of Defense Program, Nuclear Nonproliferation Research and Development Testing, and Emergency Response Program activities. Receive and store radiation sources retrieved from other locations under the Off-Site Source Recovery Project.	Cease all Security Category III and IV nuclear activities, including SHEBA. Institute surveillance and maintenance of facilities. Eliminate Pajarito Site as Key Facility.	Implement *TA-18 Closure, Including Remaining Operations Relocation and Structure Decontamination, Decommissioning & Demolition*. Move Security Category III and IV material to other LANL facilities. Cease SHEBA activities. Eliminate Pajarito Site as Key Facility.

Project/Facility	***Location***	***No Action Alternative***	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Target Fabrication Facility	TA-35	Conduct material sciences, effects testing, characterization, and technology development for weapons production and laser fusion research. Provide products for about 12,400 laser and physics tests per year.	Same as No Action Alternative	Same as No Action Alternative
Bioscience Facilities	TA-43, TA-3, TA-35, TA-46	Study intact cells, cellular components, and cellular systems. Characterize and synthesize biomaterials and molecules. Analyze samples and identify pathogens in support of biodefense and national security.	Same as No Action Alternative	Same as No Action Alternative, plus: Move selected activities to the new Science Complex in TA-62 (or Research Park or TA-3).
Radiochemistry Facility	TA-48	Conduct research, produce medical radioisotopes, and support other LANL organizations, primarily through radiological and chemical analyses of samples.	Same as No Action Alternative	Same as No Action Alternative, plus: Perform beryllium dispersion and mitigation assessments. Implement radioactive atom trapping for fundamental and applied research. Construct a new *Radiological Sciences Institute (including Phase I - the Institute for Nuclear Nonproliferation Science and Technology).*
Waste Management Operations: Radioactive Liquid Waste Treatment Facility	TA-50	Treat transuranic and low-level radioactive liquid wastes generated at LANL facilities; manage the final disposition of the treated wastes. Construct and operate 300,000-gallon (1.1-million-liter) influent storage facility.	Same as No Action Alternative	Same as No Action Alternative, plus: Treat and manage disposition of about 66 percent more liquid transuranic waste and 25 percent more liquid low-level radioactive waste. Implement the *Radioactive Liquid Waste Treatment Facility Upgrade Project.*
Los Alamos Neutron Science Center	TA-53	Operate the 800-million electron volt linear accelerator and deliver accelerator beam to Areas A, B, and C; Weapons Neutron Research Facility; Manuel Lujan Center; Dynamic Test Facility; and Isotope Production Facility for 10 months each year. Reconfigure beam delivery and support equipment to support new facilities, upgrades, and experiments. Support contained weapons-related experiments using small to moderate quantities of explosives. Install material test station equipment in Experimental Area A and construct neutron spectroscopy facility within existing buildings.	Shut down LANSCE; all capabilities would cease except treatment of radioactive liquid waste brought from the Radioactive Liquid Waste Treatment Facility. Systems would be maintained in a condition to support future restart.	Same as No Action Alternative, plus: Implement *LANSCE Refurbishment Project* for extending reliable operation of facility for next 20 to 30 years.

Project/Facility	*Location*	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Waste Management Operations: Solid Radioactive and Chemical Waste Facility	TA-54, TA-50	Characterize, process, store, transport, and dispose of radioactive and chemical waste generated at LANL, including: – Prepare and ship transuranic waste to WIPP. – Prepare and ship hazardous and mixed low-level radioactive waste for offsite treatment and disposal. – Dispose of low-level radioactive waste in TA-54, expanding into Zones 4 and 6 as necessary. – Receive 5 to 10 shipments annually of low-level radioactive waste from offsite locations.	Same as No Action Alternative	Same as No Action Alternative plus: Manage additional volumes of transuranic and low-level radioactive waste. Implement *Waste Management Facilities Transition* to include*:* – Construct new TRU Waste Facility in TA-50 or TA-63. – Construct new access control station, low-level radioactive waste compactor building, and low-level radioactive waste certification building in TA-54. – Retrieve transuranic waste from belowground storage and characterize, store, and ship. Expand support of Off-Site Source Recovery Project.
Plutonium Facility Complex	TA-55	Produce 20 plutonium pits per year and disassemble and examine up to 65 plutonium pits per year. Recover, process, and store existing plutonium residue inventory. Perform plutonium (and other actinide) materials research and processing. Process up to 900 pounds (400 kilograms) of actinides per year between TA-55 and CMR Building. Provide storage of the LANL special nuclear material inventory, mainly plutonium. Continue research and development on other fuels. Fabricate and study nuclear fuels for use in terrestrial and space power systems, and power production reactors. Support Off-Site Source Recovery Project	Same as No Action Alternative except: Produce less than 20 plutonium pits per year.	Same as No Action Alternative except: Produce up to 80 pits per year with minor facility modifications. Develop expanded pit disassembly capacity. Conduct plutonium research, development, and support. Process 1,800 pounds, (800 kilograms) of actinides per year, including polishing 460 pounds (210 kilograms) of plutonium oxide. Implement *Plutonium Facility Complex Refurbishment Project*, including major systems repairs and replacements to extend reliable operation of Plutonium Facility for 20 to 30 years. Construct a *TA-55 Radiography Facility*.

TA = technical area; MDA = material disposal area; DD&D = decontamination, decommissioning, and demolition; CMR = Chemistry and Metallurgy Research; teraflops = a trillion operations per second; SHEBA = Solution High-Energy Burst Assembly; NNSA = National Nuclear Security Administration; LANSCE = Los Alamos Neutron Science Center; WIPP = Waste Isolation Pilot Plant.
[a] *Italicized* entries indicate projects for which project-specific impact analyses are included in the SWEIS.

Alternatives Considered but Not Analyzed in Detail

Among the comments received during the scoping process and review of the Draft SWEIS were suggestions for additional alternatives that should be considered in the SWEIS. Two alternatives, a “Greener Alternative” and a “true No Action Alternative” (or shutdown alternative), were suggested.

A Greener Alternative was evaluated in the *1999 SWEIS;* the name and general description of the alternative were provided by interested citizens as a result of the scoping process for that SWEIS. This alternative evaluated LANL capabilities existing at that time with an emphasis on work performed in support of basic science, waste minimization and treatment, dismantlement of nuclear weapons, nonproliferation, and other areas of national and international importance. While the Greener Alternative contained components of both the No Action and the Expanded

Operations Alternatives evaluated in the *1999 SWEIS*, the operational focus was on science, waste management, and nuclear weapons dismantlement. NNSA is not evaluating a similar alternative in the SWEIS because, as stated in the *1999 SWEIS* ROD (64 FR 50797), a Greener Alternative would not support the nuclear weapons mission assigned to LANL. It should be noted, however, that important aspects of the Greener Alternative evaluated in the *1999 SWEIS*, specifically optimization of work in the field of nonproliferation of weapons of mass destruction, as well as enhanced weapons dismantlement work, were incorporated into the No Action Alternative analyzed in the new SWEIS. Other aspects of the Greener Alternative in the *1999 SWEIS* also incorporated into the No Action Alternative of the new SWEIS include enhanced research related to national health issues, waste minimization and environmental restoration technologies, and international nuclear safety.

The alternative characterized as a "true No Action Alternative," in which all operations at LANL, including production and testing in support of stockpile stewardship, would cease is not a reasonable alternative. Thus, NNSA is not analyzing it in the SWEIS. Ceasing operations would result in a loss of support to nonproliferation efforts and research aiding the fight against terrorism. Because these activities are vital to national security and are among the major components of the mission assigned to LANL by NNSA, this alternative is not a reasonable alternative. The SWEIS updates previous EISs that have provided information supporting a number of decisions about operations at LANL. In such situations, an alternative that assumes LANL would cease all mission-related work is not reasonable.

S.9 Summary of Environmental Consequences

This section summarizes the impacts analyses performed for the SWEIS to provide an understanding of the overall consequences of each of the proposed alternatives and how the alternatives compare to each other. Section S.9.1 presents an overview for each of the resource areas, highlighting issues, concerns, or positive impacts. **Table S–5** (located at the end of Section S.9.1) summarizes the potential consequences of each alternative by resource area. Section S.9.2 is a summary of the cumulative impacts analyses that considers operating LANL in the context of other past, present, and reasonably foreseeable actions.

The Expanded Operations Alternative includes implementation of specific projects evaluated in the appendices to the SWEIS. As discussed in Section S.4, however, NNSA may make decisions on individual projects or proposed activities rather than making a single decision to implement an entire alternative. While Section S.9.1 summarizes the impacts from these projects as part of the Expanded Operations Alternative, Section S.9.3 summarizes the environmental consequences of each of the individual proposed projects. This individual treatment is intended to facilitate the decision process by providing an understanding of how each of the proposed projects could affect the overall impacts of continued operations at LANL. Implementing the proposed projects may result in impacts to potential release sites covered under the Consent Order. As needed, these impacts would be addressed through the accelerated cleanup process described in Section VII.F of the Consent Order. NNSA intends to implement the actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.

[7] *Possible impacts from a project addressed in the SWEIS to a potential release site covered under the Consent Order would be addressed through the accelerated cleanup process described in Section VII.F of the Consent Order.*

S.9.1 Comparison of Potential Consequences of Alternatives for Continued Operation at Los Alamos National Laboratory

This section focuses on the overall LANL site, providing an overview of impacts for each SWEIS alternative and resource area to provide an understanding of the total potential impacts of each alternative. Table S–5, located at the end of this section, compares the environmental consequences of the three SWEIS alternatives.

Land Use

Under the No Action Alternative, the conveyance of land from LANL to Los Alamos County, and the New Mexico Department of Transportation, and transfer of land to the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) would continue. Of the 4,078 acres (1,650 hectares) identified under Public Law 105-119 (Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998), about 1,820 acres (737 hectares) remain to be transferred. This land conveyance and transfer, and the Power Grid Upgrades Project, could impact site and regional land use. Effects of these actions include reduction in the size of LANL, possible changes in offsite land use from development following transfer, loss of recreational opportunities, and changes in site land use. Impacts would be similar under the Reduced Operations Alternative. Under the Expanded Operations Alternative, in addition to the impacts of the No Action Alternative, changes to land use could occur as the result of projects such as the Replacement Office Buildings Project, Radiological Sciences Institute Project, TA-18 Closure Project, MDA Remediation Project,[8] Radioactive Liquid Waste Treatment Facility Upgrade Project, Waste Management Transition Project, Science Complex Project, Remote Warehouse and Truck Inspection Station Project, and Security-Driven Transportation Modifications Project. While actions associated with these projects would in many cases be compatible with existing land use plans, there is no provision in the current plans for the new bridge that could be constructed over Sandia Canyon under Auxiliary Action B of the Security-Driven Transportation Modifications Project. Although no major changes in land use would occur in most cases, environmental remediation occurring for all alternatives could lead to fewer restrictions on land use. The fewest restrictions on land use would occur under the Removal Option for the MDA Remediation Project upon completion of remedial actions.

Visual Environment

Under the No Action Alternative, possible development following conveyance and transfer of land could degrade the views of presently undeveloped areas. For many projects, impacts to the visual environment would be limited to the construction phase. Once complete, most projects would be minimally visible from offsite locations, but more noticeable from closer vantage points; however, near views are often restricted to LANL employees. Under all alternatives, environmental remediation activities at some potential release sites could be publicly visible while remediation occurs. Power grid upgrades could adversely impact the views in previously undisturbed areas. Impacts under the Reduced Operations Alternative would be similar to those identified for the No Action Alternative.

[8] *The phrase MDA Remediation Project is used in the SWEIS as a general term for environmental remediation activities under the Consent Order, addressing MDAs and other potential release sites.*

Although in many cases impacts to the visual environment from implementation of the Expanded Operations Alternative would be similar those associated with the No Action Alternative, a number of proposed projects would cause noticeable changes to the visual environment. Capping or removing MDAs under the MDA Remediation Project would temporarily disturb areas or involve the use of temporary enclosures that could be visible in some cases. MDA Remediation Project activities would increase the visibility of the borrow pit in TA-61; and the Security-Driven Transportation Modifications Project would cause the construction of roads, parking lots, and new bridges over a site canyon. Additional visible bridges could be constructed over site canyons if the auxiliary actions were selected. In addition, new buildings associated with the Replacement Office Buildings and Science Complex Projects would be readily visible from West Jemez or Pajarito Roads. The new building associated with the Remote Warehouse and Truck Inspection Station would be visible from East Jemez Road. Establishment of evaporation tanks for final treatment of effluent from the Radioactive Liquid Waste Treatment Facility would cause a permanent change to the visual environment in the area near the border of TA-52 and TA-5. There would be a break in forest cover that could be seen from areas west of LANL. The removal of old buildings would enhance the visual environment at both TA-18 and TA-21, and the visual environment at TA-21 could further change in the longer term if development takes place. Also, removal of the domes in TA-54 as part of the Waste Management Facilities Transition Project would have a beneficial impact on views of the site from both near (including the Pueblo of San Ildefonso) and far. Construction of the TRU Waste Facility, however, has the potential to impact the visual environment, including views from San Ildefonso Pueblo lands, depending on its location.

Geology and Soils

There is little difference in the impacts on geologic resources for the No Action and Reduced Operations Alternatives; however, the impacts from the Expanded Operations Alternative would be distinctly different. Under the Expanded Operations Alternative, facility construction and DD&D for the following projects would impact geologic materials: Physical Science Research Complex, Replacement Office Buildings, Radiological Sciences Institute, Radioactive Liquid Waste Treatment Facility Upgrade, TA-55 Radiography Facility, Science Complex, Remote Warehouse and Truck Inspection Station, TA-21 DD&D, Waste Management Facilities Transition, and the Security-Driven Transportation Modifications. A total of approximately 3.2 million cubic yards (2.5 million cubic meters) of soil and rock would be disturbed if all of these projects were implemented.

In addition, MDA remediation in compliance with the Consent Order would have a major impact on geologic resources. MDA remediation would require 1.2 million to 2.5 million cubic yards (0.9 million to 1.9 million cubic meters) of crushed tuff and other materials for evapotranspiration covers under the Capping Option, or up to 2.2 million cubic yards (1.7 million cubic meters) of backfill and surface materials under the Removal Option. These geologic resources would be available either at LANL or from nearby offsite sources.

Under all three alternatives, remediation of potential release sites would continue to remove existing contaminants from soils and shallow bedrock at LANL. This impact would be greatest under the Expanded Operations Alternative because the largest area and volume of contaminated soil would be remediated. The use of standard construction methods and best management practices would minimize the potential for erosion and release of soils during construction and decrease the potential for erosion, slope failure, and contaminant releases after remediation is complete.

Water Resources

There would be only minor adverse impacts on surface water quality and quantity from the No Action Alternative. There could be significant beneficial impacts on Sandia Canyon if the effluent from the Sanitary Wastewater Systems Plant is used as cooling water at the Metropolis Center for Modeling and Simulation. Under the Reduced Operations Alternative, the elimination of cooling tower effluent from LANSCE would result in a significant reduction of effluent discharge to Los Alamos Canyon. The Expanded Operations Alternative could have beneficial impacts on surface water quality due to the installation of new treatment technologies associated with the Radioactive Liquid Waste Treatment Facility Upgrade Project, and the possible elimination of the Radioactive Liquid Waste Treatment Facility discharge to Mortandad Canyon if the auxiliary action to evaporate treated effluents were implemented. Complete DD&D of TA-21 under the Expanded Operations Alternative would eliminate two industrial effluent outfalls, which would have a minor beneficial impact on Los Alamos Canyon. Environmental remediation under all alternatives would have positive impacts on surface water quality; implementation of the MDA Remediation Project under the Expanded Operations Alternative would have additional beneficial impacts on surface water quality due to the potential removal or stabilization of contaminants at the MDAs. Removal of the flood retention structure in Pajarito Canyon under all the alternatives could impact floodplains downstream immediately following removal. None of the alternatives would likely have any other impacts on floodplains.

There would be no changes in the flow of contaminants to the alluvial or regional groundwater as a result of the No Action Alternative, except for that achieved from continuing the environmental remediation program that existed before the Consent Order. Most impacts to groundwater resources identified as occurring under the No Action Alternative would also occur under the Reduced Operations Alternative. Long-term impacts might be reduced by elimination of some of the canyon outfalls and reduction of water use. Direct and indirect impacts to groundwater as a result of proposed construction and operations under the Expanded Operations Alternative would also be similar to those described for the No Action Alternative. Under the Expanded Operations Alternative, water usage would be greater than the range of LANL's water use over the last 7 years, but within the range of use over the last 14 years. Therefore, impacts to the water levels in the regional aquifer from withdrawals to supply LANL would be within historical levels. The effects of either an MDA Capping or Removal Option under the Expanded Operations Alternative would not appreciably affect the rate of transport of contaminants presently in the vadose zone in the near term, but would likely reduce very long-term migration of contaminants and corresponding impacts on the environment from wastes present in the MDAs.

Air Quality

Nonradiological air pollutant emissions from operations at LANL would continue within the limits of the operating air permit under all the alternatives. Reductions in emissions would occur under the Reduced Operations Alternative from reduced high explosives processing and testing, from shutdown of LANSCE and the Pajarito Site (TA-18), and a smaller construction scope. A minor increase in operations emissions could occur under the Expanded Operations Alternative, but emissions would remain within the limits of the operating permit. Increased employment under the Expanded Operations Alternative could result in an increase in air pollutant emissions from additional vehicles of employees commuting from Santa Fe and Rio Arriba County and other locations and waste and materials shipments. Temporary localized increases in air pollutant emissions from construction, DD&D, and remediation activities would occur under all alternatives, but under the Expanded Operations Alternative the emissions would be larger. These activities could result in exceedances of short-term ambient standards for nitrogen oxides and carbon monoxide for some projects where activities are near the site boundary or public roads unless these activities are properly controlled. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements. Development by others of lands conveyed and transferred could result in air quality impacts.

Radiological air emissions from normal operations under the No Action Alternative would be dominated by short-lived gaseous mixed activation products emitted from LANSCE (TA-53). Under the Reduced Operations Alternative, a reduction in the activity levels of some Key Facilities (including the continued use of the Chemistry and Metallurgy Research Building) and the shutdown of LANSCE and the Pajarito Site (TA-18) would greatly reduce the amount of radiological air emissions. Under the Expanded Operations Alternative, some small increases in radiological air emissions compared to the No Action Alternative would result from increased LANL activities and the operation of new facilities. These emissions would be dominated by operations at LANSCE. There could be temporary additions to radiological air emissions if the New Mexico Environment Department selects exhumation as the corrective measure for any of the MDAs.

Noise

Under the No Action Alternative, noise impacts from operations at LANL would be similar to the impacts from recent operations, including noise from explosives testing and traffic. Construction, DD&D, and remediation activities would result in a minor increase in offsite noise impacts to the public from equipment use and traffic under the No Action and Reduced Operations Alternatives. Under the Reduced Operations Alternative, however, a minor reduction in explosives testing noise would occur, as well as a minor decrease in construction and DD&D noise impacts compared to the No Action Alternative. Under the Expanded Operations Alternative, minor to moderate increases in traffic noise could occur from changes in traffic patterns due to increased construction, MDA remediation, DD&D activities, and increased employment at LANL. In addition, increased equipment-related noise impacts would occur from additional construction, DD&D, and MDA remediation activities. Activities near the site boundary or increases in truck traffic noise under various MDA remediation options could result in some public annoyance. Development by others of lands conveyed and transferred could also result in noise impacts.

Ecological Resources

Under the No Action Alternative, a number of actions would result in impacts on ecological resources. For example, conveyance of land to the county could result in the loss of 770 acres

(312 hectares) of habitat through possible future development. Therefore, impacts such as loss and displacement of wildlife would take place. The Wildfire Hazard Reduction Program would have short-term adverse impacts on wildlife due to activities such as tree trimming, but would produce long-term benefits from returning the forest to a condition similar to that which existed in the past. Increased forest health could also benefit the Mexican spotted owl at LANL and across the region. Impacts from the Reduced Operations Alternative generally would be similar to the No Action Alternative.

Under the Expanded Operations Alternative, however, impacts on ecological resources would be larger than those of the No Action Alternative. A number of projects could impact habitat and wildlife. Those impacts mostly would be temporary disturbances during construction and demolition; however, if all of the proposed projects were implemented, up to about 170 acres (69 hectares) of habitat would be lost; borrow pit expansion, if required, would disturb additional acreage. Most habitat loss would be associated with the Security-Driven Transportation Modifications Project (30 acres [12 hectares] and its two auxiliary actions (91 acres [37 hectares]). Temporary disturbances to habitat and displacement of wildlife could occur from environmental remediation under all alternatives; however, because material disposal areas are mostly grassy, open areas, temporary habitat disturbances associated with the MDA Remediation Project under the Expanded Operations Alternative would be mostly associated with remediation support activities such as operation of temporary storage areas for capping materials. Withdrawal of crushed tuff from the TA-61 borrow pit to support MDA remediation may cause loss of habitat at the borrow pit for the Mexican spotted owl; Section 7 consultation with the U.S. Fish and Wildlife Service would be required.

Impacts to the Mexican spotted owl, bald eagle, and southwestern willow flycatcher were evaluated in a biological assessment prepared by DOE (LANL 2006e). This biological assessment determined that activities associated with many projects may affect, but were not likely to adversely affect, these species. Regarding the Security-Driven Transportation Modifications Project, the U.S. Fish and Wildlife Service determined that provided that reasonable and prudent measures are taken, construction of a span bridge over Ten Site Canyon would not result in adverse affects to the Mexican spotted owl. Further consultation would be needed, however, if a land bridge was to be used. A determination of potential impacts from construction of the auxiliary action bridges associated with the Security-Driven Transportation Modifications Project could not be made because bridge locations and final designs were not known. Thus, further consultation with the U.S. Fish and Wildlife Service would be required prior to bridge construction. Depending on where the TRU Waste Facility would be located, consultation could be required prior to building this facility since construction could affect both core and buffer habitat of the Mexican spotted owl.

Human Health

None of the alternatives would result in an increase in LCFs in the population; and all doses estimated for the MEI, a hypothetical individual located at the site boundary, would meet the regulatory limit of 10 millirem per year (40 CFR 61.92). Under the No Action Alternative, radiological air emissions from LANSCE (TA-53) would be responsible for over 70 percent of the estimated population dose of 30 person-rem per year; emissions from the firing sites (TA-15 and TA-36) would contribute approximately 20 percent. Under the No Action Alternative, the dose to the MEI would be about 7.8 millirem per year, with 7.5 millirem attributable to emissions from LANSCE.[9] Under the Reduced Operations Alternative, estimated annual doses to the population and the MEI would be reduced by approximately 80 percent and 90 percent, respectively, compared to the No Action Alternative. This reduction would largely be due to the shutdown of LANSCE, along with minor reductions from termination of operations at the Pajarito Site, lower levels of high explosives processing and testing, and continued use of the Chemistry and Metallurgy Research Building. Under the Expanded Operations Alternative, there would be small increases in emissions from the Plutonium Facility Complex from increased pit manufacturing activity and reduced emissions from the Pajarito Site and TA-21, which would result in slight increases in the estimated doses to the public and the MEI from routine operations compared to the No Action Alternative. In addition, there could be temporary increases in offsite doses if the Removal Option were implemented for MDA cleanup. The annual population dose could increase by about 20 percent to approximately 36 person-rem per year, and the MEI dose could increase by about 5 percent to approximately 8.2 millirem per year.

On an individual worker basis, impacts to worker health would be the same across all alternatives. Application of procedures designed to ensure safe worker environments would control exposure to radiation, chemicals, and biohazardous materials. Individual radiation doses would be maintained below the DOE limit of 5 rem per year, with a goal of limiting the dose to 2 rem per year from external exposure. Under normal operating conditions, no adverse effects from chemical or biological exposures would be expected.

The collective dose for workers would be about 280 person-rem per year under the No Action Alternative. Under the Reduced Operations Alternative, the dose would drop to 257 person-rem annually due to the cessation of TA-18 activities and the shutdown of LANSCE. Under the Expanded Operations Alternative, collective doses would differ depending on the actions taken to remediate the MDAs. If the MDA Capping Option were implemented, the collective dose would be about 407 person-rem per year. This increase in dose over the No Action Alternative is primarily associated with manufacturing up to 80 pits per year at the Plutonium Facility Complex. If the MDA Removal Option were implemented, waste in the MDAs would be removed rather than capped in place. In this case, the collective dose would be about 543 person-rem annually. The average annual dose to the worker population contributed by the MDA Remediation Project alone would range from about 1 (MDA capping) to 137 (MDA removal) person-rem.

Cultural Resources

Under the No Action Alternative, potential impacts to cultural resources include conveyance or transfer of lands containing cultural resources from DOE. Further, there is potential for damage to these resources from development and for adverse effects on historic buildings from demolition and remodeling. From a positive standpoint, the Trails Management Program could enhance cultural resource protection by limiting public access to certain trails or trail segments. Documentation could be required to resolve possible adverse effects from demolishing and remodeling historic buildings involved in high explosives processing and testing. Impacts from

---

[9] Administrative controls established at LANSCE to regulate beam operations as emissions levels increase require operational changes to prevent the generation of excessive radioactive air emissions, so that the maximum dose to the LANL site-wide MEI from air emissions at LANSCE is 7.5 millirem per year or less.

the Reduced Operations Alternative generally would be similar to those described for the No Action Alternative.

Under the Expanded Operations Alternative, many impacts would also be similar to those that would occur under the No Action Alternative. In general, individual projects would have a minimal potential for impacting archaeological resources because most projects would not be located in the immediate area of archaeological sites; however, the proposed TRU Waste Facility has the potential to directly impact archaeological resources depending on its location, which has yet to be determined. Potentially affected resources would be protected by LANL requirements for protecting sensitive areas. Additionally, the implementation of LANL requirements would ensure that any proposed demolition or modification of existing historic buildings and structures would be in keeping with *A Plan for the Management of Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006a). If the auxiliary actions to build bridges across canyons as part of the Security-Driven Transportation Modifications Project were implemented, certain traditional cultural properties could be adversely affected. Also, the proposed TRU Waste Facility has the potential to impact the view from traditional cultural properties if constructed within certain locations of the Pajarito Road corridor. Removal of the domes from Area G of TA-54 as part of the Waste Management Facilities Transition Project, however, would have a positive effect on views from Pueblo of San Ildefonso lands.

Possible impacts to cultural resources from environmental restoration would be reviewed for all potential release sites and protective measures taken as needed. There would be no direct impacts to cultural resources from either capping or removing material disposal areas under the Expanded Operations Alternative. Any temporary support areas needed for MDA remediation would be located and operated to be protective of cultural resources.

Socioeconomics

Under the No Action Alternative, no change in the socioeconomic impacts on the region from those currently being observed would be expected. As a major employer, LANL provides large socioeconomic contributions to the region. Impacts from the Reduced Operations Alternative would be similar to those associated with the No Action Alternative. Under the Reduced Operations Alternative, however, direct employment at LANL would be expected to decrease by about 3.7 percent (500 jobs) due to the closure of LANSCE, the reduction in high explosives processing and testing, and the cessation of TA-18 activities. This decrease in LANL employment would also be expected to indirectly result in additional job losses in the region. The combined loss of employment due to both direct and indirect job losses would be approximately 1,030 positions, but these losses are not expected to have a major adverse impact on the regional economy because the losses would be small in comparison to the total employment base for the region (less than 1 percent).

Under the Expanded Operations Alternative, jobs would be added at LANL to support the increased workload. It is projected that, compared to the 2005 level, up to 600 jobs by 2007 and 1,890 jobs by 2011 would be added at LANL, in addition to 640 indirect jobs by 2007 and 2,000 indirect jobs by 2011. Although the addition of these positions would be beneficial from an economic standpoint, the influx of workers would place demands on the regional infrastructure in terms of additional housing needs, schools, and community services. There is currently a housing shortage in Los Alamos County, although the county is planning for additional housing that could allow more employees to live within its borders. Rio Arriba and Santa Fe counties also would be expected to grow as a result of LANL employment increases. Considering that LANL positions are some of the highest paying positions in the region, the benefits associated with these positions in terms of increased revenues and taxes should more than offset any drawbacks. This is especially true in light of regional growth projections that show the region growing at a rate in line with LANL's projected growth rate under the Expanded Operations Alternative.

Infrastructure

Utility infrastructure demands for electricity, natural gas, and water are projected to increase in the LANL region of influence through 2011 regardless of the alternative selected in the SWEIS, mainly due to increasing demands among other Los Alamos County users who rely upon the same utility systems as LANL. Total projected utility infrastructure requirements are summarized for LANL operations and for other Los Alamos County users in Table S–5. Under the No Action Alternative, the total energy and peak load requirements would be about 49 percent and 74 percent, respectively, of the capacity of the power pool serving the Los Alamos area. Natural gas requirements and water requirements respectively would be about 27 percent and 90 percent of system capacity. For the Reduced and Expanded Operations Alternatives, respectively, projected electricity requirements would be about 39 and 63 percent of capacity, peak load demand would be about 54 percent and 96 percent of capacity, natural gas requirements would be about 27 percent and 29 percent of capacity, and water requirements would be about 85 percent and 98 percent of capacity. Projections for natural gas demand show less variation across the alternatives because the demand is controlled mainly by space heating requirements, which are affected less than other utilities by operational levels. LANSCE operations have a major effect on LANL's demand for water and electricity. LANSCE has historically accounted for as much as 25 percent of total water demand and 50 percent of electrical demand at LANL.

Under the Expanded Operations Alternative, peak load demand would approach the capacity of the Los Alamos Power Pool. Similarly, the water demand under the Expanded Operations Alternative could approach the Los Alamos Water Supply System's available water rights. This potential exists because of the projected infrastructure requirements for increased operations at LANL and the forecasted demands of other non-LANL users in Los Alamos County. Completion of a new transmission line and other upgrades, however, would reduce any concerns about peak load capacity. Also there are plans to install a second new combustion turbine generator at the TA-3 Co-Generation Complex, if needed. The second generator would add an additional 20 megawatts (175,200 megawatt-hours) of generating capacity. As for future water needs, Los Alamos County, as owner and operator of the Los Alamos Water Supply System, is currently pursuing use of the San Juan-Chama Transmountain Diversion Project to secure additional water for its customers, including LANL. This would supply the Los Alamos area with up to an additional 391 million gallons (1,500 million liters) of water per year, an increase in capacity of approximately 20 percent.

Waste Management

Under the No Action Alternative, waste management impacts from LANL operations would remain within the capacity of LANL's infrastructure. Most wastes, with the exception of low-level radioactive waste, would be disposed of offsite at facilities designed for specific categories of wastes. The expansion into TA-54, Area G, Zones 4 and 6 as necessary, would provide onsite disposal capacity for low-level radioactive waste from operations through 2016 and beyond. Due to the uncertainties of predicting environmental remediation wastes, variances from projections are likely in future years. The waste management infrastructure at LANL would be adequate, in terms of staffing and facilities, to manage the quantities of waste expected to be generated under the No Action Alternative.

Under the Reduced Operations Alternative, waste management impacts from LANL operations would be similar to those under the No Action Alternative, with some reductions in waste quantities from operations due to the closure of LANSCE and the Pajarito Site, and reduced operational levels at the high explosives facilities, and a smaller construction scope. Although some reductions in operational waste volumes are expected, continued generation of low-level radioactive waste would be expected to result in the expansion of future disposal operations into Zone 4. Wastes generated by environmental restoration and DD&D activities would be expected to be the same as those generated under the No Action Alternative. The LANL waste management infrastructure would be capable of managing the projected quantities.

The Expanded Operations Alternative includes implementing a large number of projects involving major construction and DD&D, as well as increases in operation levels at a number of Key Facilities, so larger volumes of all waste types would be generated than under the other alternatives. Retrieval and processing of transuranic waste stored below grade in Area G of TA-54 would also generate additional volumes of transuranic and low-level radioactive waste. To accommodate the processing and storage of legacy and newly generated transuranic waste from LANL operations, NNSA is proposing to install and operate additional waste management equipment and facilities, and upgrade existing processes.

Full implementation of the MDA Removal Option is conservatively estimated to generate about 1.1 million cubic yards (840,000 cubic meters) of low-level radioactive waste and 22,000 cubic yards (17,000 cubic meters) of transuranic waste, most of which DOE buried before 1970. Final waste volumes may be smaller than the maximum volumes analyzed in the SWEIS because waste generation is dependent on future regulatory decisions by the New Mexico Environment Department. In addition, the estimates are based on the volume of waste as excavated (including soil) and the removal of all major MDAs; no credit has been taken for waste volume reduction techniques such as sorting.

Onsite disposal capacity for low-level radioactive wastes may be sufficient, depending upon the actual volumes generated by remediation; disposal capacity would be supplemented by offsite facilities if needed. The transportation analysis includes the impacts of shipping all low-level radioactive wastes offsite. In the SWEIS, it is assumed that the transuranic waste would be disposed of at WIPP. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste plus all transuranic waste buried before

1970 across the DOE complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs, if generated, would be based on the needs of the entire DOE complex. Any transuranic waste that may be generated at LANL without a disposal pathway would be safely stored until disposal capacity becomes available.

Transportation

Under all alternatives, radioactive, hazardous, and commercial materials would be transported onsite and to and from various offsite locations. The evaluation of impacts in the SWEIS focuses on repeated shipments of materials to and from offsite locations. The specific locations analyzed were the Pantex Plant in Texas, the Y-12 Complex and Oak Ridge National Laboratory in Tennessee, the Lawrence Livermore National Laboratory in California, the Nevada Test Site in Nevada, and the Savannah River Site in South Carolina for transport of special nuclear material (such as plutonium, highly enriched uranium [mainly uranium-235], and uranium-233); WIPP in New Mexico for the transport of transuranic wastes; the Nevada Test Site and a commercial disposal site for low-level radioactive wastes; and multiple locations for disposal of hazardous and nonhazardous waste materials.

It is unlikely that transportation of radioactive materials under any of the alternatives would cause a fatality as a result of radiation either from incident-free operations or postulated accidents. The highest risks to the public would result from the Expanded Operations Alternative if all of the large MDAs were exhumed under the MDA Remediation Project and the Nevada Test Site was the main option for disposal of low-level radioactive waste. This alternative could result in about 122,440 shipments of radioactive materials (both special nuclear material and radioactive waste). It is estimated that there could be about three fatalities from nonradiological traffic accidents associated with the transportation activities required to implement this alternative.

All trucks carrying radioactive materials to or from LANL would travel the section of road from LANL to Pojoaque; many of these trucks would also travel the section of road from Pojoaque to Santa Fe. The radiological risks to the population along these two sections of road are very small under all alternatives. The nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) are greater than the radiological risks; however, even under the scenario involving the largest amount of transportation, the Expanded Operations Alternative with the MDA Removal Option, no fatalities would be expected along these routes.

Local traffic flows would be expected to remain at current levels under the No Action Alternative because employment would stay at current levels. Under the Reduced Operations Alternative, traffic through LANL would decline by about 4 percent, mainly as a result of the projected decrease in employment. Under the Expanded Operations Alternative, traffic would be expected to increase by up to 18 percent (averaged across all LANL entrances) due to the projected increases in employment and construction, DD&D, and remediation activities. Transportation of waste and fill material by truck for DD&D and MDA remediation could accelerate wear on local roads and exacerbate traffic problems.

Environmental Justice

Executive Order 12898 (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*) requires every Federal agency to analyze whether its Proposed Actions and alternatives would have disproportionately high and adverse impacts on minority or low-income populations. Based on the impacts analysis, NNSA expects no high and adverse impacts from the continued operation of LANL under any of the alternatives. For all alternatives the radiological dose from emissions associated with normal operations are slightly lower for members of Hispanic, Native American, total minority, and low-income populations than for the members of the population that are not in these groups. The maximum annual dose for the average member of any of the minority or low-income populations was 0.092 millirem compared to a dose of 0.10 millirem for a member of the general population and a dose of 0.11 millirem for a member of the population that does not belong to a minority or low-income group.

NNSA also analyzed human health impacts from exposure through special pathways, including subsistence consumption of native vegetation (pinyon nuts and Indian Tea [Cota]), locally grown produce and farm products, groundwater, surface waters, fish (game and nongame), game animals, other foodstuffs and incidental consumption of soils and sediments (on produce, in surface water, and from ingestion of inhaled dust). The special pathways could be important to the environmental justice analysis because some of these pathways may be more important or viable for the traditional or cultural practices of members of minority populations in the area. Analyses, however, show that the human health impacts associated with these special pathways would not present disproportionately high and adverse impacts to minority or low-income populations.

Facility Accidents

There is little difference among the alternatives for the maximum potential wildfire, seismic, or facility accident at LANL because actions under each alternative do not, for the most part, affect the location, frequency, scenario, or material at risk of the postulated accidents. Facility accident impacts are presented in terms of consequences and risks. Reported consequences assume that the accident occurs and do not account for how probable the accident is. The risk associated with an accident reflects the probability of the accident occurring; it is calculated by multiplying the consequences times the probability of occurrence.

In 2000, the Cerro Grande Fire burned a heavily forested canyon area to within about 0.75 miles (1.2 kilometers) of the waste storage domes in TA-54, but none were burned and there were no radiological releases from domes. Additional fuel reduction has been conducted since the Cerro Grande Fire, both to the vegetation surrounding the TA-54 area and within the domes themselves (for example, wooden pallets have been replaced with metal pallets), to further decrease the potential for a waste storage dome fire occurring as a result of a site wildfire. In the event of a wildfire that impacted LANL, burned the waste storage domes at TA-54, and caused their contents to be released to the environment, the radiological releases from those waste storage domes would dominate the potential impacts to LANL workers and to the public from the fire. Should such an accident scenario occur in which the contents of the waste storage domes actually caught on fire and burned, the MEI would likely develop a fatal cancer during his or her lifetime and an additional 55 LCFs could be expected in the general area population. Any onsite worker located within 110 yards (100 meters) of the facility during such an accident would likely develop a fatal cancer during his or her lifetime. Taking into account the probability of occurrence, the annual risks are estimated to be about 1 chance in 20 of an LCF for the MEI or for an onsite worker and an additional 3 (calculated value of 2.7) LCFs in the offsite population. These risks assume that workers and members of the public do not take evasive action in the event of a wildfire. It is likely that workers and the public would be evacuated, as happened during the Cerro Grande Fire. These risks would decrease as transuranic waste is removed from the domes and transported to WIPP for disposal. In terms of chemical risks from a wildfire, the accidental release of formaldehyde from the Bioscience Facilities in TA-43 would expose the public and noninvolved workers to the greatest risks, similar to those associated with a seismic event, as discussed below.

The seismic event that presents the largest risk to the public would be a postulated Performance Category 3 earthquake (Seismic 2 scenario). If this accident were to occur, there would be widespread damage at LANL and across the region resulting in a large number of fatalities and injuries unrelated to LANL operations. Facilities at LANL would be affected and the public and workers at the site would be exposed to increased risks from both radiological and chemical releases. The consequences of such a seismic accident would be an increased lifetime risk of an LCF of 0.55 (1 chance in 1.8) for the MEI and an additional 22 LCFs could be expected in the population; a noninvolved worker 110 feet (100 meters) from certain failed buildings would likely develop an LCF.

The seismic accident scenarios (Seismic 1 and 2) analyzed in the SWEIS are based on the *Seismic Hazards Evaluation of the Los Alamos National Laboratory (February 24, 1995)*. The 1995 study concluded that a seismic event characterized by a peak horizontal ground acceleration of 0.22g (0.22 times the acceleration due to gravity) had an estimated annual probability of exceedance (probability of occurrence when calculating risk) of 0.001 (1 in 1,000). The study also showed that the more severe seismic event characterized by a peak ground acceleration of 0.31g had an estimated annual probability of exceedance of 0.0005 (1 in 2,000). An updated probabilistic seismic hazard analysis that provides an improved understanding of the seismic characteristics of LANL was completed in 2007 (LANL 2007). The new study indicates that the seismic hazard is higher than previously understood; that is, the likelihood of earthquakes capable of producing strong ground shaking at the LANL site is greater than previously estimated. For example, the annual probabilities of exceedance for the previously analyzed peak ground accelerations are now estimated to be about 1 in 700 rather than 1 in 1000 and 1 in 1,250 rather than 1 in 2,000. Using the assumptions inherent in the accident source terms developed for the SWEIS Seismic 1 (Performance Category 2 earthquake) and Seismic 2 (Performance Category 3 earthquake) accident scenarios, the most conservative effect on accident risks would be an increase of 50 percent and 60 percent, respectively. Although the greater probability of exceedance results in a higher risk from seismic events, these risks remain lower than those associated with other postulated accidents.

Taking into account the probability of occurrence, the annual risks from a Seismic 2 accident are estimated to be an increase of 1 chance in 2,200 of the MEI developing an LCF and no additional LCFs (a calculated risk much less than 1) in the offsite population. The largest chemical risk from such an event would result from a formaldehyde release from the Biosciences Facilities in TA-43, leading to life-threatening concentrations at the locations of the noninvolved worker and the MEI. The seismic event that presents the largest risk to a noninvolved worker is the Seismic 1 accident (a Performance Category 2 earthquake) with a frequency of once every 700 years. The annual increased risk of a LCF to the noninvolved worker would be about 0.0015 or 1 in 700.

Just as the updated probabilistic seismic hazards analysis used new data and advanced methods to calculate LANL seismic hazards, revised structural analysis tied to damage states credited in the safety assessments will be used to update the seismic structural integrity evaluation of LANL facilities. The effect of the higher values of peak horizontal ground acceleration on calculated seismic accident consequences and risks will be analyzed in future LANL facility safety analyses and incorporated as appropriate into future LANL NEPA documents. NNSA and the LANL contractor will undertake an evaluation of LANL facility performance in terms of the updated seismic hazard information. Until a revised analysis is completed, facility operations are authorized based on NNSA approval of a contractor-prepared justification for continued operation.

Under all alternatives, the facility accident with the highest radiological risk to the offsite population would be a lightning strike fire at the Radioassay and Nondestructive Testing Facility. If this accident were to occur, there could be six additional LCFs in the offsite population. Under the Expanded Operations Alternative, if the Chemistry and Metallurgy Research Building fire involving sealed sources were to occur, the consequence to the offsite population would be greater (seven LCFs) than that of the Radioassay and Nondestructive Testing Facility lightning strike fire; however, the estimated frequency is much less. Also, the consequences of that accident are based on a conservative assumption that the entire inventory of radiological material allowed in the Chemistry and Metallurgy Research Building is dedicated to a single isotope contained in sealed sources.

Under all alternatives, the individual facility accident with the highest estimated consequences to the MEI and noninvolved workers would be a fire at a waste storage dome in TA-54. If this accident were to occur as modeled, the noninvolved worker and the MEI would receive large radiation doses. Depending on the specific radionuclides released and the route of human exposure, radiation doses of this magnitude would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual, mitigating health impacts, or both. In addition to the conservative assumptions used to develop the source term (amount of radioactive material released) for this accident, the calculated doses are based on the assumptions that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs.

Taking into account the frequency of the postulated accidents, the estimated highest risk accident would be a lightning strike fire at the Radioassay and Nondestructive Testing Facility. The relatively large risk of the accident is due to the conservative assumption that any lightning strike at the Radioassay and Nondestructive Testing Facility has sufficient energy and occurs at a location that results in a building fire and concomitant source term. The increased risk of an LCF for this accident would be 0.06 (about 1 chance in 16) for the MEI, 0.12 (about 1 chance in 8) for the noninvolved worker,[10] and 0.8 for the offsite population (a risk of 1 LCF occurring in the population over approximately 1.3 years of operation).

For chemical accident risks, the individual facility accident with the largest risk to the public is a selenium hexafluoride release from TA-54. There is an annual risk of about 1 chance in 240 that members of the public could receive life-threatening exposures from this accident. For a chlorine gas release outside of TA-55, there is an annual risk of about 1 chance in 15 that noninvolved workers could receive a life-threatening exposure to this chemical from an accident. There is a great deal of uncertainty regarding how much and which chemicals were disposed of in the MDAs. The MDA closest to the public (and thus with the potentially greatest impacts on the public), MDA B, was chosen to bound the chemical accident impacts for MDA cleanup. Two chemicals, sulfur dioxide (a gas) and beryllium (assumed to be in powder form), were chosen based on their respective hazards to bound the impacts of chemicals possibly disposed of in the MDAs. Both of these chemicals, if present in the quantities assumed, would dissipate to below life-threatening concentrations very close to the release point, but would continue to present a risk to the public due to the short distance to the nearest public access point for MDA B.

Substantive details of terrorist attack scenarios and security countermeasures are not released to the public because disclosure of this information could be exploited by terrorists to plan attacks. Depending on the malevolent, terrorist, or intentionally destructive acts, impacts may be similar to or would exceed bounding accident impact analyses prepared for the SWEIS. A separate classified appendix to the Final SWEIS has been prepared that evaluates the underlying facility threat assumptions with regard to malevolent, terrorist, or intentionally destructive acts. These data provide the NNSA decisionmaker with information upon which to base, in part, his or her decisions supported by the SWEIS.

---

[10] The lightning strike fire at the Waste Characterization, Reduction, and Repackaging Facility has a slightly higher risk for the noninvolved worker; an increased risk of an LCF of 0.14 (1 chance in 7) per year.

Table S–5 Summary of Environmental Consequences by Resource Area

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative (Preferred Alternative)
Land Use			
	Land Conveyance and Transfer - The remaining 1,820 acres (737 hectares) of the 4,078 acres (1,650 hectares) of land identified per Public Law 105-119 would be conveyed or transferred. - Development may occur on up to 826 acres (334 hectares). - Potential introduction of incompatible land uses. - Loss of recreational opportunities. *Electrical Power System Upgrades* - 473 acres (191 hectares) affected by upgrades. - Project generally compatible with existing land use.	Same as No Action Alternative.	Same as No Action Alternative, plus: *MDA Remediation Project* - Fewer restrictions on land use for Removal Option than for the Capping Option. - No major changes in land use designations in most cases because surrounding land uses would retain their current classification. *Security-Driven Transportation Modifications Project* - Most development would not conflict with current land use designations. - Auxiliary Action A - Within scope of current land use plans. - Auxiliary Action B - Partially within scope of current land use plans. Current plans, however, contain no provision for a bridge over Sandia Canyon. *Replacement Office Buildings Project* - 13 acres (5.3 hectares) of undeveloped land in TA-3 would be developed consistent with a change in future land use from Reserve to Physical/Technical Support. *TA-18 Closure Project* - Possible change in land use designation of TA-18 to Reserve after DD&D of the Pajarito Site. *TA-21 Structure DD&D Project* - Future LANL development could negate the proposed change in land use from the current designation to Reserve. *Radiological Sciences Institute Project* - 12.6 acres (5.1 hectares) of undeveloped land at or near TA-48 would be developed consistent with land use plans. *RLWTF Upgrade Project* - Up to 4 acres (1.6 hectares) of undeveloped land near the border of TA-5 and TA-52 could be developed for evaporation tanks. *Science Complex Project* - 5 acres (2 hectares) of undeveloped land at or near TA-62 would be developed; 15.6 acres (6.3 hectares) could undergo a change in land use plans to Experimental Science.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
			Remote Warehouse and Truck Inspection Station Project - 4 acres (1.6 hectares) of undeveloped land in TA-72 would be developed with a change in land use plans to Physical/Technical Support. *Waste Management Facilities Transition Project* - Up to 7 acres (2.8 hectares) of undeveloped land could be disturbed that could result in a change in land use designation.
Visual Environment			
	Land Conveyance and Transfer - Development could degrade views of presently undeveloped tracts. *Electrical Power System Upgrades* - Short-term visual impacts during construction. - Adverse visual impact in undisturbed areas. - No overall change in view from Bandelier National Monument. *Wildfire Hazard Reduction Program* - Forest would appear more park-like. - Some LANL facilities would be more visible. *Disposition of Flood Retention Structures* - Temporary impacts during removal if staging areas are located near Pajarito Road. Temporary impacts during construction of the CMRR Facility at TA-55. Temporary impacts during construction of replacement or new buildings and long-term enhancement of visual environment from removal of old buildings for the following projects: - High Explosives Processing Facilities, and - High Explosives Testing Facilities.	Same as No Action Alternative.	Same as No Action Alternative, plus: *MDA Remediation Project* - Temporary visual impacts during MDA capping or removal. - Borrow pit in TA-61 would become more visible due to the large quantities of material needed under both options. *Security-Driven Transportation Modifications Project* - Temporary impacts during construction. - Pronounced impacts due to parking lots, as well as vehicle and pedestrian bridges, especially for auxiliary actions involving bridges across canyons. *Physical Science Research Complex* - Temporary impacts during construction. - New structures would blend with other TA-3 construction. - Appearance of TA-3, TA-35, and TA-53 would improve with demolition of vacated structures. *Replacement Office Buildings Project* - Temporary impacts during construction. - New buildings and parking lot would be visible from West Jemez Road and Pajarito Road. *TA-18 Closure Project* - Temporary impact from demolition of Pajarito Site facilities at TA-18. - Long-term enhancement of visual environment as area is restored to more natural appearance. *TA-21 Structure DD&D Project* - Enhancement of visual environment from the removal of old structures from TA. Both conveyed and nonconveyed lands could undergo development which could change visual environment.

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative (Preferred Alternative)
			Radiological Sciences Institute Project - Temporary impacts during demolition and construction. *RLWTF Upgrade Project* - Short-term impact from construction of new treatment building in TA-50. - Permanent change to the visual environment if evaporation tanks are built near the border of TA-5 and TA-52. *Waste Management Facilities Transition Project* - Beneficial impact on near and distant views from removal of domes in TA-54. - Minimal visual impact of the TRU Waste Facility to the public; possible impact on views from San Ildefonso Pueblo lands, depending on its location. - Temporary impacts during construction of structures at TA-54 and another location in the Pajarito Road corridor. *Science Complex Project* - Under Options 1 and 2, the new facility would be readily visible from West Jemez Road and forested buffer between LANL and Los Alamos Canyon would be lost; potential impacts to Los Alamos Canyon from night lighting. - Negligible impacts for Option 3. *Remote Warehouse and Truck Inspection Station Project* - 4 acres (1.6 hectares) would be cleared making the site readily visible from East Jemez Road; lighting could be visible from Tsankawi Unit of Bandelier National Monument.
Geology and Soils			
	Overall level of legacy contamination in soil should continue to decrease as a result of ongoing remediation projects including cleanup of suspected contamination at TA-21.	Same as No Action Alternative, except that the potential impact of LANL operations on soil could decrease because of the 20 percent reduction in high explosives testing activities.	Same as No Action Alternative, except: *MDA Remediation Project* - Use of large amounts of soil and rock for backfill or closure caps (up to 2.5 million cubic yards) (1.9 million cubic meters). - Positive impact from removal or containment of legacy waste. - TA-61 borrow pit would be expanded to provide additional soil and rock; other sources may be required. Temporary adverse impacts from excavation of large amounts of rock and soil during construction and DD&D, and positive impacts from removal of legacy contamination for the following projects: - *Physical Science Research Complex,* - *Replacement Office Buildings,*

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
			- TA-18 Closure, *- TA-21 Structure DD&D,* *- Radiological Sciences Institute* *- RLWTF Upgrade,* *- Waste Management Facilities Transition,* *- TA-55 Radiography Facility,* *- Science Complex,* *- Remote Warehouse and Truck Inspection Station, and* *- Security-Driven Transportation Modifications.*
Water Resources – Surface Water			
	Only minor impact on surface water quality or quantity, or floodplains from activities other than the project to remove flood retention structures. Removal of flood retention structures could result in potential impacts on Pajarito floodplains. Restoration of normal flow would cause sediments to alter channel and readjust floodplains.	Same as No Action Alternative, except shutdown of LANSCE operations would result in significant reductions of NPDES-permitted cooling tower discharges, particularly to Los Alamos Canyon.	Same as No Action Alternative, and: Potentially long-term positive impact from MDA remediation because water quality would be protected by removal or stabilization of waste or contaminants in soil. DD&D of TA-18 structures would eliminate potential sources of contaminants, thereby enhancing protection of surface water quality. Complete Removal Option for DD&D of TA-21 would eliminate two NPDES-permitted outfalls reducing discharges to Los Alamos Canyon. Although increased pit production would increase RLWTF outfall volumes by 25 percent, this would have a negligible effect on surface water volumes in Mortandad Canyon because other facilities contribute 90 percent of the outfall flow in that canyon. Implementing the zero discharge option at the RLWTF (evaporation tanks) would have a minor effect on surface water volume, but would improve surface water quality by reducing the uptake of historical contaminations in the sediments downstream of that outfall.
Water Resources – Groundwater			
	Construction and DD&D activities are unlikely to affect groundwater resources. Operations-related impacts to groundwater are not likely to be significant in nature.	Same as No Action Alternative, except long-term impacts as a result of operations might be reduced by elimination of additional outfalls and reduction of water use.	Same as No Action Alternative, except impacts from water supply well withdrawals could increase and positive long-term impacts could occur from MDA remediation and the reduced potential for contaminant migration.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Nonradiological Air Quality			
	Minor temporary localized increases in air emissions from construction and demolition activities. Minor increases in air emissions from operations and remediation activities, including operation of new combustion turbine generators.	Same as No Action Alternative, except for reductions in emissions from reduced high explosives processing and testing activities and shutdown of LANSCE and the Pajarito Site (TA-18).	- Higher level of emissions from increased operations and proposed construction, demolition, and remediation including increases in emissions from commuter vehicles, and waste and materials shipments. - Hazardous air pollutants could increase by up to 2.5 percent from the High Explosives Processing Facilities resulting from the increased use of mock explosives. - Temporary construction-type releases of criteria pollutants would occur from MDA remediation, DD&D, and construction of new facilities. - Minor to moderate air quality impacts would result from remediating MDAs, and other PRSs, particularly for MDA removal.
Radiological Air Quality			
Curies per year:			
Tritium [a]	2,400	2,400	2,400 [b]
Americium-241	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6} [c]
Plutonium [d]	0.00082	0.000092	0.00084 [c]
Uranium [e]	0.15	0.12	0.15
Particulate and vapor activation products	30	0.014	30
Gaseous mixed activation products	30,600	100 [f]	30,600 [f]
Mixed Fission Products [g]	1,650	1,650	1,650
Emissions from remediation	Not applicable	Not applicable	Variable [h]

[a] Includes both gaseous and oxide forms of tritium.
[b] Tritium emissions would decrease to 1,850 curies per year after about 2009 following decontamination, decommissioning, and demolition of TA-21.
[c] Americium-241 emissions could increase to 1.1×10^{-5} curies per year and plutonium emissions to 0.00089 curies per year if the Decontamination and Volume Reduction System, the new TRU Waste Facility, and remote-handled transuranic waste retrieval activities operated simultaneously (estimated to occur from 2012 through 2015).
[d] Includes plutonium-238, plutonium-239, and plutonium-240.
[e] Includes uranium-234, uranium-235, and uranium-238.
[f] Gaseous mixed activation products emissions would decrease by 100 curies per year after about 2009 due to the permanent shutdown of TA-18, resulting in zero emissions of gaseous mixed activation products in the Reduced Operations Alternative and 30,500 curies per year in the Expanded Operations Alternative.
[g] Mixed fission products include krypton-85, xenon-131m, xenon-133, and strontium-90.
[h] There would be additional emissions from the remediation of the larger MDAs. These emissions would depend on radionuclides present, whether an MDA is being capped or removed, the number of MDAs being remediated at one time, and whether exhumation occurs under an enclosure.

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative (Preferred Alternative)
Noise			
	Operations noise levels would have little impact on the public with the exception of sporadic noise from explosives detonations and traffic noise. Temporary localized increases in noise levels would occur from construction, demolition, and remediation activities that would be expected to have little impact on the public.	Same as No Action Alternative, except minor reductions in noise levels from reduced high explosives testing activities and shutdown of LANSCE and Pajarito Site (TA-18).	Higher noise levels than the No Action Alternative from increased operations, construction, DD&D, and remediation activities. Increase in truck and personal vehicle traffic noise, some of which could occur during nighttime, could result in public annoyance: - Up to a 32 percent increase in traffic along DP Road affecting nearby businesses and residents. - Up to a 13 percent increase in traffic along East Jemez Road affecting residents.
Ecological Resources			
	Land Conveyance and Transfer - 770 acres (312 hectares) of habitat could be lost through development. - Transfer of resource protection responsibility could result in a less rigorous environmental protection review process. *Electrical Power System Upgrades* - Temporary displacement of wildlife due to construction-related activities. - Potentially positive impact by providing perching sites for larger birds. *Wildfire Hazard Reduction Program* - Short-term disturbance of wildlife due to forest thinning activities. - Increased forest health could benefit the Mexican spotted owl and other species. *Disposition of Flood Retention Structures* - Temporary displacement of wildlife due to construction-related activities. - Potentially minor impacts on downstream wetlands *Trails Management Program* - Temporary disturbance of wildlife during implementation activities. Clearing of some ponderosa pine forest in TA-48 and TA-55 for construction of CMRR Facility would cause loss or displacement of associated wildlife.	Same as No Action Alternative, plus: - Reduction in high explosives testing activities would reduce the number of times animals would be subjected to stress resulting from high explosives testing.	Same as No Action Alternative, plus: *MDA Remediation Project* - Short-term disturbance and displacement of wildlife during capping or waste removal. - Loss of habitat at borrow pit in TA-61, including buffer and core habitat for the Mexican spotted owl. Section 7 consultation with the U.S. Fish and Wildlife Service would be required. - Remediation activities may affect, but are not likely to adversely affect the Mexican Spotted Owl, bald eagle, and southwestern willow flycatcher. *Security-Driven Transportation Modifications Project* - Parking lot construction and placement of pedestrian and vehicle bridges would destroy up to 30 acres (12 hectares) of natural habitat. Construction of a span bridge over Ten Site Canyon would be unlikely to adversely affect the Mexican spotted owl. - Auxiliary Action A would disturb up to 25.4 acres (10.6 hectares) of undeveloped core and buffer Mexican spotted owl habitat. Auxiliary Action B would disturb up to 67.1 acres (27.2 hectares) of undeveloped core and buffer habitat. - Under both auxiliary actions, bridge traffic over the core zone of the Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest could cause long-term impacts. Section 7 consultation with the U.S. Fish and Wildlife Service would be needed. *Replacement Office Buildings Project* - Temporary displacement of wildlife due to construction-related activities.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
	Short-term impacts in TA-6, TA-22, and TA-40 from construction of new High Explosives Test Facility buildings and demolition of old structures would cause loss or displacement of wildlife.		- Clearing 13 acres (5.3 hectares) of mixed conifer forest in TA-3 would result in loss or permanent displacement of wildlife. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. *TA-18 Closure Project* - Minor impact on wildlife during demolition of Pajarito Site structures in TA-18. DD&D activities may affect, but is not likely to adversely affect, the Mexican spotted owl and southwestern willow flycatcher. - Restoration of TA-18 (Pajarito Site) would create a more natural habitat and benefit wildlife, potentially including the Mexican spotted owl. *TA-21 Structure DD&D Project* - Minor disturbance of wildlife on adjacent land during demolition of structures. DD&D activities may affect, but is not likely to adversely affect, the Mexican spotted owl. *Radiological Sciences Institute Project* - Temporary disturbance of wildlife during demolition of structures and construction in TA-48. - Clearing of 12.6 acres (5 hectares) of ponderosa pine forest would cause loss or displacement of associated wildlife. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. - DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl. *RLWTF Upgrade Project* - Loss of up to 5.4 acres (2.2 hectares) of habitat if the evaporation tanks and pipeline are constructed. - Implementation of the evaporation tank option would reduce wetlands and riparian habitat in Mortandad Canyon and the abundance and diversity of Mexican spotted owl prey species, requiring Section 7 consultation with the U.S. Fish and Wildlife Service. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. *Waste Management Facilities Transition Project* - Short-term impacts on wildlife in the vicinity of TA-54 and the TRU Waste Facility site from new construction and demolition activities. - TRU Waste Facility construction could result in the loss of 2.5 to 7 acres (1.0 to 2.8 hectares) of ponderosa pine forest or open field.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
			- Construction at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. - A TRU Waste Facility could be built in portions of the Mexican spotted owl Area of Environmental Interest which would require Section 7 consultation with the U.S. Fish and Wildlife Service.
			Science Complex Project - Temporary displacement of wildlife due to construction-related activities. - Options 1 and 2 would remove 5 acres (2 hectares) of ponderosa pine forest. - Under Option 3, less than 5 acres (2 hectares) of grassland and forest would be cleared. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. *Remote Warehouse and Truck Inspection Station Project* - Temporary displacement of wildlife due to construction-related activities. - 4 acres (1.6 hectares) of ponderosa pine forest and pinyon-juniper woodland would be cleared. - Construction may affect, but is not likely to adversely affect, the bald eagle.
Human Health			
Offsite Population			
Dose (person-rem per year)	30	6.1 [i]	Less than 36 [j, k]
Risk (LCFs per year)	0.018	0.0037	0.022
MEI [l]			
Dose (millirem per year)	7.8	0.78 [i]	Less than 8.2 [j, k]
Risk (LCFs per year)	4.7×10^{-6}	4.7×10^{-7}	4.9×10^{-6}
Workers			
Dose (person-rem per year)	280	257	407 to 543 [m]
Risk (LCFs per year)	0.17	0.15	0.24 to 0.33 [m]

[i] After about 2009, TA-18 (Pajarito Site) would no longer be able to contribute to radiological air emissions, thereby reducing the MEI and population doses.

[j] Population dose and MEI dose include 6.2 person-rem and 0.42 millirem respectively, attributable to the assumed removal of all MDAs (LCF risk of 3.7×10^{-3} and 2.5×10^{-7}, respectively). This dose could be smaller depending on the MDAs being remediated, whether an MDA is capped rather than removed, the number of MDAs being remediated at one time, and other factors.

[k] After about 2009, TA-18 (Pajarito Site) and TA-21 would not contribute to radiological air emissions, thereby reducing the MEI and population doses.

[l] Under the No Action Alternative and the Expanded Operations Alternative, the LANL site-wide MEI would be located near LANSCE. Under the Reduced Operations Alternative, the LANL site-wide MEI would be located near the firing sites at TA-36.

[m] The range for the Expanded Operations Alternative reflects the contribution from the two MDA Remediation Project options. The lower value is for the Capping Option, the higher value is for the Removal Option. The annual average worker doses contributed by the MDA Remediation Project alone would range from about 1 (MDA capping) to 137 (MDA removal) person-rem per year (0.0006 to 0.082 LCF per year).

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Cultural Resources			
	Land Conveyance and Transfer - Potential damage to cultural resources and impacts on protection of and accessibility to Native American sacred sites from conveyance or transfer of cultural resources out of the responsibility and protection of DOE. Potential damage on conveyed or transferred parcels due to future development. *Trails Management Program* - Enhanced protection of cultural resources. Potentially adverse effects from demolition and remodeling of historic buildings in High Explosive Processing and Testing Facilities. Documentation would be required to resolve adverse effect.	Same as No Action Alternative.	Same as No Action Alternative plus: *Waste Management Facilities Transition Project* Removal of domes would have a positive impact on views from traditional cultural properties. Potential impact to cultural resources from construction of the TRU Waste Facility. Also, this facility could be visible from lands of the Pueblo of San Ildefonso, depending on its location. *MDA Remediation Project* No direct impacts are expected for either option of the MDA Remediation Project, although the potential for indirect impacts from temporary remediation support activities in the vicinities of the MDAs and PRSs would require review and protective measures taken as needed. To varying degrees, impacts on archaeological sites or historic structures eligible or potentially eligible for listing on the National Register of Historic Places could result from the following projects. These resources would be protected as appropriate and documentation would be developed as required to resolve adverse effects. - *Security-Driven Transportation Modifications,* - *Physical Science Research Complex,* - *Replacement Office Buildings,* - *Radiological Sciences Institute (including the Institute for Nuclear Nonproliferation Science and Technology),* - *RLWTF Upgrade,* - *LANSCE Refurbishment,* - *Waste Management Facilities Transition,* - *TA-55 Radiography Facility,* - *Science Complex* - *Remote Warehouse and Truck Inspection Station.* - *TA-18 Closure Project* - *TA-21 Structure DD&D*

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative (Preferred Alternative)
Socioeconomics			
	LANL Employment		
	2005 levels of employment assumed to remain steady at 13,504 employees.	A decrease of 500 employees from 2005 levels would be expected to result in the loss of 530 indirect jobs in the region (total 1,030 jobs lost).	An employment increase of 2.2 percent per year from 2007 to 2011 would result in an additional 600 to 1,890 employees working at LANL and creation of another 640 to 2,000 indirect jobs. This growth rate is consistent with the projected regional growth rate.
	Housing		
	No new housing units needed specific to changes in LANL employment level.	Additional housing units could become available in the tri-county area as a result of the projected decrease in LANL's employment level. These could be expected to offset the need for additional housing units in the region because the population would still be expected to grow, although at a slower rate (about 1.5 percent versus 2.3 percent).	Additional housing units would be required in the tri-county area due to the projected increase in LANL's employment level along with the projected increase in the region's population. More LANL employees could be expected over time to reside in Rio Arriba, Santa Fe, or other surrounding counties, compared to Los Alamos County, where a shortage of available housing would likely continue. The number of housing units needed would depend on the number of workers relocating from outside the area. Overall, the number of units needed would likely be small compared to overall needs in the tri-county area.
	Construction		
	Completion of previously approved construction projects is expected to draw workers already in the region who historically work from job-to-job.	Same as the No Action Alternative for construction projects.	An increase in the number of construction projects would be expected to draw workers already in the region who historically work from job-to-job.
	Local Government Finance		
	Annual gross receipts tax yields would be expected to remain at current levels in real terms.	Annual gross receipts tax yields directly and indirectly associated with LANL employment could decrease by about 1.1 percent.	Annual gross receipts tax yields directly and indirectly associated with LANL employment are projected to increase by between 1.3 and 3.9 percent from 2007 through 2011 over 2005 levels in real terms.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
		Services	
	The demand for services such as police, fire, and hospital beds would be expected to remain at current levels in proportion to LANL employment. Regional population is projected to increase even if LANL employment remains flat, so there would be an increase in the demand for regional services but the increased demand would not be driven by LANL employment growth.	Demand for services would be expected to decrease in proportion to the number of out-of-work LANL-related employees leaving the region. However, regional population would still be projected to increase even if LANL employment was to decrease by the small levels envisioned in this alternative compared to the No Action Alternative. Demand for services would likely increase as well.	Demand for services would be expected to increase in proportion to the number of additional LANL-related jobs added to the region. The associated number of additional school age children would be between 440 and 1,400 in the tri-county area, resulting in an estimated increase in needed public school funding from the State of $3.2 million in 2007 to $11 million in 2011. Most of the additional services would be required in Rio Arriba, Santa Fe, and other surrounding counties.
		Site Infrastructure	
LANL Site and Other Los Alamos County Users Total Per Alternative (annual)	Electricity requirements: 645,000 megawatt-hours total (495,000 megawatt-hours for LANL); 49 percent of system capacity. Electric Peak Load: 111 megawatts total (91.2 megawatts for LANL); 74 percent of system capacity. Natural Gas Demand: 2,215,000 decatherms total (1,197,000 decatherms for LANL); 27 percent of system contract capacity supply. Water Demand: 1,621 million gallons total (380 million gallons for LANL); 90 percent of system available water rights. *Project Effects:* - Ongoing electrical power system upgrades would have a positive incremental impact on site electrical energy and peak load capacity. - Potential for increased natural gas consumption from increased capacity at the TA-3 Co-Generation Complex. Note: Values are rounded.	Electricity Requirements: 516,000 megawatt-hours total (366,000 megawatt-hours for LANL); 39 percent of system capacity. Electric Peak Load: 80.6 megawatts total (60.4 megawatts for LANL); 54 percent of system capacity. Natural Gas Demand: 2,181,000 decatherms total (1,163,000 decatherms for LANL); 27 percent of system contract supply capacity. Water Demand: 1,544 million gallons total (303 million gallons for LANL); 85 percent of system available water rights. *Project Effects:* Same as the No Action Alternative.	Electricity Requirements: 827,000 megawatt-hours total (677,000 megawatt-hours for LANL); 63 percent of system capacity. Electric Peak Load: 144 megawatts total (124 megawatts for LANL); 96 percent of system capacity. Natural Gas Demand: 2,331,000 decatherms total (1,313,000 decatherms for LANL); 29 percent of system contract supply capacity. Water Demand: 1,763 million gallons total (522 million gallons for LANL); 98 percent of system available water rights. *Project Effects:* - Increases in electrical energy, peak load, and water demands over the No Action Alternative due to increased operational levels at the Metropolis Center and LANSCE (see above).
MDA Remediation (total over ten years)	No change in utility demands.	Same as No Action Alternative.	Annual average of up to 70 million gallons of liquid fuels and 58 million gallons of water for remediation activities.

Waste Type	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative (Preferred Alternative)		
			Total Including MDA Remediation Project	*Total Excluding MDA Remediation Project*	*MDA Remediation [n] Project Only*
Waste Management (10-Year Total)					
Transuranic Waste					
Contact-handled [o] (cubic yards)	3,500 to 5,900	3,500 to 5,900	5,300 to 33,000	5,200 to 11,000	68 to 22,000
Remote-handled [p] (cubic yards)	–	–	11 to 61	11	0 to 50
Low-Level Radioactive Waste [p, q]					
Bulk low-level radioactive waste (cubic yards)	39,000	39,000	196,000 to 884,000	186,000	11,000 to 698,000
Packaged low-level radioactive waste (cubic yards)	33,000 to 128,000	33,000 to 110,000	80,000 to 183,000	80,000 to 183,000	–
High activity low-level [p] radioactive waste (cubic yards)	–	–	0 to 347,000	–	0 to 347,000
Remote-handled low-level [p] radioactive waste (cubic yards)	–	–	480 to 1,700	480	0 to 1,200
Mixed low-level radioactive waste (cubic yards)	1,800 to 2,800	1,800 to 2,800	3,900 to 183,000	3,200 to 4,400	710 to 178,000
Construction/Demolition Debris [r] (cubic yards)	198,000	197,000	642,000 to 722,000	595,000	47,000 to 126,000
Chemical waste [s] (pounds)	19,000,000 to 37,000,000	19,000,000 to 36,000,000	64,000,000 to 129,000,000	22,000,000 to 39,000,000	42,000,000 to 90,000,000
Liquid Radioactive Wastes					
Liquid transuranic waste (gallons)	300,000	300,000	500,000	500,000	(t)
Liquid low-level radioactive waste (at TA-50) (gallons)	40,000,000	40,000,000	50,000,000	50,000,000	(t)
Liquid low-level radioactive waste (at TA-53) (gallons)	1,400,000	50,000 [u]	1,400,000	1,400,000	(t)

[n] Waste volumes are the incremental increase over remediation waste projections from the No Action Alternative.

[o] Operations waste volumes are assumed to be contact-handled transuranic waste and packaged low-level radioactive waste; small volumes of remote-handled or high-activity waste may be generated.

[p] These waste types are generated during retrieval of waste from MDAs under the Expanded Operations Alternative. Nominal volumes generated under other alternatives are accounted for in other waste categories.

[q] The subcategories of low-level radioactive waste do not necessarily meet precise definitions, but are used to assist in the analysis of transportation and disposal options and impacts.
- Bulk low-level radioactive waste = wastes that can be transported in large volumes in soft-sided containers.
- Packaged low-level radioactive waste = typical low-level radioactive waste packaged in drums or boxes.
- High activity low-level radioactive waste = waste exceeding 10 CFR 61.55 Class A concentrations (greater than 10 nanocuries per gram of transuranic nuclides) and therefore not accepted at certain facilities.
- Remote-handled low-level radioactive waste = waste with a dose rate exceeding 200 millirem per hour at the surface of the container.

[r] Demolition waste includes uncontaminated wastes such as steel, brick, concrete, pipes and vegetative matter from land clearing.

[s] Chemical waste includes wastes regulated under the Resource Conservation and Recovery Act, Toxic Substances Control Act, or state hazardous waste regulations. The large increase under the Expanded Operations Alternative is primarily due to high volumes of waste associated with MDA remediation.

[t] MDA remediation is projected to generate roughly 10,000 to 24,000 gallons (38,000 to 91,000 liters) of industrial, hazardous, low-level, and mixed low-level liquid wastes.

[u] Under the Reduced Operations Alternative, operations at the LANSCE facility would cease. Approximately 5,000 gallons (20,000 liters) of radioactive liquid waste per year from TA-50 would continue to be treated at TA-53.

Note: Because values have been rounded to the nearest hundred, thousand, or million, totals may not equal the sum of individual contributions.
To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359; gallons to liters, multiply by 3.78533.

	No Action Alternative	Reduced Operation Alternative	Expanded Operations Alternative (Preferred Alternative)				
			Total Including MDA Remediation Project		Excluding MDA Remediation Project	MDA Remediation Project Only	
			Capping	Removal		Capping	Removal
Transportation (for 10-Year Period 2007-2016)							
Incident Free							
Public Radiation Exposure *Dose (person-rem) / Risk (LCFs):*							
Total	58.4/0.035	53.1/0.032	89.1/0.053	286.8/0.17	88.6/0.053	0.49/0.0003	198.2/0.12
LANL to Pojoaque	1.8/0.0011	1.7/0.0010	2.8/0.0017	8.1/0.0049	2.8/0.0017	0.01/0.000006	5.3/0.0032
Pojoaque to Santa Fe	3.3/0.0020	3.1/0.0019	4.6/0.0028	13.3/0.0080	4.6/0.0028	0.02/0.00001	8.7/0.0052
Worker Radiation Exposure: (transport drivers) *Dose (person-rem) / Risk (LCFs):*	163.8/0.098	147.2/0.088	255.9/0.15	910.3/0.55	254.0/0.15	1.9/0.0012	656.4/0.40
Transportation Accidents							
Population: - *Radiological Risk (LCFs)*	0.00017	0.00015	0.00025	0.0016	0.00024	0.00001	0.0013
- *Nonradiological Traffic Fatalities* [v]	0 (0.37)	0 (0.34)	1 (0.95)	3 (3.23)	1 (0.90)	0 (0.02)	2 (2.3)

[v] Nonradiological traffic fatalities include all traffic accidents involving both radioactive and nonradioactive materials and waste shipments. Values presented are the nearest whole number.

	No Action Alternative	Reduced Operation Alternative	Expanded Operations Alternative (Preferred Alternative)
Local Traffic			
Average Daily Traffic at Entry Points	42,300	40,600	up to 49,800
Environmental Justice			
	No disproportionately high and adverse impacts on minority or low-income populations. Radiological doses to minority and low-income populations would be lower than those to sectors of the population that are not members of these groups. Human health impacts from exposure through special pathways (including subsistence consumption of fish and wildlife) would not present disproportionately high and adverse impacts to minority or low-income populations.	Same as No Action Alternative.	While there would be small, but not significant, increases in radiological and chemical risks to the public (0.004 LCFs), increased levels of operations and implementation of proposed projects are not expected to have any disproportionately high and adverse impacts on minority or low-income populations. Radiological doses to minority and low-income populations would be lower than those to sectors of the population that are not members of these groups.

	No Action Alternative	*Reduced Operation Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Facility Accidents (highest risk and MDA removal accidents presented)			
Wildfire – Radiological (Waste Storage Domes at TA-54 – assumed frequency 1 in 20 years)			
Offsite Population			
Dose (person-rem)	91,000	Same as No Action Alternative.	Same as No Action Alternative.
Risk (LCFs per year)	2.7		
MEI			
Dose (rem)	1,900 [w]		
Risk (LCFs per year)	0.05 [x]		
Noninvolved Worker			
Dose (rem)	8,700 [w]		
Risk (LCF per year)	0.05 [x]		
Wildfire – Chemical (Releases formaldehyde at TA-43 – assumed frequency 1 in 20 years)			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit)	25 parts per million	Same as No Action Alternative	Same as No Action Alternative.
- ERPG-3 distance	97 yards		
- Distance to the site boundary	13 yards		
Site-Wide Seismic Event – Radiological (PC-3 seismic event – assumed frequency 1 in 1,250 years) [z]			
Offsite Population			
Total Dose (person-rem)	36,000	Same as No Action Alternative	Same as No Action Alternative
Risk (LCF per year)	0.014		
MEI			
Maximum Dose (rem)	460 [w]		
Risk (LCF per year)	0.00045		
Noninvolved Worker [aa]			
Maximum Dose (rem)	2,000 [w]		
Risk (LCF per year)	0.0008		
Site-Wide Seismic Event – Chemical (PC-3 seismic event releases formaldehyde at TA-43 – assumed frequency 1 in 1,250 years) [z]			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit)	25 parts per million	Same as No Action Alternative	Same as No Action Alternative.
- ERPG-3 distance	120 yards		
- Distance to the site boundary	13 yards		
Facility Accident (RANT lightning strike fire – assumed frequency 1 in 8 years)			
Offsite Population			
Dose (person-rem)	11,000	Same as No Action Alternative	Same as No Action Alternative
Risk (LCF per year)	0.8		
MEI			
Dose (rem)	410 [w]		
Risk (LCF per year)	0.06		
Noninvolved Worker [bb]			
Dose (rem)	1,900 [w]		
Risk (LCF per year)	0.12 [x]		

	No Action Alternative	*Reduced Operation Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Facility Chemical Release (Selenium hexafluoride at TA-54 – assumed frequency 1 in 240 years)			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit)	5 parts per million	Same as No Action Alternative	Same as No Action Alternative.
- ERPG-3 distance	962 yards		
- Distance to the site boundary	537 yards		
MDA G Removal Accident – Radiological (explosion – assumed frequency 1 in 100 years)			
Offsite Population	Not applicable	Not applicable	
Dose (person-rem)			770
Risk (LCF per year)			0.005
MEI			
Dose (rem)			55
Risk (LCF per year)			0.0007
Noninvolved Worker			
Dose (rem)			410
Risk (LCF per year)			0.005
MDA B Removal Accident (sulfur dioxide – frequency not assumed)			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit)	Not applicable	Not applicable	15 parts per million
- ERPG-3 distance			37 yards
- Distance to the site boundary			49 yards

[w] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[x] The risk to any individual would not exceed the risk of the accident scenario.

[y] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005c).

[z] Based on the 2007 update of the probabilistic seismic hazard analysis (LANL 2007).

[aa] The maximum risk (considering consequence and probability) to the noninvolved worker comes from the PC-2 seismic event which has a frequency of 1 in 700 (LANL 2007).

[bb] The maximum risk (considering consequence and probability) to the noninvolved worker comes from the Waste Characterization, Reduction, and Repackaging Facility lightning strike fire which has a frequency of 1 in 7.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MDA = material disposal area; LANSCE = Los Alamos Neutron Science Center; NPDES = National Pollutant Discharge Elimination System; RLWTF = Radioactive Liquid Waste Treatment Facility; CMRR = Chemistry and Metallurgy Research Replacement Facility; LCF = latent cancer fatality; MEI = maximally exposed individual; ERPG = Emergency Response Planning Guideline; PC = performance category; RANT = Radioassay and Nondestructive Testing; USFWS = U.S. Fish and Wildlife Service; ROI = region of influence.

Note: To convert gallons to liters, multiply by 3.7854; cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

S.9.2 Summary of Cumulative Impacts

In accordance with CEQ regulations, a cumulative impact analysis includes "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). The cumulative impact analysis for the SWEIS includes (1) an examination of cumulative impacts presented in the *1999 SWEIS*; (2) impacts since the *1999 SWEIS* was issued (presented in the new SWEIS); and (3) a review of the environmental impacts of past, present, and reasonably foreseeable actions for other Federal and non-Federal agencies in the region.

Reasonably foreseeable actions that are likely to occur at LANL are described under the Expanded Operations Alternative. Additional DOE or NNSA actions that could impact LANL include the possible consolidation of nuclear operations related to production of radioisotope power systems (DOE/EIS-0373D), proposed operation of a Biosafety Level 3 facility, a proposed advanced fuel cycle facility for research and development associated with the Global Nuclear Energy Partnership (GNEP) initiative; the potential implementation of Complex Transformation, and a potential disposal facility for Greater-Than-Class C waste.

Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems – As proposed in the *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems* (DOE/EIS-0373D) (*Consolidation EIS*) (DOE 2005a), consolidation of DOE plutonium-238 activities at the Idaho National Laboratory would reduce plutonium-238 operations at LANL. But regardless of the decision on the *Consolidation EIS*, some plutonium-238 operations would continue at LANL. Therefore, very small changes in the impacts from plutonium-238 activities at LANL would occur.

If current plutonium-238 operations were to continue at the LANL Plutonium Facility Complex, as described under the *Consolidation EIS* No Action Alternative, manufacturing of up to 80 pits per year could still be accomplished within the LANL Plutonium Facility Complex. This would be accommodated by consolidating a number of plutonium processing and support activities (such as analytical chemistry and materials characterization at the Chemistry and Metallurgy Research Replacement Facility). The impacts of the 80-pit-per-year production rate and plutonium-238 processing (at levels far above the level of plutonium-238 processing identified in the *Consolidation EIS*) have been evaluated in both the LANL *1999 SWEIS* and the new SWEIS. Therefore, there would be no additional cumulative effects from these activities.

Biosafety Level 3 Facility – NNSA is preparing an *Environmental Impact Statement for the Operation of a Biosafety Level-3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0388D) to analyze the potential environmental impacts of operating a Biosafety Level 3 Facility. Operation of the facility would be consistent with the land use designation of Research & Development for Experimental Science. The facility is visually compatible with surrounding structures; therefore, there would be no impacts to visual resources. There would be no impacts to geology and soils and water resources from operations. Air emissions from the facility's laboratories would be HEPA-filtered, resulting in very minor air quality effects. Noise impacts would be limited to noise from heating, ventilation, and air conditioning system operations, consistent with other buildings in the area. Facility operations would have no effect upon ecological resources or prehistoric, historic, traditional, or paleontological resources in the area. Facility personnel would come primarily from the existing LANL workforce, leading to no socioeconomic impacts. Operations would be well within LANL infrastructure capability to provide utilities such as electricity, water, and natural gas. There would be no discernable effects on local traffic conditions. There have been no reported cases of illnesses in the United States due to the release of diagnostic specimens during transport (Cummings 2007).

There would be a low potential risk of illness to site workers or visitors and no public human health effect from routine operations involving biohazardous material. Accident conditions would result in minimal or no impact to the public primarily because there would be severely limited opportunity for transport of an infectious dose of a biohazardous material to the public. Biohazardous material in open cultures would be handled only in a biosafety cabinet where a spill would be contained. In addition, biohazardous material would be handled in a liquid or solid culture container that would release very few organisms to the air if dropped or spilled. This means that one of the most critical risk factors, public exposure to an infectious dose from a biohazardous material, is greatly minimized, and therefore, the potential risk of disease would be very low. The EIS will address slope stability at the Biosafety Level 3 Facility based on the recent update to the LANL probabilistic seismic hazard analysis (Cummings 2007, LANL 2007).

Advanced Fuel Cycle Facility – On January 4, 2007, DOE issued an NOI (72 FR 331) to prepare a Programmatic EIS for the GNEP initiative. GNEP would encourage expansion of domestic and international nuclear energy production while reducing nuclear proliferation risks, and reduce the volume, thermal output, and radiotoxicity of spent nuclear fuel before disposal in a geologic repository. LANL is one of the DOE sites being considered for an advanced fuel cycle facility. The advanced fuel cycle facility would be a large shielded facility (approximately 1 million square feet [92,900 square meters]) (DOE 2008). Potential cumulative impacts at LANL associated with the proposed advanced fuel cycle facility are based on preliminary data and could change prior to the public release of the Draft *GNEP PEIS*.

Complex Transformation – On January 11, 2008, NNSA announced the availability of the Draft *Complex Transformation SPEIS* (73 FR 2023), which evaluates NNSA's proposal for a smaller, more efficient nuclear weapons complex that would be better able and more suited to respond to future national security challenges. The Preferred Alternative in the Draft *Complex Transformation SPEIS* is to pursue distributed centers of excellence. LANL would be the center of excellence for plutonium manufacturing and research and development, with a production capacity of up to 80 pits per year. This alternative would be based on the use of the existing and planned infrastructure already described in the SWEIS Expanded Operations Alternative (DOE 2007b). Among other alternatives for LANL that are evaluated in the *Complex Transformation SPEIS*, the one that would have the largest potential cumulative impacts is the consolidated nuclear production center. The SWEIS cumulative impacts analysis addresses the impacts of construction and operation of a consolidated nuclear production center at LANL.

Disposal of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC EIS). In July 2007, DOE issued an NOI to prepare an *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC EIS)* (72 FR 40135). The *GTCC EIS* will address the disposal of low-level radioactive waste generated by activities licensed by the

Nuclear Regulatory Commission or an Agreement State that contain radionuclides in concentrations exceeding 10 CFR 61 Class C limits, as well as DOE waste having similar characteristics. LANL is being considered as one of eight candidate DOE disposal sites for Greater-Than-Class C waste, along with a generic commercial disposal facility option in arid and humid environments. In addition, DOE is evaluating several disposal technologies in the *GTCC EIS* including geologic repositories, intermediate depth boreholes, and enhanced near-surface disposal facilities. The alternatives in the *GTCC EIS* could result in changes to facilities or operations at LANL, but because the changes have yet to be developed, quantitative data are not available for the cumulative impacts analysis.

Reasonably foreseeable actions for the region surrounding LANL were also reviewed for the cumulative impacts analysis. Interviews were conducted with personnel in planning departments in the surrounding counties, as well as from the regional Bureau of Land Management and Santa Fe National Forest offices, to collect information on activities that might affect cumulative impacts. Available documentation was reviewed for activities that could contribute to cumulative impacts.

Each resource area in the SWEIS was reviewed for potential cumulative impacts; the analyses are summarized in the following paragraphs. The level of detail provided for each resource area is commensurate with the extent of the potential cumulative impacts. Some resources were not provided with a detailed analysis based on minimal or very localized impacts from LANL operations and a judgment that, cumulatively, there would be no appreciable impacts on these resources.

The following paragraphs summarize cumulative impacts for LANL and the surrounding region of influence. The maximum cumulative impacts for all resource areas would occur if a decision was made to implement the SWEIS Expanded Operations Alternative in its totality.

Land Use, Visual Environment, Ecological Resources, and Cultural Resources

Impacts on land use, visual environment, ecological resources, and cultural resources from LANL operations have been discussed previously. Additional impacts could arise from the conveyance and transfer of land as required under Public Law 105-119. Up to 826 acres (334 hectares) of land could be developed after transfer or conveyance. For example, Los Alamos County has indicated there are proposals to develop approximately 1,000 new residences on land adjacent to LANL and to develop land for light industry, retail, and residential units along the Los Alamos Canyon rim across from the airport. This could change the current land use and increase cumulative impacts on visual, ecological, and cultural resources. In addition, the *Complex Transformation SPEIS* consolidated nuclear production center facilities, if constructed at LANL, could result in disturbance of up to 545 acres (221 hectares) of land. The total land area required for the GNEP advanced fuel cycle facility would be approximately 373 acres (151 hectares) with 144 acres (58 hectares) inside a property protection fence, including approximately 62 acres (25 hectares) within a perimeter intrusion, detection, and assessment system (DOE 2008).

Impacts from the construction of the consolidated nuclear production center or the GNEP advanced fuel cycle facility at LANL would include the loss of habitat and of less mobile wildlife, such as reptiles and small mammals. Best management practices and implementation measures set forth in the LANL *Threatened and Endangered Species Habitat Management Plan* would be used to minimize the potential for any adverse effects to plant and animal communities and on threatened and endanger or special interest species. After construction, temporary structures would be removed and the sites reclaimed.

Proposed sites for the *Complex Transformation SPEIS* consolidated nuclear production center in TA-16 or TA-55 and the GNEP advanced fuel cycle facility in TA-36 that involve undisturbed lands are likely to contain archaeological resources due to the high density of these resources in the region. Identification, evaluation, determination of impact, and implementation of mitigative measures would be conducted in consultation with the New Mexico State Historical Preservation Office (SHPO), interested Native American tribes, and in accordance with *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*.

Geology and Soils

For geology and soils, the primary impacts are due to proposed closure of the MDAs under the Expanded Operations Alternative in compliance with the Consent Order. If the waste at the MDAs is contained in place (MDA Capping Option), the final covers would require up to 2.5 million cubic yards (1.9 million cubic meters) of bulk materials including crushed tuff, rock, gravel, topsoil, and other materials for surface grading and erosion control. Construction of the consolidated nuclear production center or the GNEP advanced fuel cycle facility would also require the use of bulk geologic materials. These materials would be obtained from LANL resources and from quarries and mines in the surrounding counties. While the quantity of materials would be large, there would be sufficient resources in the region to meet the demand.

Water Resources

Reasonably foreseeable activities in the region could affect surface water and groundwater in combination with past and present activities, as well as those proposed at LANL in the SWEIS. Mitigation measures implemented by Federal agencies during fire and vegetation management projects and modification of water control structures installed after the Cerro Grande Fire would minimize impacts on surface water quality and quantity. Use of facilities to evaporate treated effluent from the Radioactive Liquid Waste Treatment Facility would improve surface water resources in Mortandad Canyon. Additional groundwater depletion projected as a result of potential new residential development within Los Alamos County could be somewhat offset by reduced depletion of the regional aquifer following implementation of the city of Santa Fe’s water diversion project and reduced pumping of the Buckman Well Field. Monitoring of the quality and quantity of the regional aquifer would be needed to evaluate the rate and direction of contaminant movements and to track the amount of water available for use. The North Railroad Avenue groundwater contamination plume located over 12 miles (19 kilometers) from the LANL boundary is undergoing remediation, and is not expected to migrate into groundwater and surface water impacted by past or present LANL operations.

Air Quality

Under the Expanded Operations Alternative, construction, excavation, and remediation activities could result in temporary increases in air pollutant concentrations at the site boundary and along publicly accessible roads. These impacts would be similar to those that would occur during construction of a housing project or a commercial complex. Emissions of fugitive dust from these activities would be controlled with water sprays and other engineering and management practices as appropriate. The maximum ground level concentrations offsite and along publicly accessible roads would be below ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide for certain projects that could occur near the site boundary. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements. The impacts on the public would be expected to be minor.

The projected increase in LANL employees and vicinity populations would cause an increase in vehicles and an associated increase in vehicle emissions along the routes used to access the site. However, cumulative concentrations of all criteria pollutants are expected to remain compliant with Federal and State ambient air quality standards.

The 24-hour standard for nitrogen dioxide and total suspended particulates could be exceeded if the Complex Transformation consolidated nuclear production center operated at LANL along with implementation of the Expanded Operations Alternative. Based on these potential exceedances, more detailed site-specific analyses would need to be performed if LANL were selected as the site for the consolidated nuclear production center. Preliminary data available for the GNEP advanced fuel cycle facility do not include emissions.

The contribution to cumulative air quality impacts from offsite construction and operation activities was also evaluated. The maximum impacts from construction activities (including fugitive dust) for oil and gas development in the region are evaluated in the *Farmington Proposed Resource Management Plan and Final EIS* and were shown to occur very close to the source, with concentrations decreasing rapidly with distance. Therefore, it is expected that offsite air emissions from disturbance and construction would not contribute substantially to cumulative impacts at LANL.

Impacts of inert pollutants (pollutants other than ozone and its precursors) generally were found to be limited to a few miles downwind from the source. For emissions from the oil and natural gas well fields, the distance where the nitrogen dioxide concentrations dropped below their significance levels was 15.6 to 24.9 miles (25 to 40 kilometers). Therefore, it is expected that emissions from the operation of offsite facilities would not contribute substantially to cumulative impacts at LANL.

In contrast, the maximum effects of volatile organic compounds and nitrogen oxide emissions on ozone levels usually occurs several hours after these compounds are emitted and many miles from their sources. A number of mitigation measures for activities occurring in the region are designed to reduce the cumulative air quality impacts from gas and oil wells and pipelines. One of the more successful mitigation measures requires that new and replacement wellhead compressors limit their nitrogen oxide emissions to less than 10 grams per horsepower-hour, and each pipeline compressor station limit its total nitrogen oxide emissions to less than 1.5 grams per horsepower-hour. This measure is intended to substantially reduce the level and extent of emissions that form ozone throughout the region and to reduce visibility impacts on Class I Areas such as Bandelier National Monument.

Human Health

For human health, the dose to the general public from all anticipated airborne emissions at LANL (Expanded Operations Alternative) could be as much as 36 person-rem per year. The dose to the offsite MEI from all anticipated airborne emissions at LANL could be as much as 8.2 millirem per year. The Clean Air Act regulations limit airborne radiation doses to 10 millirem per year for any individual member of the public. No additional LCFs would be expected at these dose levels. If the consolidated nuclear production center facilities were sited at LANL, the offsite radiological impacts would be essentially unchanged due to closure of facilities whose functions would be included in the new center. Preliminary data available for the GNEP advanced fuel cycle facility do not include estimates of offsite dose impacts.

Collective worker doses would increase if the MDA Removal Option was implemented. Collective worker dose would increase from about 280 person-rem per year under the No Action Alternative to an average of up to about 540 person-rem per year due to the number of workers involved. At the maximum dose, the annual risk of a LCF in the worker population would be about 0.3 (or for each 3 years of operation, 1 chance of an LCF in the worker population). Worker dose would decrease by about 140 person-rem annually after the MDA remediation work was complete. Worker doses would be expected to increase from operation of the consolidated nuclear production center facilities at LANL. The net increase in collective worker doses would be approximately 105 person-rem per year. The increased annual risk of an LCF in the worker population would be 0.06 (or for each 17 years of operation, an additional LCF might be expected in the worker population). Preliminary data for the GNEP advanced fuel cycle facility do not include a worker population dose estimate. Individual worker doses would be maintained as low as reasonably achievable (ALARA) and within applicable regulatory limits.

Environmental surveillance results for radioisotopes and chemicals, monitoring of LANL radiological emissions and radiation dose data, and cancer mortality and incidence rates in New Mexico and all counties surrounding LANL are presented in the SWEIS. These data, along with the final LANL Public Health Assessment, issued on August 31, 2006, by the U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, show that "there is no evidence of contamination from LANL that might be expected to result in ill health to the community" and "[o]verall, cancer rates in the Los Alamos area are similar to cancer rates found in other communities." Additionally, there is currently a Center for Disease Control and Prevention dose reconstruction project at LANL in the initial information gathering phase; therefore, this information is not available to include in the cumulative impacts analysis.

Socioeconomics

By 2011, LANL operations under the No Action Alternative could account for approximately 20 percent of employment in the tri-county area (Los Alamos, Rio Arriba, and Santa Fe Counties) and an even higher percentage of wages due to the large difference in average wages for LANL employees versus the county averages. Under the Expanded Operations Alternative, direct employment at LANL could increase by another 14 percent by 2011. Of the 1,890 direct and 2,000 indirect jobs thus created, about 1,600 and 1,700 jobs respectively, would be held by those in the tri-county area. This would increase the estimated percentage of the population employed in the tri-county area as a result of LANL operations activities to 22 percent.

If the maximum number of jobs estimated for operation of the Los Alamos Research Park and the conveyance and transfer of land were also created by 2011, there could be additional socioeconomic impacts in the region of influence. Cumulatively, the Expanded Operations Alternative and these activities could result in nearly 21,000 direct and 22,000 indirect jobs in the region. This scenario would increase the estimated percentage of the population employed by LANL-related activities or actions to 31 percent of the region of influence.

Increases in employment related to the proposed *Complex Transformation SPEIS* consolidated nuclear production center facilities would add approximately 1,500 direct and 1,600 indirect jobs for a total of 3,100 additional employees living in the tri-county region of influence. The addition of the GNEP advanced fuel cycle facility could add about 1,100 direct jobs in the tri-county region of influence, generating approximately 1,200 indirect jobs for a total 2,300 additional employees living in the tri-county region of influence. Combined with the other initiatives discussed above and LANL's continuing operations under the Expanded Operations Alternative, this scenario could increase the estimated percentage of the population employed by LANL-related activities to 33 percent of the region of influence.

The rate of population growth in the region would likely exceed current rates, placing additional strain on regional infrastructure and social services. For example, additional demand would be placed on regional water and electrical systems, roads would be more heavily traveled, additional housing would need to be constructed, and there may be demands for additional schools and hospitals. There would also be beneficial gains in terms of average wages and benefits flowing into the local economy because many of these jobs should be relatively higher paying jobs (for example, research jobs), and the unemployment rate would likely fall.

Infrastructure

Under the SWEIS Expanded Operations Alternative, the cumulative peak electrical load would approach, but not exceed, the system capacity; and the water use would approach, but not exceed, the system available water rights. Planned upgrades to the electrical system should enhance peak load capacity and ensure that electric energy is available for future operations. For water use, Los Alamos County is currently pursuing additional water rights to supply its water customers, including LANL. LANL water requirements have been decreasing compared to the demand in 1999, and are far below projections included in the *1999 SWEIS*. In the near term, no infrastructure capacity constraints are expected, and LANL demands on infrastructure resources are below projected levels and within site capacities. Potential shortfalls in available capacity would need to be addressed if increased site requirements are larger than those analyzed in the SWEIS.

If the proposed Complex Transformation consolidated nuclear production center, the GNEP advanced fuel cycle facility, or both were located at LANL, the system capacities for electricity and water could be exceeded and additional resources might need to be identified to satisfy the projected demand. It is likely that significant modifications would be required and LANL would need to obtain greater water resources, or significantly reduce its potable water use through mitigative measures. Overall LANL work assignments might have to be revamped, reduced, or eliminated so that existing potable water supplies would be adequate to support the assigned LANL work load.

Waste Management

Cumulative generation of all waste types is expected to be substantial, largely due to future remediation of MDAs and DD&D of facilities. Although this would be the case under all alternatives, the quantities of wastes projected under the Expanded Operations Alternative would be significantly larger than those projected under the other alternatives. Sufficient disposal capacity, both on- and offsite, for all waste types would be available except possibly under the Expanded Operations Alternative. Up to 1.4 million cubic yards (1.1 million cubic meters) of low-level radioactive waste and 33,000 cubic yards (25,000 cubic meters) of transuranic waste are projected. About two-thirds of the transuranic waste volume is associated with postulated complete removal of all waste from the MDAs – including transuranic waste buried before 1970. Final waste volumes from MDA remediation may be smaller because waste generation is dependent on future regulatory decisions by the New Mexico Environment Department and on waste volume reduction techniques such as sorting. Additional resources, including new storage and handling facilities, could be required to augment existing and proposed waste management capabilities.

Onsite disposal capacity for low-level radioactive wastes may be sufficient, depending on the actual volumes generated by remediation; disposal capacity can be supplemented by offsite facilities if needed. It is assumed that the transuranic waste would be disposed of at WIPP. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste and all of the transuranic waste buried before 1970 across the complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs would be based on the needs of the entire DOE complex. Any transuranic waste that may be generated at LANL without a disposal pathway would be safely stored until disposal capacity becomes available.

Operation of the proposed Complex Transformation consolidated nuclear production center would result in additional radioactive waste being generated. Up to 1,160 cubic yards (890 cubic meters) of transuranic waste, 12,000 cubic yards (9,000 cubic meters) of low-level radioactive waste, and 72 cubic yards (55 cubic meters) of mixed low-level radioactive waste would be generated annually. Operations would also generate up to 8,900 gallons (33,800 liters) of liquid low-level waste and up to 3,600 gallons (13,700 liters) of mixed low-level liquid waste annually. These wastes would be treated and packaged for disposal in accordance with their characteristics and applicable requirements in existing facilities or new facilities. Low-level waste would be disposed of onsite, mixed low-level waste would be disposed of at a permitted offsite facility, and transuranic waste would be disposed of at WIPP.

The volumes of low-level radioactive waste (up to 3,450 cubic yards [2,640 cubic meters]) and mixed low-level radioactive waste (up to 4.4 cubic yards [3.4 cubic meters]) projected to be generated annually by the GNEP advanced fuel cycle facility (DOE 2008) would be managed within the current waste management program. In addition, the project could generate up to 928 cubic yards (710 cubic meters) of nondefense transuranic waste annually (DOE 2008), which is not eligible for disposal at WIPP. Transuranic waste without a disposal pathway would be safely stored until a disposal facility became available. The project could also generate 34 cubic yards (26 cubic meters) of high-level radioactive waste annually (DOE 2008). Facilities to safely manage high-level radioactive waste until it could be sent to a geologic repository would have to be provided by the project since no high-level radioactive waste is currently managed at LANL.

Transportation

The total cumulative worker dose from 130 years of radioactive materials shipments (general transportation, historical DOE shipments, and reasonably foreseeable actions as estimated in the *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1D) (DOE 2007a), as well as shipments associated with the LANL SWEIS alternatives, would be a maximum of 382,400 person-rem, which could result in 229 LCFs. The total cumulative dose to the general public would be a maximum of 343,900 person-rem, which could result in 206 excess LCFs. The total estimated traffic fatalities associated with accidents involving radioactive material and waste transports would be a maximum of 119.

Implementing the Expanded Operation Alternative would result in no more than three additional traffic fatalities and zero worker or public cancer deaths (LCFs); therefore, they would not contribute substantially to cumulative impacts. For perspective, in 2004, there were 522 traffic fatalities in New Mexico, 58 of which occurred in the three counties neighboring LANL (Los Alamos, Rio Arriba, and Santa Fe Counties).

Daily traffic could increase on county roads by up to 18 percent (averaged across all LANL entrances) due to (1) increased development of both housing and light industry as a result of the conveyance and transfer of lands; (2) increased truck shipments under the Expanded Operations Alternative; (3) projected increases in the LANL workforce under the Expanded Operations Alternative; and (4) increased employment at the Los Alamos Research Park. Development of land transferred under the *Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracks Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE/EIS-0293) could increase traffic in the vicinity of the airport and TA-21 based on current Los Alamos County plans to develop light industry, retail, and residential units on these tracts. This action, combined with the increased traffic associated with DD&D activities at TA-21, could cause excessive traffic loads on NM 502.

The major radiological transportation actions involving Category I/II special nuclear material related to the proposal to consolidate activities at LANL would be transportation of pits currently stored at Pantex and highly enriched uranium currently stored at Y-12 to LANL. After these one-time shipments were completed, there would be no annual shipment of pits and highly enriched uranium from these sites. The estimated radiological health impacts of the one-time transportation of pits and highly enriched uranium to LANL would not result in any additional LCFs in the general public. Non-radiological impacts would be expected to result in zero fatalities as a result of accidents. Workers handling the movement of pits and highly enriched uranium would receive a collective dose of approximately 5,500 person-rem, resulting in an estimated 3.3 LCFs. It should be noted that in accordance with DOE regulations, the maximum annual dose to a radiation worker would be administratively controlled to 2 rem per year; therefore, an individual worker would not be expected to develop a lifetime latent fatal cancer from exposures during these activities.

The major transportation actions involving radioactive materials related to the *GNEP PEIS* advanced fuel cycle facility at LANL would involve the receipt of shipments of spent reactor fuel, shipments of transmutation fuel, shipments of spent fast reactor fuel, and radioactive waste shipments associated with operation of the advanced fuel cycle facility (DOE 2008).

The addition of proposed facilities and an increased number of workers for the consolidated nuclear production center in TA-16 would likely result in increased traffic along NM 4 from White Rock to West Jemez Road and on West Jemez Rd to the center of the site. The consolidation of facilities in TA-16 would somewhat alleviate current concerns related to increased traffic along Pajarito Road under the Expanded Operations Alternative, because there could be a corresponding decrease in traffic along Pajarito Road from NM 4 to TA-55 if the activities at the Plutonium Facilities Complex were relocated to TA-16. Conversely, the GNEP advanced fuel cycle facility is proposed to be built in TA-36 which would lead to increased traffic along Pajarito Road from NM 4 to the center of LANL, if approved.

Environmental Justice

No disproportionately high adverse human and environmental effects to minority or low-income populations would be expected as a result of implementing any of the three alternatives considered in the SWEIS, or constructing and operating the *Complex Transformation SPEIS* consolidated nuclear production center or the GNEP advanced fuel cycle center. Employment at LANL and in the surrounding region would be expected to increase, thus creating additional employment opportunities for local individuals. As additional funding flows into the regional economy, increased opportunities for low-income and minority populations should be realized. Also, the conveyance and transfer of land to the Department of the Interior that has occurred benefits people inhabiting the Pueblo of San Ildefonso. A consultation process is in place to address possible impacts to traditional cultural properties from LANL actions.

S.9.3 Summaries of Potential Consequences from Project-Specific Analyses

Appendices of the SWEIS contain evaluations of the environmental impacts of projects proposed for implementation under the Expanded Operations Alternative. They include projects to replace or refurbish existing structures and their related capabilities, DD&D of old structures and remediation of environmental contamination, modifications to site infrastructure, and expansion of site capabilities. This section summarizes the potential consequences of implementing each of the proposed projects.

The sliding-scale approach is used in the SWEIS to evaluate environmental consequences. This approach implements the CEQ instruction to “focus on significant environmental issues” (40 CFR 1502.1) and to discuss impacts “in proportion to their significance” (40 CFR 1502.2[b]). For some of the project-specific analyses it was determined that there would be no or only minor impacts for some resource areas. Consequently, these resource areas are not analyzed in detail. In the following tables, these resource areas are identified as having “no or negligible impacts.”

General temporary construction-related impacts would be expected to occur for most of the projects summarized in this section during construction and DD&D activities. After project completion, these impacts would cease and the area would return to normal. These impacts are not discussed in detail in the project summaries:

- Physical disturbances to areas under or in the vicinity of construction and DD&D projects would disrupt land use, affect the visual environment, and disturb the soils and geology, the latter primarily from excavation activities.
- Water resources, primarily surface water quality, could be temporarily affected by runoff and increased sediment loads from construction and DD&D sites. Stormwater Pollution Prevention Plans describing best management practices would be required and would mitigate most of these impacts. A Construction General Permit, a U.S. Army Corps of Engineers Section 404 Dredge and Fill Permit, and a Section 401 New Mexico Water Quality Certification would be obtained, if needed, for projects that may affect surface water.
- Air quality impacts would be increased by emissions of criteria air pollutants, primarily carbon monoxide and nitrogen oxides from vehicles and heavy equipment, as well as particulate matter from soil disturbance.
- Noise levels could rise from the increased number of personal vehicles, trucks hauling materials and waste to and from construction sites, and heavy equipment involved in the activities. Most noise would be localized, but if a project were near a LANL site boundary, offsite populations could be disturbed.
- Loss of habitat from land disturbance and increased noise and light are potentially adverse ecological impacts from construction and DD&D activities. Impacts could be minimized by avoiding working during nesting seasons for sensitive species, using special lighting, protecting areas of concern, and working only during certain times of the day or year.
- Construction workers would be subject to accidents typical of any construction site. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities). To prevent serious exposures and injuries, all site construction contractors would be required to submit and adhere to a Construction Safety and Health Plan and undergo site-specific hazard training. Appropriate personal protection measures would be a routine part of construction activities, including use of personal protection equipment such as coveralls, respirators, gloves, hard hats, steel-toed boots, eye shields, and earplugs or covers. Workers also would be protected by other engineered and administrative controls.
- Increased consumption of fuels, water, and electricity would occur during construction and DD&D.
- Implementing the projects addressed in this section may result in impacts to potential release sites covered under the Consent Order. As needed, these potential impacts would be addressed through the accelerated cleanup process described in Section VII.F of the Consent Order.

Summary of Impacts for the Physical Science Research Complex Project

The Physical Science Research Complex would be a complex of four buildings in TA-3 with approximately 350,000 square feet (32,500 square meters) of floor space, approximately 30 percent of which would be laboratory space (primarily laser). This complex would be available to consolidate staff currently located in TA-3 and other LANL locations in newer, more efficient and modern space. A number of structures would be demolished to make room for the Physical Science Research Complex, and a number of buildings vacated by staff moving to the new facility would also undergo DD&D. A building potentially eligible for listing on the National Register of Historic Places could be impacted, as well as the Administration Building which has been determined to be eligible. Proposed activities would require documentation to resolve adverse effects. Only minor impacts would be expected from construction and operation of this facility. There would be some improvement in the overall appearance of areas in which aging buildings and temporary structures would be demolished. **Table S–6** summarizes the potential impacts of implementing this project.

Table S–6 Summary of Impacts for the Physical Science Research Complex Project

Resource Area	***Impact Summary***
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – Demolition of vacated structures would improve the overall appearance of TA-3, TA-35, and TA-53.
Geology and Soils	Temporary construction- and DD&D-related impacts. Approximately 499,000 cubic yards of rock and soil would be disturbed during construction.
Water Resources	No or negligible impact.
Air Quality and Noise	*Air Quality* – Temporary construction- and DD&D-related impacts. Little or no change in emissions from operations. *Noise* – Temporary construction- and DD&D-related impacts.
Ecological Resources	No or negligible impact.
Human Health	Temporary construction-related impacts and accident potential for workers. Potential worker exposure to radiological contamination and asbestos during DD&D. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. Positive impact on relocated staff from improved working conditions.
Cultural Resources	Possible impact on a building potentially eligible for listing on the National Register of Historic Places and the Administration Building, which has been determined to be eligible. Proposed activities would require documentation to resolve adverse effects.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity, requirements would be similar to or less than the facilities being replaced.
Waste Management	*Construction* – 1,600 cubic yards of construction debris. *DD&D* – 17,000 cubic yards of low-level radioactive waste; 177,000 cubic yards of solid waste including demolition debris; and 314,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes and demolition wastes (some radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for the Replacement Office Buildings Project

The TA-3 Replacement Office Buildings Project would consolidate staff and activities currently located in temporary or aging permanent buildings into more efficient and safer structures. The complex would include the construction of 11 two-story buildings, 1 three-story building, and related parking structures. The Wellness Center and a warehouse would be demolished to accommodate this project.

There would be no major environmental impacts from construction, operation, and DD&D of existing buildings for the Replacement Office Buildings Project. Most construction would be in a developed portion of TA-3; however, a portion of the project area would require use of about 13 acres (5.3 hectares) of currently undeveloped land. Protection of cultural resources and potential accommodation for the Mexican spotted owl during construction could be required. **Table S–7** summarizes the potential impacts of implementing this project.

Table S–7 Summary of Impacts for the Replacement Office Buildings Project

Resource Area	***Impact Summary***
Land Resources	*Land Use* – Consistent with future land use plans; about 13 acres of undeveloped land would be disturbed. *Visual Environment* – New buildings and parking lot could be visible from West Jemez Road and Pajarito Road.
Geology and Soils	Temporary construction- and DD&D-related impacts. Approximately 369,000 cubic yards of rock and soil would be disturbed during construction.
Water Resources	Temporary construction- and DD&D-related impacts.
Air Quality and Noise	*Air Quality* – Temporary construction-and DD&D-related impacts. No change in emissions from operations. *Noise* – Temporary construction- and DD&D-related impacts.
Ecological Resources	Temporary construction-related impacts. Loss of 13 acres of habitat. Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle.
Human Health	Temporary construction- and DD&D-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment.
Cultural Resources	Possible impact on a historic trail potentially eligible for listing on the National Register of Historic Places. Proposed activities could require documentation to resolve adverse effects.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity; requirements would be similar to or less than the facilities being replaced.
Waste Management	*Construction* – 1,700 cubic yards of construction waste. *DD&D* – 31 cubic yards of low-level radioactive waste and 6,900 cubic yards of demolition debris.
Transportation	No or negligible impact.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

Summary of Impacts for the Radiological Sciences Institute Project, Including Phase I – the Institute for Nuclear Nonproliferation Science and Technology

The proposed project would involve the DD&D of 52 obsolete structures scattered over 6 TAs, and the construction of the Radiological Sciences Institute in TA-48, which would include as many as 13 new facilities. Phase I would include construction of five buildings associated with the Institute for Nuclear Nonproliferation Science and Technology. This facility would include

Security Category I and II laboratories and vaults, other laboratory space, a secure radiochemistry laboratory, and associated offices and support facilities.

DD&D activities and transportation would result in the largest potential impacts. DD&D activities are expected to generate large quantities of debris, including some radioactively-contaminated debris. With the exception of low-level radioactive waste, most DD&D waste would be transported to appropriate offsite facilities. Transportation impacts would include temporary disruption of traffic on Pajarito Road during construction; increased local traffic during operations; and movement of large amounts of DD&D waste. **Table S–8** summarizes the potential impacts of implementing this project.

Table S–8 Summary of Impacts for the Radiological Sciences Institute Project, Including Phase I – the Institute for Nuclear Nonproliferation Science and Technology

Resource Area	*Impact Summary*
Land Resources	*Land Use* – Some currently designated Reserve and Experimental Science areas would be redesignated in the future as Nuclear Materials Research and Development; 12.6 acres of undeveloped land would be disturbed. *Visual Environment* – Minor impact from new development in TA-48 west of existing buildings.
Geology and Soils	Temporary construction-related impacts. Approximately 802,000 cubic yards of rock and soil would be disturbed during construction. Excavation of welded tuff could necessitate blasting. Negligible impacts anticipated from DD&D activities.
Water Resources	Temporary construction-related impacts. DD&D of older contaminated structures could reduce the potential for future surface water and groundwater contamination.
Air Quality and Noise	*Air Quality* – Temporary construction- and DD&D-related nonradiological impacts and potential for release of radionuclides in contaminated soils in the vicinity of the proposed building location. Little or no change in emissions from operations. *Noise* – Temporary construction- and DD&D-related impacts could include blasting.
Ecological Resources	Temporary construction-related impacts. Loss of 12.6 acres of habitat. Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl.
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. No additional LCFs in general population or to the MEI from radiological doses from facility construction or operation and associated DD&D.
Cultural Resources	Possible impact on two archaeological sites determined to be eligible for the National Register of Historic Places and on potentially eligible historic buildings, including the Radiochemistry Building. Documentation to resolve adverse effects on the archaeological sites would be required before beginning construction of the Radiological Sciences Institute and could be required before demolition of any of the potentially important historic structures.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity, requirements would be similar to or less than the facilities being replaced.
Waste Management	*Construction* – 2,800 cubic yards of construction debris and associated solid waste. *DD&D* – 1,100 cubic yards of transuranic waste; 96,000 cubic yards of low-level radioactive waste; 1,000 cubic yards of mixed low-level radioactive waste; 77,000 cubic yards of demolition debris; and 988,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes, and demolition wastes (some of which would be radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	Postulated facility accident with the highest impacts would result in an LCF risk of 1 in 12,000 for a noninvolved worker and 1 in 77,000 for the MEI; there would be no excess LCFs expected in the exposed population.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality; MEI = maximally exposed individual.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359; acres to hectares, multiply by 0.40469.

Summary of Impacts for Radioactive Liquid Waste Treatment Facility Upgrade Project

This project has been proposed to improve the operation and reliability of the Radioactive Liquid Waste Treatment Facility in TA-50. Three options have been proposed to upgrade the facility, each involving DD&D of part of the existing facility. Under Option 1, a new building for treating liquid low-level radioactive and transuranic wastes would be constructed west of the existing facility in a parking area, along with a central utilities building. The East Annex would be demolished. Under Option 2, the Radioactive Liquid Waste Treatment Facility treatment capabilities would be housed in two or more separate structures to the west and north of the existing facility (for example, one or more structures for low-level radioactive liquid waste and one or more structures for transuranic liquid waste). The East Annex, the North Annex, and a transformer located on the north side of the existing facility would be demolished to accommodate the new construction. Option 3 is identical to Option 2, except that the existing facility would be renovated for reuse; the most DD&D would be required under this option. An auxiliary action of installing a pipeline and constructing evaporation tanks to treat effluent could occur with any of the options, including the No Action Option (not upgrading the facility).

Potential impacts from each of the action options would be similar. Demolition of the East Annex and the transuranic influent storage tanks would likely produce considerable low-level radioactive waste and some transuranic waste. There is also the potential for releasing radioactive or other hazardous constituents from contaminated soils and contaminated structural materials, but proper procedures would be followed to minimize their release. **Table S–9** summarizes the potential impacts of implementing this project.

Implementing the auxiliary action to construct evaporation tanks and a pipeline would result in a change in the land use category and the permanent loss of habitat of up to 5.4 acres (2.2 hectares) of currently undeveloped land. Tank construction would cause a break in the forest cover that would be noticeable from areas west of LANL. Use of the evaporation tanks would improve surface water quality by eliminating a discharge that could contribute to movement of existing environmental contamination.

Summary of Impacts for Los Alamos Neutron Science Center Refurbishment Project

The LANSCE Refurbishment Project would include renovations and improvements to the existing facility in TA-53 to increase its reliability and extend its operating life. Impacts from implementation would be minimal. There could be minimal indirect effects on utility usage and air emissions from increased usage of the facilities after the project was complete. **Table S–10** summarizes the potential impacts of LANSCE Refurbishment Project activities.

Table S–9 Summary of Impacts for the Radioactive Liquid Waste Treatment Facility Upgrade Project

Resource Area	Impact Summary
Land Resources	*Land Use* – If the option to construct evaporation tanks and pipeline were implemented, the land use designation of up to 5.4 acres of land for the area of the tanks would change from Reserve to Waste Management. *Visual Environment* – The new treatment buildings would not result in a change to the overall visual character of the area within TA-50, but the area proposed for construction of the evaporation tanks is currently undeveloped and wooded, and a break in the forest cover would be noticeable from areas west of LANL.
Geology and Soils	Temporary construction- and DD&D-related impacts. Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. Permanent removal of contaminated soil to accommodate new facilities. Up to 164,000 cubic yards of rock and soil could be disturbed, assuming construction of the evaporation tanks and pipeline.
Water Resources	Potential positive impact on effluent water quality and quantity due to more stringent discharge requirements and improved processing.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. Potential for increased radioactive emissions during DD&D. Minimal impact expected from operation. *Noise* – Minor construction equipment and traffic noise impact to workers.
Ecological Resources	Temporary construction- and DD&D-related impacts. Loss of up to 4 acres of habitat if the evaporation tanks and pipeline are built. May affect, but is not likely to adversely affect, the Mexican Spotted Owl and bald eagle.
Human Health	Temporary construction-related impacts and accident potential for workers. Potential worker exposure to radiological contamination during DD&D. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. During operations, worker health and safety would be improved because of improved reliability and design and less maintenance on new systems. RLWTF emissions do not have a distinguishable effect on the projected dose to the public.
Cultural Resources	Possible impact on several historic properties, including the RLWTF, potentially eligible for listing on the National Register of Historic Places. Proposed activities could require documentation or excavation to resolve adverse effects.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Utility requirements are expected to increase but to stay within LANL utility capacity.
Waste Management	*Construction* – Up to 1,150 cubic yards of construction debris. *DD&D* – Up to 230 cubic yards of transuranic waste; 10,300 cubic yards of low-level radioactive waste; 150 cubic yards of mixed low-level radioactive waste; 1,800 cubic yards of demolition debris; and 212,000 pounds of chemical waste.
Transportation	Temporary disruption of local traffic during construction and DD&D. Transportation of construction materials and wastes and demolition wastes (some of which would be radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality; RLWTF = Radioactive Liquid Waste Treatment Facility.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.7854; pounds to kilograms, multiply by 0.45359; acres to hectares, multiply by 0.40469.

Table S–10 Summary of Impacts for the Los Alamos Neutron Science Center Refurbishment Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	No or negligible impact.
Water Resources	Project implementation may result in a small increase in nonradiological cooling water discharge from increased facility usage.
Air Quality and Noise	*Air Quality* – Negligible to minor impacts during refurbishment. Operations may result in increased nonradiological air emissions from increased facility usage. *Noise* – Potential temporary increase in onsite noise levels during refurbishment.
Ecological Resources	No or negligible impact.
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and use of personal protective equipment. Operations impacts may increase as a result of increased accelerator usage. The maximum dose to the MEI as a result of emissions, however, would be limited to 7.5 millirem per year.
Cultural Resources	Possible impact on several historic buildings potentially eligible for listing on the National Register of Historic Places and the LANSCE accelerator building, which has been determined to be eligible. Documentation to resolve adverse effects would be required before making modifications to the accelerator building and could be required before modifications or demolition of any of the other potentially important historic structures.
Socioeconomics and Infrastructure	*Socioeconomics* – No impacts identified. *Infrastructure* – Negligible utility requirements during refurbishment. Project implementation could result in increased utility demands from increased facility usage. Peak load demand could approach current capacity but ongoing improvements to LANL's electric power infrastructure should alleviate this concern.
Waste Management	Small quantities of low-level radioactive waste, mixed low-level radioactive waste, chemical waste, and nonhazardous solid waste would be generated during refurbishment.
Transportation	No or negligible impact.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

MEI = maximally exposed individual; LANSCE = Los Alamos Neutron Science Center.

Summary of Impacts for the Radiography Facility Project

The proposed Radiography Facility would be constructed at TA-55 to eliminate the need for transporting nuclear items to different locations at LANL during the examination process. Minor impacts from construction would be expected. Radiography operations would use engineering and administrative controls to ensure workers would not be exposed to high radiation fields. Implementation of the project would reduce the number of onsite trips for nuclear components, resulting in fewer road closures and improved traffic flow. **Table S–11** summarizes the potential impacts of the proposed TA-55 Radiography Facility Project.

Table S–11 Summary of Impacts for the Technical Area 55 Radiography Facility Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	Temporary construction-related impacts. Up to 8,000 cubic yards of soil and rock would be disturbed.
Water Resources	No or negligible impact.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. *Noise* – Temporary construction-related impacts.
Ecological Resources	No or negligible impact.
Human Health	*Construction* – Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. *Operations* – Operations would involve high radiation fields. Worker health would be protected by facility design, radiation control procedures, and personal protective equipment.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity.
Waste Management	*Construction* – Up to 24 cubic yards of solid waste would be generated during construction of the new building.
Transportation	Implementation of project would reduce onsite nuclear material transport.
Environmental Justice	No or negligible impact.
Facility Accidents	Accident impacts are bounded by those analyzed for the TA-55 Plutonium Facility Complex.

TA = technical area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Summary of Impacts for Plutonium Facility Complex Refurbishment Project

The TA-55 Plutonium Facility Complex Refurbishment Project would upgrade the electrical, mechanical, safety, and other selected facility systems to improve overall reliability to ensure continued operations. The project would be implemented in phases as a series of subprojects. All work would be performed inside the existing TA-55 complex. Several subprojects could have positive impacts on the environment, including replacement of the chiller, which would result in fewer emissions of ozone-depleting substances; implementation of the Steam System Subproject, which would reduce emissions of criteria pollutants; several subprojects that would improve the safety basis of the complex; and improvement in stack mixing and emissions monitoring resulting from implementation of the Stack Upgrade and Replacement Subproject. Implementation of the project would result in small amounts of radioactive and chemical waste that would be accommodated by the LANL waste management infrastructure. **Table S–12** summarizes the potential impacts for the Plutonium Facility Complex Refurbishment Project.

Table S–12 Summary of Impacts for the Plutonium Facility Complex Refurbishment Project

Resource Area	***Impact Summary***
Land Resources	*Land Use* – Temporary construction-related impacts of previously disturbed areas. *Visual Environment* – No impacts identified.
Geology and Soils	Temporary construction-related impacts.
Water Resources	No impacts identified.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. Potential reduction in air emissions from upgrades and installation of new equipment. *Noise* – Temporary construction-related impacts confined to LANL site in and near TA-55, except for a very small potential increase in traffic noise.
Ecological Resources	No or negligible impact.
Human Health	Temporary construction-related impacts and accident potential for workers. Potential worker exposure to radiological contamination during refurbishment activities. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. No radiological risks to members of the public identified from construction or normal operations.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No impacts identified. *Infrastructure* – No more than negligible impact on LANL utility capacity.
Waste Management	*Construction and DD&D* – 340 cubic yards of transuranic waste; 1,300 cubic yards of low-level radioactive waste; 220 cubic yards of mixed low-level radioactive waste; 2,700 cubic yards of demolition debris; and 2,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes and demolition wastes (some of which would be radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	A number of the higher-priority subprojects involve upgrades that would substantially improve the safety basis of the Plutonium Facility Complex.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.4536.

Summary of Impacts for the Science Complex Project

The proposed Science Complex, a state-of-the-art multidisciplinary facility used for light laboratory and offices, would consist of two buildings and one supporting parking structure. The Science Complex would be constructed at one of three proposed sites: in TA-62, west of the Research Park area; in the Research Park in the northwest portion TA-3; or in the southeast portion of TA-3.

Construction of the Science Complex at the TA-62 site or the Research Park site would disturb about 5 acres (2 hectares) of undeveloped land. Each of the locations would require some modification of site infrastructure such as extending natural gas pipelines. The Research Park option would likely require rerouting of additional utilities currently located in or near the project area. **Table S–13** summarizes the potential impacts of Science Complex Project activities.

Table S–13 Summary of Impacts for the Science Complex Project

Resource Area	Impact Summary		
	Northwest TA-62 Option	***Research Park Option***	***South TA-3 Option***
Land Resources	*Land Use* – 5 acres of undeveloped land would be permanently disturbed; the land use plans for 15.6 acres would be changed. *Visual Environment* – Views from neighboring properties and roadways would be altered by construction of the proposed structures and from night lighting. Forested buffer between LANL and Los Alamos Canyon would be lost.	*Land Use* – Impacts similar to Northwest TA-62 Site. *Visual Environment* – Impacts similar to Northwest TA-62 Site.	*Land Use* – Negligible impacts identified. *Visual Environment* – No impacts identified.
Geology and Soils	Temporary construction-related impacts. Approximately 840,000 cubic yards of soil and rock would be disturbed.		
Water Resources	Temporary construction-related impacts.		
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. *Noise* – Temporary construction-related impacts. Minor increased noise levels from operation.		
Ecological Resources	Temporary construction-related impacts; loss of up to 5 acres of habitat. Under the TA-62 option, construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle.		
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment.		
Cultural Resources	Possible impact on two archaeological sites determined to be eligible for the National Register of Historic Places. Proposed activities would require documentation to resolve adverse effects.	No impacts identified.	No impacts identified.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Addition of a natural gas line and tie-in to sanitary sewage system would be required. No more than negligible impact on LANL utility capacity.	*Socioeconomics* – No or negligible impact. *Infrastructure* – Would likely require rerouting of many utilities currently located on the site and extension of a sewer trunk line.	*Socioeconomics* – No or negligible impact. *Infrastructure* – Addition of a natural gas line and tie-in to sanitary sewage system would be required.
Waste Management	*Construction* – Approximately 3,300 cubic yards of construction debris would be generated.		
Transportation	Once complete, impacts would include an estimated 5,790 vehicle trips on the average weekday (2,895 vehicles entering and exiting in a 24-hour period).	Impacts similar to Northwest TA-62 Site.	Impacts would be greater than those for the Northwest TA-62 site due to the site location within the planned Security Perimeter Road and higher traffic flows on Diamond Drive relative to those on West Jemez Road. Construction traffic impacts would also be greater due to travel on Diamond Drive.
Environmental Justice	No or negligible impact.		
Facility Accidents	Risk of an LCF for a Science Complex occupant from a CMR Building accident: 1 chance in 560,000 per year.	Risk of an LCF for a Science Complex occupant from a CMR Building accident: 1 chance in 240,000 per year.	Risk of an LCF for a Science Complex occupant from a CMR Building accident: 1 chance in 60,000 per year.

TA = technical area; LCF = latent cancer fatality; CMR = Chemistry and Metallurgy Research.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

Summary of Impacts for Remote Warehouse and Truck Inspection Station Project

The Remote Warehouse and Truck Inspection Station Project would relocate shipment receiving, warehousing, and distribution functions from TA-3 to a site in TA-72. In addition, the Truck Inspection Station would be relocated from its current location on the northwest corner of NM 4 and East Jemez Road to the new location. Impacts resulting from this project would be minor, although the proposed facilities would be constructed in a relatively undeveloped area with desirable aesthetic qualities. Some screening of the proposed facilities would be possible using selective tree cutting and strategic placement of the facilities, but the view would be permanently altered to one that is typical of a more developed area. Nearby sensitive archaeological sites and National Historic Landmarks would be protected from construction and operation activities and increased visitation by installing fencing around the perimeter of the Remote Warehouse and Truck Inspection Station. **Table S–14** summarizes the potential impacts for this project.

Table S–14 Summary of Impacts for the Remote Warehouse and Truck Inspection Station Project

Resource Area	***Impact Summary***
Land Resources	*Land Use* –Land use designation would change from Reserve to Physical/Technical Support; 4 acres of undeveloped land would be disturbed. *Visual Environmental* – Views would change from primarily natural landscape to include developed area. Lighting could be visible from Tsankawi Unit of Bandelier National Monument.
Geology and Soils	Temporary construction-related impacts. Approximately 90,000 cubic yards of soil and rock would be disturbed during construction.
Water Resources	Temporary construction-related impacts.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. *Noise* – Temporary construction-related impacts. Possible noticeable noise along East Jemez Road during operations.
Ecological Resources	Temporary construction-related impacts; loss of 4 acres of habitat. Construction may affect, but is not likely to adversely affect, the bald eagle.
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment.
Cultural Resources	Possible impact on three nearby archaeological sites potentially eligible for listing on the National Register of Historic Places and two National Historic Landmarks. Proposed activities could require documentation to resolve adverse effects. Fencing around perimeter of project site would aid in protecting these sensitive sites.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Addition of a natural gas line and means of sanitary sewage treatment, conveyance, or disposal would be required. No more than negligible impact on LANL utility capacity.
Waste Management	Approximately 610 cubic yards of construction debris would be generated.
Transportation	Changes to geometry of East Jemez Road. Potential reduction of traffic in and around TA-3.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

Summary of Impacts for TA-18 Closure Project, Including Remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition

This proposed project would relocate the Security Category III and IV capabilities and materials remaining in TA-18, and would conduct DD&D of the buildings and structures at TA-18. The removal of buildings and structures at TA-18 (Pajarito Site) would provide positive local visual impacts, as would the eventual return of the area to its natural state, which would blend with other undisturbed portions of LANL. Buildings of historic importance and other cultural sites are located in TA-18. These cultural resources would be protected during DD&D activities as required. **Table S–15** summarizes the potential impacts of these activities.

Table S–15 Summary of Impacts for the Technical Area 18 Closure Project, Including Remaining Operations Relocation and Structure Decontamination, Decommissioning, and Demolition

Resource Area	*Impact Summary*
Land Resources	*Land Use* – DD&D could result in an overall change in the land use designation from Nuclear Materials Research and Development to Reserve. *Visual Environmental* – Potentially positive impact from removal of old buildings.
Geology and Soils	Temporary DD&D-related impacts.
Water Resources	DD&D would remove facilities from a floodplain, thereby enhancing protection of surface water quality.
Air Quality and Noise	*Air Quality* – Temporary DD&D-related impacts. *Noise* – Temporary DD&D-related impacts.
Ecological Resources	Temporary DD&D-related impacts. DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl and southwestern willow flycatcher. Restoration of the site could create a more natural habitat and benefit wildlife.
Human Health	The primary source of potential impacts on workers and members of the public would be associated with the release of radiological contaminants during DD&D. Potential impacts would be much less than during past operations and would be mitigated using confinement and filtration methods.
Cultural Resources	Three archaeological resources sites found at TA-18 (a rock shelter, a cavate complex, and the Ashley Pond cabin) have been determined to be eligible for listing on the National Register of Historic Places, and there are other eligible and potentially eligible buildings within the TA. Proposed activities would require documentation to resolve adverse effects, and these buildings would be protected during DD&D activities as required. Several historic properties at TA-18 have been identified for permanent retention, including the Pond Cabin, the Slotin Accident Building (TA-18-1), and other properties that represent the history of the TA and LANL.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No or negligible impact.
Waste Management	Waste generated from the disposition of the buildings and structures is estimated to be 4,700 cubic yards of low-level radioactive waste; 5 cubic yards of mixed low-level radioactive waste; 17,000 cubic yards of demolition debris; and 75,000 pounds of chemical waste.
Transportation	Transportation of wastes would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for the TA-21 Structure Decontamination, Decommissioning, and Demolition Project

All or a portion of the buildings and structures at TA-21 would undergo DD&D under this project. Two options are proposed: the Complete DD&D Option would remove essentially all structures within TA-21; the Compliance Support Option would remove only those structures necessary to support remediation activities.

Onsite and offsite visual impacts would be improved by removal of some or all of the buildings and structures at TA-21. DD&D activities would affect buildings and structures potentially eligible for listing on the National Register of Historic Places, so documentation to resolve adverse effects could be required. Implementation of this project at the same time that TA-21 MDA remediation is underway would result in local traffic impacts along DP Road and in the Los Alamos townsite. **Table S–16** summarizes the potential impacts of these activities.

Table S–16 Summary of Impacts for Technical Area 21 Structure Decontamination, Decommissioning, and Demolition Project

Resource Area	*Impact Summary*	
	Complete DD&D Option	*Compliance Support Option*
Land Resources	*Land Use* – The remainder of the western portion of the area would be available for conveyance to Los Alamos County. The eastern part of the TA would remain a part of LANL for the foreseeable future. *Visual Resources* – Temporary DD&D-related impacts. Long-term impacts would be positive with the removal of old industrial buildings.	*Land Use* – Currently unconveyed portions of TA-21 would remain under control of DOE. Land use designations would remain unchanged. *Visual Environment* – Temporary construction- and DD&D-related impacts. Over the long-term, the view of the TA from NM 502 and from higher elevations to the west would still include portions of the current mix of 50-year-old structures.
Geology and Soils	Temporary DD&D-related impacts.	Temporary DD&D-related impacts.
Water Resources	Improvement in overall water resources from discontinuing processes and associated water use and eliminating two outfalls.	Little or no impact on water resources.
Air Quality and Noise	*Air Quality* – Temporary DD&D impacts. Operational emissions would be relocated or cease. *Noise* – Temporary DD&D-related impacts.	*Air Quality* – Nonradioactive air pollutant emissions from the three natural gas-fired boilers in Building 21-0357 and the vehicle exhaust and emissions from activities in the maintenance facilities would remain. *Noise* – Temporary DD&D-related impacts.
Ecological Resources	Temporary DD&D-related impacts. Activities may affect, but are not likely to adversely affect, the Mexican spotted owl.	
Human Health	East Gate MEI would receive 2×10^{-4} millirem over the life of the project.	
Cultural Resources	DD&D of buildings and structures at TA-21 would have direct effects on 15 NRHP-eligible historic buildings and structures (and 1 potentially eligible building) associated with the Manhattan Project and Cold War years at LANL.	
Socioeconomics and Infrastructure	*Socioeconomics* – Temporary modest increase in employment due to DD&D activities. *Infrastructure* – No or negligible impact.	
Waste Management	DD&D would generate 1 cubic yard of transuranic waste; 34,000 cubic yards of low-level radioactive waste, 65 cubic yards of mixed low-level radioactive waste; 47,000 cubic yards solid waste; and 420,000 pounds of chemical waste.	The volume of solid waste and debris generated under this Option would be about 29,000 cubic yards less than that under the Complete DD&D Option.
Transportation	Transportation of construction materials and wastes and demolition wastes (some radioactive) would not be expected to result in any fatalities or excess LCFs. Local traffic impacts associated with DD&D activities would be exacerbated by MDA remediation occurring at the same time.	
Environmental Justice	No or negligible impact.	
Facility Accidents	No or negligible impact.	

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MEI = maximally exposed individual; NRHP = National Register for Historic Places; LCF = latent cancer fatality; MDA = material disposal area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for Waste Management Facilities Transition Project

This project involves DD&D of certain aboveground facilities in TA-54, Areas G and L, to facilitate closure of those areas; construction of additional waste management facilities; removal of waste stored underground in pits and shafts in Area G; and preparation and shipment of this waste for disposal. New waste management facilities would include a retrieval facility to assist in removal of high-activity remote-handled transuranic waste from certain shafts, new low-level radioactive waste facilities in TA-54, and a new TRU Waste Facility in the Pajarito Road Corridor to store and process transuranic waste.

The waste storage domes in Area G would be removed as part of this project, which would have a beneficial impact on both near and distant views. Because these domes are visible from the lands of the Pueblo of San Ildefonso, their removal would improve the views from that vantage point. Construction at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Construction of the TRU Waste Facility, which could require up to 7 acres (2.8 hectares), could occur within Mexican spotted owl Areas of Environment Interest which would require consultation with the U.S. Fish and Wildlife Service. (The location of the TRU Waste Facility has not been finalized, so land resource, ecological, and cultural resource impacts could vary.) Eventual removal of stored wastes in Area G would reduce the dose to the facility-specific MEI. Worker doses could also decrease after 2015, once waste management activities in Area G are completed. **Table S–17** summarizes the potential impacts of these activities.

Summary of Impacts for Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions[11]

The environmental impacts that could result from implementation of the Consent Order depend on decisions yet to be made by the New Mexico Environment Department. To bound the range of possible consequences of implementing different corrective measures, two action options have been evaluated: (1) a Capping Option, in which specific MDAs are stabilized in-place, and (2) a Removal Option, in which the waste and contamination within the MDAs are removed. These options are for analytical purposes only and do not necessarily represent the corrective measures that NNSA would propose to the New Mexico Environment Department. Remediation of other potential release sites would also occur at LANL. The impacts of remediating other potential release sites would be small relative to those for MDA remediation.

The Removal Option would result in larger near-term impacts than the Capping Option. Both options would involve major ground-disturbing activities that would require use of heavy equipment and hauling of materials and wastes. Temporary construction impacts such as increases in noise levels and emissions of criteria pollutants and particulate matter would be expected. Because these activities would be widespread and would continue over a number of years, MDA remediation activities would have a larger impact than other proposed projects. Under the Removal Option, large quantities of wastes would be generated including low-level radioactive waste and transuranic waste buried at LANL before 1970. Onsite disposal capacity

---

[11] NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.

Table S–17 Summary of Impacts for the Waste Management Facilities Transition Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – Temporary construction-related impacts. The TRU Waste Facility could require up to 7 acres of undeveloped land and could result in a change in land use designation, depending on its location. *Visual Environment* – Positive impact due to removal of the domes in TA-54. The TRU Waste Facility could be visible from San Ildefonso Pueblo lands, depending on its location.
Geology and Soils	Temporary construction- and DD&D-related impacts would occur in previously disturbed areas; impacts would be minor. Up to 169,000 cubic yards of soil and rock would be disturbed.
Water Resources	Minor impacts to surface water and groundwater. New facilities would use mitigative techniques to minimize impacts of spills.
Air Quality and Noise	*Air Quality* – Temporary construction impacts. Operational emissions would be mitigated using engineering controls, such as filtration systems, and monitored. Emissions from new facilities would not exceed those currently measured at the Decontamination and Volume Reduction System. Point source and area emissions in Area G would decrease by the end of 2015. *Noise* – Temporary construction-related impacts.
Ecological Resources	Temporary construction-related impacts at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Construction of the TRU Waste Facility could disturb up to 7 acres of ponderosa pine forest and open field. Consultation with the U.S. Fish and Wildlife Service could be required since construction could take place within Mexican spotted owl Areas of Environmental Interest.
Human Health	Minimal radiological impacts to offsite population. Reduced impacts to the MEI. Removal of transuranic waste would reduce area sources of occupational radiological exposure in Area G, potentially decreasing worker exposures after 2015.
Cultural Resources	Removal of the domes at TA-54 would reduce visual impacts on nearby traditional cultural properties. Potential impact to cultural resources could occur from construction of the TRU Waste Facility, depending on its location.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Infrastructure demands would not exceed current LANL site capabilities.
Waste Management	Construction waste would include 500 cubic yards of construction debris. DD&D waste would include 30,000 cubic yards of low-level radioactive waste; 8 cubic yards of mixed low-level radioactive waste; 54,000 cubic yards of solid waste including demolition debris; and 566,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes and demolition wastes (some radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	The postulated facility accident having the highest impacts would result in an LCF risk of 1 in 900 for a noninvolved worker, 1 in 12,000 for the MEI, and 1 in 500 to the exposed population.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MEI = maximally exposed individual; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359; acres to hectares, multiply by 0.40469.

for low-level radioactive wastes may be sufficient, depending on the actual volumes generated by remediation; disposal capacity can be supplemented by offsite facilities if needed. WIPP's disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste plus all transuranic waste buried before 1970 across the DOE complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs, if generated, would be based on the needs of the entire DOE complex. Any transuranic waste generated at LANL without a disposal pathway would be safely stored until disposal capacity becomes available.

The Removal Option would result in over 100,000 shipments of radioactive and nonradioactive wastes that could require transportation to offsite disposal facilities. These shipments could lead to two to three traffic fatalities over a 10-year period from nonradiological (truck collision) accidents. In addition, both the Capping or Removal Option would require the use of large quantities of soil, rock, and other bulk materials that would be obtained from LANL or local sources including the borrow pit in TA-61. Transporting this material to the MDAs could increase traffic congestion on LANL and local roads. Acquisition of large quantities of material from the TA-61 borrow pit could result in local visual impacts and some elimination of wildlife habitat.

Operational accidents postulated for the Removal Option could result in radiological or chemical exposures and risks to noninvolved workers, the MEI, and the population within a 50-mile (80-kilometer) radius. Although sulfur dioxide is not known to be present in MDA B, an accident was postulated in which a quantity of the gas would be released. This postulated accident could result in concentrations of sulfur dioxide in excess of the Emergency Response Planning Guideline (ERPG)-3 out to 111 feet (34 meters). The MDA B MEI distance is 148 feet (45 meters). The ERPG-2 distance would be approximately 270 feet (80 meters). **Table S–18** summarizes the potential impacts of the options for remediation, cleanup, and Consent Order actions.

Table S–18 Summary of Impacts for Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions

Resource Area	***Capping Option***	***Removal Option***
Land Resources	*Land Use* – Temporary commitment of land may be required to support remediation. Future use of the MDAs would remain restricted because capping would stabilize rather than remove existing contamination. *Visual Environment* – Temporary adverse impacts would result from capping activities. Borrow pit in TA-61 would become more visible.	*Land Use* – Temporary commitment of land may be required to support remediation. Decontamination would provide expanded opportunities for future use of some lands. *Visual Environment* – Temporary adverse impacts would result from removal activities. Borrow pit in TA-61 would become more visible.
Geology and Soils	Up to 2.5 million cubic yards of soil and rock would be required for capping; most material would be available from LANL sources. Covers for the MDAs would be contoured and provided with run-on and run-off control measures. Contamination within the subsurface of the MDAs and in the immediate vicinities would be fixed in-place except for contaminated gases or vapors.	Up to 2.2 million cubic yards of soil and rock would be required for fill and cover material; most would be available from LANL sources. Complete removal of the MDAs would eliminate the susceptibility of buried materials to erosional or other geological processes. Existing soil contamination in the vicinity of the MDAs would be greatly reduced, and contaminated soil or gas would be largely eliminated.
Water Resources	Few, if any impacts to surface water or groundwater from site investigations. Final MDA covers would minimize surface water run-on, runoff, erosion, and could protect surface and groundwater resources.	Few, if any, impacts to surface or groundwater from site investigations. There would be much less contamination in soils and sediments that could present a risk to water quality.
Air Quality and Noise	*Air Quality* – Minor to moderate impacts from releases of airborne pollutants caused by heavy equipment used in remediation and trucks hauling materials. Increased potential for particulate matter release from TA-61 borrow pit. *Noise* – Minor to moderate increase in traffic noise associated with remediation.	*Air Quality* – Larger releases of airborne pollutants than Capping Option from additional vehicles and heavy equipment. Comparable particulate matter release. The potential for long-term release of volatile organic compounds from the MDAs would be greatly reduced, if not eliminated. *Noise* – Temporary increase in noise in vicinity of remediation. Minor to moderate increase in traffic noise associated with remediation.

Resource Area	Capping Option	Removal Option
Ecological Resources	Temporary localized, construction-type impacts during site investigations and remediation. In a few cases, remediation activities may affect, but are not likely to adversely affect, the Mexican spotted owl, bald eagle, and southwestern willow flycatcher. Possible loss of habitat at the TA-61 borrow pit, including undeveloped buffer and core habitat for the Mexican spotted owl. Expansion of the borrow pit would require consultation with the U.S. Fish and Wildlife Service.	
Human Health	Radiological and nonradiological risks to workers would be minor. There would be no risk to the public during MDA capping, while future risks would be reduced.	Radiological and nonradiological risks to workers would be increased. There would be small risk to the public during MDA removal, while future risks would be greatly reduced.
Cultural Resources	No archaeological resources are located within any of the MDAs. Few or no risks to cultural resources at potential release sites. All work would be coordinated with LANL personnel responsible for preservation of cultural resources.	
Socioeconomics and Infrastructure	*Socioeconomics* – Marginal increases in employment, personal income, and other economic measures. *Infrastructure* – Marginal increases in utility usage.	*Socioeconomics* –Increases anticipated in employment, personal income, and other economic measures. *Infrastructure* – Increases in utility infrastructure demands.
Waste Management	280 cubic yards of transuranic waste; 20,000 cubic yards of low-level radioactive waste; 1,800 cubic yards of mixed low-level radioactive waste; 47,000 cubic yards of solid waste; and 50 million pounds of chemical waste. Sufficient capacity would exist at LANL to dispose of the low-level radioactive waste.	22,000 cubic yards of transuranic waste; 1,000,000 cubic yards of low-level radioactive waste; 180,000 cubic yards of mixed low-level radioactive waste; 130,000 cubic yards of solid waste; and 97 million pounds of chemical waste. This volume of low-level radioactive waste may require use of some offsite disposal capacity.
Transportation	Increase in shipments of waste and bulk materials on onsite and offsite roads would not be expected to result in any LCFs among workers or the public from radiation exposure during waste transport, nor traffic fatalities from accidents.	Large increase in shipments of waste and bulk materials on onsite and offsite roads would not be expected to result in any LCFs among workers or the public from radiation exposure during waste transport, but could result in traffic fatalities.
Environmental Justice	No disproportionately high and adverse impacts on minority or low-income populations.	
Facility Accidents	Low risks of accidents involving radioactive or hazardous materials.	Postulated facility accident with the highest radiological impacts would result in an LCF risk of 1 in 210 for a noninvolved worker; 1 in 1,500 for the MEI; and 1 in 220 for the population within a 50-mile radius. Postulated facility accident with the highest chemical impacts would result in concentrations of sulfur dioxide exceeding ERPG-3 out to 111 feet; ERPG-2 out to 270 feet.

MDA = material disposal area; TA = technical area; LCF = latent cancer fatality; MEI = maximally exposed individual; ERPG = Emergency Response Planning Guideline.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; feet to meters, multiply by 0.3048; miles to kilometers, multiply by 1.6093; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for Security-Driven Transportation Modifications Project

This proposed project would restrict privately owned vehicles (according to their security level) along portions of the Pajarito Corridor West between TA-48 and TA-63. The project would involve constructing new roadways, parking lots, pedestrian and vehicle bridges across Ten Site Canyon, and security check points. Auxiliary actions are also being considered that would construct bridges across Mortandad and Sandia Canyons. **Table S–19** summarizes the potential impacts of these activities.

Table S–19 Summary of Impacts for the Security-Driven Transportation Modifications Project

Resource Area	Impact Summary	
	Proposed Action	***Auxiliary Actions***
Land Resources	*Land Use* – Development of portions of the Pajarito Corridor West would be within current land use plans. *Visual Environment* – Temporary construction impacts. Permanent, pronounced changes to views from parking lots and pedestrian and vehicle bridges across Ten Site Canyon.	*Land Use* – The route for Auxiliary Action A would represent a change in land use but would be within the scope of the LANL Comprehensive Site Plan. The route for Auxiliary Action B would be partially within current land use plans. *Visual Environment* – Permanent, pronounced changes to views from proposed bridges over Mortandad and Sandia Canyons.
Geology and Soils	Temporary construction-related impacts. Approximately 238,000 cubic yards of soil and rock would be disturbed during construction. Up to 26,000 cubic yards of soil and rock would be disturbed if both auxiliary actions are implemented.	
Water Resources	Temporary construction-related impacts.	
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. Minor increase in vehicle emissions during operation. *Noise* – Temporary construction-related impacts. Minor increase in traffic noise in vicinity of new roads and bus routes during operation.	*Air Quality* – Temporary construction-related impacts. Minor increase in vehicle emissions during operation. *Noise* – Temporary construction-related impacts. Minor increase in traffic noise in vicinity of new roads and bus routes during operation.
Ecological Resources	Temporary construction-related impacts. Up to 30 acres of habitat loss from parking lot and bridge construction. Construction of a span bridge across Ten Site Canyon would be unlikely to cause adverse affects to the Mexican spotted owl.	Temporary construction-related impacts. Proposed Auxiliary Action A construction falls within Areas of Environmental Interest core and buffer zones for the Mexican spotted owl and would disturb up to 25.4 acres of habitat. Proposed Auxiliary Action B construction falls within the Area of Environmental Interest buffer zone for the Mexican spotted owl, and would disturb 67.1 acres of habitat. Potentially adverse impacts on owls from traffic noise and light. Implementation of either Auxiliary Action would necessitate consultation with the U.S. Fish and Wildlife Service.
Human Health	No or negligible impact.	
Cultural Resources	Proposed bridges could adversely affect views of Ten Site Canyon from nearby Traditional Cultural Properties.	Further detailed analysis would be required once the exact bridge locations are determined to ensure protection of prehistoric and historic sites located to the east and west of the proposed bridge corridor. Proposed bridges could adversely affect views of Mortandad and Sandia Canyons from nearby Traditional Cultural Properties.
Socioeconomics and Infrastructure	*Socioeconomics* – No impacts identified. *Infrastructure* – Temporary construction-related impacts. Some existing utilities might require relocation or rerouting.	
Waste Management	Approximately 1,260 cubic yards of construction debris.	Approximately 160 cubic yards under Auxiliary Action A, and 110 cubic yards under Auxiliary Action B, of construction debris.
Transportation	Some temporary and intermittent disruption of traffic during construction of new roads and bridges. Traffic patterns would be permanently altered, but impacts would be minor.	
Environmental Justice	No or negligible impact.	

Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

The most consequential impacts from implementing this project would be on the visual environment and the Mexican spotted owl. The removal of open and forested land under the Proposed Action would add to the overall developed appearance of the Pajarito Corridor West as viewed from nearby and higher elevations to the west. The construction of both vehicle and pedestrian bridges across Ten Site Canyon under the Proposed Action, and Mortandad and Sandia Canyons under the auxiliary actions, would be major changes to the landscape. While careful site selection and bridge design would help mitigate visual impacts, the bridges would nevertheless alter the natural appearance of the canyons as viewed from both nearby and distant locations. The proposed bridges could adversely affect views of the three canyons from nearby traditional cultural properties. Bridges constructed across Mortandad and Sandia Canyons would pass through Areas of Environmental Interest for the Mexican spotted owl. Habitat would be lost as a result of the proposed and auxiliary actions, and the light and noise from traffic could create adverse effects. The U.S. Fish and Wildlife Service has determined that, provided reasonable and prudent measures are taken, construction of a span bridge over Ten Site Canyon would be unlikely to cause adverse affects to the Mexican spotted owl. Additional consultation with the U.S. Fish and Wildlife Service would be needed for the proposed action if a land rather than span bridge was to be used, and for the auxiliary actions once the exact locations and designs of the optional bridges over Mortandad and Sandia Canyons are better known.

Summary of Impacts for Nicholas C. Metropolis Center for Modeling and Simulation Increase in Level of Operations

This project would expand the computing capabilities of the Metropolis Center to support a 100-teraflops capability at a minimum, and could approach 1,000 teraflops (1 petaflops). This action would add mechanical and electrical equipment, including chillers, cooling towers, and air-conditioning units. **Table S–20** summarizes the potential impacts of these activities.

Table S–20 Summary of Impacts for Nicholas C. Metropolis Center for Modeling and Simulation Increase in Level of Operations

Resource Area	*Impact Summary*
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	No or negligible impact.
Water Resources	Discussed in infrastructure.
Air Quality and Noise	No or negligible impact.
Ecological Resources	No or negligible impact.
Human Health	No or negligible impact.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Water usage would expand to 51 million gallons per year, which would not exceed available water supply capacities. Electrical demand would increase to 15 megawatts, which would not exceed available electrical supply capacities.
Waste Management	No or negligible impact.
Transportation	No or negligible impact
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

Note: To convert gallons to liters, multiply by 3.7854.

The level to which operations could increase would be limited by the amount of electricity (15 megawatts) and water (51 million gallons [193 million liters] per year) needed to support the increased capabilities. Because each new generation of computing machinery continues to be designed with increased computational speed and enhanced efficiency in cooling water and electrical requirements, it is anticipated that higher computing capabilities could be achieved within these limitations. Planned improvements to the Sanitary Effluent Recycling Facility should increase its effectiveness in supplying the Metropolis Center with cooling water. Accordingly, the Metropolis Center's reliance on groundwater is expected to diminish substantially.

Summary of Impacts for Increase in Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project

This proposed project would expand the types and quantities of sealed sources that could be managed at LANL by the Off-Site Source Recovery Project. The proposed project would continue the current approach of providing safe storage of sealed sources at LANL when other reasonable options for disposition, such as reuse or commercial disposal, are not available. The only impacts resulting from these activities would result from exposure to the radioactive sources during normal operations and postulated accidents. Under normal conditions, the sealed sources would be completely contained and would contribute only to external radiation exposure. Proper shielding and radiation control procedures would minimize worker exposure. Noninvolved workers and the public would not be expected to receive any measurable dose during normal operations.

For purposes of analysis, potential bounding accident scenarios were assessed for an aircraft crash with fire at Area G at TA-54, as well as a seismic event with fire at Wing 9 of the Chemistry and Metallurgy Research Building. Consequences of the Wing 9 event also were calculated for a release emanating from TA-48 because the Radiological Sciences Institute that would be built in TA-48 would provide a replacement for the Chemistry and Metallurgy Research Building Wing 9 hot cell. The highest LCF risk to the population would result from an accident at Wing 9 of the Chemistry and Metallurgy Research Building with consequences calculated at TA-3. Taking into consideration the frequency, this postulated accident could result in an increase in LCF risk of approximately 1 chance in 6 million for the noninvolved worker, 1 chance in 70 million for the MEI, and 1 chance in 600 for the population within a 50-mile (80-kilometer) radius.

Potential mitigation measures could include placing sealed sources at locations where they would not be susceptible to damage from an aircraft crash, fire, or seismic event (kept underground); or instituting lower limits for maximum allowable source radioisotope activity in shipping containers, the TA-54 dome, and Wing 9 of the Chemistry and Metallurgy Research Building. **Table S–21** summarizes the potential impacts from increasing the scope of the Off-Site Source Recovery Project at LANL.

Table S–21 Summary of Impacts for Increase in Type and Quantity of Sealed Sources Managed at Los Alamos National Laboratory by the Off-Site Source Recovery Project

Resource Area	***Impact Summary***
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	No or negligible impact.
Water Resources	No or negligible impact.
Air Quality and Noise	*Air Quality* – No or negligible impact. *Noise* – Temporary construction-related impacts from construction and burial activities.
Ecological Resources	No or negligible impact.
Human Health	Involved worker doses would be maintained below their regulatory and administrative limits through use of shielding, safe work practices, procedures, and personal protective equipment. Noninvolved workers and the public would not be expected to receive any measurable doses during normal operations.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No impacts identified.
Waste Management	No impacts identified.
Transportation	No or negligible impact.
Environmental Justice	No or negligible impact.
Facility Accidents	Postulated accidents could result in an increase in LCF risk to the noninvolved worker, the MEI, and population within a 50-mile radius. Highest LCF risk to population would be from a CMR Building Wing 9 accident.

LCF = latent cancer fatality; MEI = maximally exposed individual; CMR = Chemistry and Metallurgy Research.
Note: To convert miles to kilometers, multiply by 1.6093.

S.10 References

Cummings, L., 2007, Los Alamos Site Office, Document Manager, *Environmental Impact Statement for the Operation of a Biosafety Level-3 Facility at Los Alamos National Laboratory, Los Alamos*, *New Mexico*, DOE/EIS-0388D, Personal communication with K. Owens, Science Applications International Corporation, Germantown, Maryland, "BSL-3 Summary Update for LANL SWEIS," August 9.

DOE (U.S. Department of Energy), 1996, *Plutonium: The First 50 Years, United States Plutonium Production, Acquisition, and Utilization from 1944 through 1994,* DOE/DP-0137, Washington, DC, February.

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 2005a, *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems* (DOE/EIS-0373D), Office of Nuclear Energy, Science and Technology, Washington, DC, June.

DOE (U.S. Department of Energy), 2005b, *Recommendations for the Nuclear Weapons Complex of the Future,* Secretary of Energy Advisory Board, Washington, DC, July 13.

DOE (U.S. Department of Energy), 2005c, "AEGLs, ERPGs, or Rev. 21 TEELs for Chemicals of Concern 2005, DKC-05-0002, Rev. 21," Washington, DC (accessed at www.eh.doe.gov/chem_safety/teeldef.html), September.

DOE (U.S. Department of Energy), 2007a, *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1D, Office of Civilian Radioactive Waste Management, Las Vegas, Nevada, October.

DOE (U.S. Department of Energy), 2007b, *Draft Complex Transformation Supplemental Programmatic Environmental Impact Statement*, DOE/EIS-0236-S4, National Nuclear Security Administration, Washington, DC, December.

DOE (U.S. Department of Energy), 2008, Memorandum from A. R. Griffith, Office of Nuclear Energy to E. Withers, Los Alamos National Laboratory Site-Wide Environmental Impact Statement Document Manager, Subject: Advanced Fuel Cycle Facility (AFCF) Data for the Los Alamos National Laboratory (LANL) Site-wide Environmental Impact Statement (SWEIS), March 31.

LANL (Los Alamos National Laboratory), 2003, *Water Supply at Los Alamos 1998-2001*, LA-13985-PR, Risk Reduction and Environmental Stewardship Division, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2004, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2006a, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006b, *Interim Measures Work Plan for Chromium Contamination in Groundwater*, LA-UR-06-1961, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006c, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006d, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Environment and Remediation Support Services Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006e, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group, Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2007, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Design Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

NMED (New Mexico Environment Department), 2005, Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act Section 74-4-10 and the New Mexico Solid Waste Act Section 74-9-36(D), (available at www.nmenv.state.nm.us/hwb/lanl/OrderConsent/03-01-05/Order_on_Consent_2-24-05.pdf), March 1.

NNSA (National Nuclear Security Administration), 2006a, Letter from L. Brooks, National Nuclear Security Administration, to A. Makhijani, Institute for Energy and Environmental Research, Response to "Accounting Discrepancy of Plutonium at LANL," February 28.

NNSA (National Nuclear Security Administration), 2006b, *Complex 2030, An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century*, DOE/NA-0013, Office of Defense Programs, Washington, DC, October.

NNSA (National Nuclear Security Administration), 2007, *Report on the Plan for Transformation of the National Nuclear Security Administration Nuclear Weapons Complex*, Office of Transformation, Washington, DC, January 31.

S.11 Glossary

actinide—Any member of the group of elements with atomic numbers from 89 (actinium) to 103 (lawrencium) including uranium and plutonium. All members of this group are radioactive.

activation products—Nuclei, usually radioactive, formed by the bombardment and absorption in material with neutrons, protons, or other nuclear particles.

alluvium (alluvial)—Unconsolidated, poorly sorted detrital sediments, ranging from clay-to-gravel sizes, deposited by streams.

as low as reasonably achievable (ALARA)—An approach to radiation protection to manage and control worker and public exposures (both individual and collective) and releases of radioactive material to the environment to as far below applicable limits as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit but a process for minimizing doses to as far below limits as is practicable.

Atomic Energy Act—A law originally enacted in 1946 and replaced in 1954 that placed nuclear production and control of nuclear materials within a civilian agency, originally the Atomic Energy Commission. The functions of the Atomic Energy Commission were replaced by the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

baseline—The existing environmental conditions against which impacts of the Proposed Action and its alternatives can be compared. The environmental baseline is the site environmental conditions as they exist or are estimated to exist in the absence of the Proposed Action.

bedrock—The solid rock that lies beneath soil and other loose surface materials.

best management practices—Structural, nonstructural, and managerial techniques, other than effluent limitations, to prevent or reduce pollution of surface water. They are the most effective and practical means to control pollutants that are compatible with the productive use of the resource to which they are applied. Best Management Practices are used in both urban and agricultural areas. Best Management Practices can include schedules of activities; prohibitions of practices; maintenance procedures; treatment requirements; operating procedures; and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

borrow—Excavated material that has been taken from one area to be used as raw material or fill at another location.

bound—To use simplifying assumptions and analytical methods in analyzing potential impacts or risks such that the result provides an overestimate or upper limit that encompasses the potential impacts or risks.

capable fault—A fault that has exhibited one or more of the following characteristics: (1) movement at or near the ground surface at least once within the past 35,000 years, or movement of a recurring nature within the past 500,000 years; (2) macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault; (3) a structural relationship to a capable fault according to characteristic (1) or (2) above, such that movement on one could be reasonably expected to be accompanied by movement on the other.

carcinogen—An agent that may cause cancer. Ionizing radiation is a physical carcinogen; there are also chemical and biological carcinogens, and biological carcinogens may be external (such as viruses) or internal (such as genetic defects).

cavate—Consists of a room carved into a cliff face within the Bandelier Tuff geological formation. The category includes isolated cavates, multi-roomed contiguous cavates, and groups of adjacent cavates that together form a cluster or complex.

chemical wastes—Defined as hazardous waste (designated under the Resource Conservation and Recovery Act regulations); toxic waste (asbestos and polychlorinated biphenyls [PCBs], designated under the Toxic Substances Control Act); and special waste (designated under the New Mexico Solid Waste Regulations and including industrial waste, infectious waste, and petroleum contaminated soils). In the past, LANL tracking efforts for chemical waste included construction and demolition debris and all other non-radioactive waste that managed through the Solid Chemical and Radioactive Waste Facilities. For waste projections in the SWEIS, construction and demolition debris are presented as a separate categories.

classified information—(1) Information that has been determined pursuant to Executive Order 12958, any successor order, or the Atomic Energy Act of 1954 (42 U.S.C. 2011) to require protection against unauthorized disclosure; (2) certain information requiring protection against unauthorized disclosure in the interest of national defense and security or foreign relations of the United States pursuant to Federal statute or Executive Order.

***Code of Federal Regulations* (CFR)—**All Federal regulations in effect are published in codified form in the CFR. References to the CFR usually take the form of XX CFR Part YY, where XX refers to Title (major division) and YY refers to Part (section).

collective dose—The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation. Collective dose is expressed in units of person-rem or person-sievert.

Compliance Order on Consent (Consent Order)—An enforcement document signed by the New Mexico Environment Department, the U.S. Department of Energy, and the Regents of the University of California on March 1, 2005, which prescribes the requirements for corrective action at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the LANL Hazardous Waste Facility Permit.

criteria pollutants—An air pollutant that is regulated by National Ambient Air Quality Standards. The U.S. Environmental Protection Agency must describe the characteristics and potential health and welfare effects that form the basis for setting, or revising, the standard for each regulated pollutant. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter, less than or equal to 10 micrometers (0.0004 inch) in diameter, and less than or equal to 2.5 micrometers (0.0001 inch) in diameter. New pollutants may be added to, or removed from, the list of criteria pollutants as more information becomes available. (See National Ambient Air Quality Standards.)

criticality—The condition in which a system is capable of sustaining a nuclear chain reaction.

cultural resources—Archaeological materials (artifacts) and sites that date to the prehistoric, historic, and ethnohistoric periods and that are currently located on the ground surface or buried beneath it; standing structures and/or their component parts that are over 50 years of age and are important because they represent a major historical theme or era, including the Manhattan Project and the Cold War era and structures that have an important technological, architectural, or local significance; cultural and natural places, select natural resources, and sacred objects that have importance for American Indians; American folklife traditions and arts; "historic properties" as defined in the National Historic Preservation Act; "archaeological resource" as defined in the Archaeological Resources Protection Act; and "cultural items" as defined in the Native American Graves Protection and Repatriation Act.

cumulative impacts—The impacts on the environment that result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of the agency or person who undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

curie—A unit of radioactivity equal to 37 billion disintegrations per second (37 billion becquerels); also a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

deactivation—The placement of a facility in a radiologically and industrially safe shutdown condition that is suitable for a long-term surveillance and maintenance phase prior to final decontamination and decommissioning.

decommissioning—Retirement of a facility, including any necessary decontamination and dismantlement.

decontamination—The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive or chemical contamination, from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

decontamination, decommissioning, and demolition (DD&D)—Actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the structure.

depleted uranium—Uranium whose content of the fissile isotope uranium-235 is less than the 0.7 percent (by weight) found in natural uranium, so that it contains more uranium-238 than natural uranium. (See enriched uranium, highly enriched uranium, natural uranium, low-enriched uranium, and uranium.)

dose (radiological)—A generic term meaning absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or committed equivalent dose. It is a measure of the energy imparted to matter by ionizing radiation. The unit of dose is the rem or rad. The radiation dose delivered per unit of time (such as rem per year) is the dose rate.

drinking water standards—The level of constituents or characteristics in a drinking water supply specified in regulations under the Safe Drinking Water Act as the maximum permissible.

effluent—A waste stream flowing into the surface water, groundwater, or soil. Most frequently the term applies to wastes discharged to surface waters.

emission—A material discharged into the atmosphere from a source operation or activity.

endangered species—Plants or animals that are in danger of extinction through all or a significant portion of their ranges and that have been listed as endangered by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the Endangered Species Act and its implementing regulations (50 CFR Part 424). The lists of endangered species can be found in 50 CFR 17.11 for wildlife, 50 CFR 17.12 for plants, and 50 CFR 222.23(a) for marine organisms. (See threatened species.)

enriched uranium—Uranium whose content of the fissile isotope uranium-235 is greater than the 0.7 percent (by weight) found in natural uranium. (See depleted uranium, uranium, natural uranium, low-enriched uranium, and highly enriched uranium.)

environmental impact statement (EIS)—The detailed written statement required by the National Environmental Policy Act (NEPA) section 102(2)(C) for a proposed major Federal action significantly affecting the quality of the human environment. A U.S. Department of Energy (DOE) EIS is prepared in accordance with applicable requirements of the Council on Environmental Quality National Environmental Policy Act regulations in 40 CFR Parts 1500 to 1508 and DOE NEPA regulations in 10 CFR Part 1021. The statement includes, among other information, discussions of the environmental impacts of the Proposed Action and all reasonable alternatives, adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of the human environment and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources.

environmental justice—The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Executive Order 12898 directs Federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations. (See minority population and low-income population.)

fault—A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred. A normal fault occurs when the hanging wall has been depressed in relation to the footwall. A reverse fault occurs when the hanging wall has been raised in relation to the footwall.

fission—The splitting of the nucleus of a heavy atom into two lighter nuclei. It is accompanied by the release of neutrons, gamma rays, and kinetic energy of fission products.

fission products—Nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the fission fragments' radioactive decay.

grading—Any stripping, cutting, filling, stockpiling, or combination thereof that modifies the land surface.

groundwater—Water below the ground surface in a zone of saturation.

habitat—The environment occupied by individuals of a particular species, population, or community.

hazardous air pollutants—Air pollutants not covered by ambient air quality standards but which may present a threat of adverse human health effects or adverse environmental effects. Those specifically listed in 40 CFR 61.01 are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, hazardous air pollutants are any of the 189 pollutants listed in or pursuant to the Clean Air Act, Section 112(b). Very generally, hazardous air pollutants are any air pollutants that may realistically be expected to pose a threat to human health or welfare.

hazardous chemical—Under 29 CFR Part 1910, Subpart Z, hazardous chemicals are defined as "any chemical which is a physical hazard or a health hazard." Physical hazards include combustible liquids, compressed gases, explosives, flammables, organic peroxides, oxidizers, pyrophorics, and reactives. A health hazard is any chemical for which there is good evidence that acute or chronic health effects occur in exposed employees. Hazardous chemicals include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, agents that act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes.

hazardous material—A material, including a hazardous substance, as defined by 49 CFR 171.8, that poses a risk to health, safety, and property when transported or handled.

hazardous waste—A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20-24 (ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the U.S. Environmental Protection Agency in 40 CFR 261.31-33.

high-efficiency particulate air (HEPA) filter—An air filter capable of removing at least 99.97 percent of particles 0.3 micrometers (about 0.00001 inches) in diameter. High-efficiency particulate air filters include a pleated fibrous medium (typically fiberglass) capable of capturing very small particles.

historic structure—A building or other structure constructed after AD 1593 (but most typically in the Los Alamos area constructed after about AD 1900).

hot cell—A shielded facility that requires the use of remote manipulators for handling radioactive materials.

isotope—Any of two or more variations of an element in which the nuclei have the same number of protons (and thus the same atomic number), but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable; carbon-14 is radioactive).

latent cancer fatalities (LCFs)—Deaths from cancer occurring some time after, and postulated to be due to, exposure to ionizing radiation or other carcinogens.

long-term impact—In general, an impact that endures beyond the timeframe of the action or activity that causes the impact.

low-income population—Low-income populations, defined in terms of Bureau of the Census annual statistical poverty levels (Current Population Reports, Series P-60 on Income and Poverty), may consist of groups or individuals who live in geographic proximity to one another or who are geographically dispersed or transient (such as migrant workers or American Indians), where either group experiences common conditions of environmental exposure or effect. (See environmental justice and minority population.)

low-level radioactive waste—Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material as defined by Section 11e (2) of the Atomic Energy Act of 1954, as amended. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level radioactive waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

material disposal area (MDA)—An area used any time between the beginning of Los Alamos National Laboratory operations in the early 1940s and the present for disposing of chemically, radioactively, or chemically and radioactively contaminated materials.

maximally exposed individual (MEI)—A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (inhalation, ingestion, direct exposure).

maximally exposed individual (transportation analysis)—A hypothetical individual receiving radiation doses from transporting radioactive materials on the road. For the incident-free transport operation, the maximally exposed individual would be an individual stuck in traffic next to the shipment for 30 minutes. For accident conditions, the maximally exposed individual is assumed to be an individual located approximately 33 meters (100 feet) directly downwind from the accident.

millirem—One-thousandth of 1 rem. (See rem.)

minority population—Minority populations exist where either: (a) the minority population of the affected area exceeds 50 percent, or (b) the minority population percentage of the affected area is meaningfully greater than in the general population or other appropriate unit of geographic analysis (such as a governing body's jurisdiction, a neighborhood, census tract, or other similar unit). "Minority" refers to individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. "Minority populations" include either a single minority group or the total of all minority persons in the affected area. They may consist of groups of individuals living in geographic proximity to one another or a geographically dispersed/transient set of individuals (such as migrant workers or American Indians), where either group experiences common conditions of environmental exposure or effect. (See environmental justice and low-income population.)

mitigate—Mitigation includes: (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; or (5) compensating for an impact by replacing or providing substitute resources or environments.

mixed waste—Waste that contains both nonradioactive hazardous waste and radioactive waste, as defined in this glossary.

National Environmental Policy Act (NEPA) of 1969—This Act is the basic national charter for protection of the environment. It establishes policy, sets goals (Section 101), and provides means (Section 102) for carrying out policy. Section 102(2) contains "action-forcing" provisions to ensure that Federal agencies follow the letter and spirit of the act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the National Environmental Policy Act requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the Proposed Action and other specified information.

National Pollutant Discharge Elimination System—A provision of the Clean Water Act which prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the U.S. Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation. The National Pollutant Discharge Elimination System permit lists either permissible discharges, the level of cleanup technology required for wastewater, or both.

National Register of Historic Places—The official list of the Nation's cultural resources that are worthy of preservation. The National Park Service maintains the list under direction of the Secretary of the Interior. Buildings, structures, objects, sites, and districts are included in the National Register for their importance in American history, architecture, archaeology, culture, or engineering. Properties included on the National Register range from large-scale, monumentally proportioned buildings to smaller-scale, regionally distinctive buildings. The listed properties are not just of nationwide importance; most are significant primarily at the state or local level. Procedures for listing properties on the National Register are found in 36 CFR Part 60.

natural uranium—Uranium with the naturally occurring distribution of uranium isotopes (approximately 0.7-weight percent uranium-235, and the remainder essentially uranium-238). (See uranium, depleted uranium, enriched uranium, highly enriched uranium, and low-enriched uranium.)

neptunium-237—A manmade element with the atomic number 93. Pure neptunium is a silvery metal. The neptunium-237 isotope has a half-life of 2.14 million years. When neptunium-237 is bombarded by neutrons, it is transformed to neptunium-238, which in turn undergoes radioactive decay to become plutonium-238. When neptunium-237 undergoes radioactive decay, it emits alpha particles and gamma rays.

nitrogen oxides—Refers to the oxides of nitrogen, primarily nitrogen oxide and nitrogen dioxide. These are produced in the combustion of fossil fuels and can constitute an air pollution problem. Nitrogen dioxide emissions contribute to acid deposition and formation of atmospheric ozone.

nonnuclear aboveground experimentation—Aboveground experimentation or testing in support of nuclear weapons programs that does not involve detonation of a nuclear explosive.

nonproliferation—Preventing the spread of nuclear weapons, nuclear weapon materials, and nuclear weapon technology.

normal operations—All normal (incident-free) conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency greater than 0.1 events per year.

Notice of Intent (NOI)—Public announcement that an environmental impact statement will be prepared and considered. It describes the Proposed Action, possible alternatives, and scoping process, including whether, when, and where any scoping meetings will be held. The NOI is usually published in the *Federal Register* and local media. The scoping process includes holding at least one public meeting and requesting written comments on issues and environmental concerns that an environmental impact statement should address.

nuclear facility—A facility that is subject to requirements intended to control potential nuclear hazards. Defined in U.S. Department of Energy directives as any nuclear reactor or any other facility whose operations involve radioactive materials in such form and quantity that a significant nuclear hazard potentially exists to the employees or the general public.

nuclear material—Composite term applied to—(1) special nuclear material; (2) source material such as uranium or thorium or ores containing uranium or thorium; and (3) byproduct material, which is any radioactive material that is made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material.

nuclear weapons complex—The sites supporting the research, development, design, manufacture, testing, assessment, certification, and maintenance of the Nation's nuclear weapons and the subsequent dismantlement of retired weapons.

outfall—The discharge point of a drain, sewer, or pipe as it empties into the environment.

ozone—The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere, ozone is considered an air pollutant.

particulate matter (PM)—Any finely divided solid or liquid material, other than uncombined (pure) water. A subscript denotes the upper limit of the diameter of particles included. Thus, PM_{10} includes only those particles equal to or less than 10 micrometers (0.0004 inches) in diameter; $PM_{2.5}$ includes only those particles equal to or less than 2.5 micrometers (0.0001 inches) in diameter.

person-rem—A unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group. (See collective dose.)

pit—The central core of a primary assembly in a nuclear weapon typically composed of plutonium-239 and/or highly-enriched uranium and other materials.

plutonium—A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially by neutron bombardment of uranium. Plutonium has 15 isotopes with atomic masses ranging from 232 to 246 and half-lives from 20 minutes to 76 million years.

plutonium-238—An isotope with a half-life of 87.74 years used as the heat source for radioisotope power systems. When plutonium-238 undergoes radioactive decay, it emits alpha particles and gamma rays. Plutonium-238 may fission if exposed to neutrons. The likelihood of plutonium-238 undergoing fission is dependent upon many factors including the number and energy of neutrons, temperature, plutonium-238 purity and shape, and the presence and proximity of other elements.

plutonium-239—An isotope with a half-life of 24,110 years that is the primary radionuclide in weapons-grade plutonium. When plutonium-239 decays, it emits alpha particles. Plutonium-239 may fission if exposed to neutrons. The likelihood of plutonium-239 undergoing fission is dependent upon many factors including the number and energy of neutrons, temperature, plutonium-239 purity and shape, and the presence and proximity of other elements.

population dose—See collective dose.

potential release site (PRS)—A site suspected of releasing or having the potential to release contaminants (radioactive, chemical, or both) into the environment. PRS is a generic term that includes solid waste management units and areas of concern that are cited and defined in the Compliance Order on Consent (Consent Order).

radioactive waste—In general, waste that is managed for its radioactive content. Waste material that contains source, special nuclear, or byproduct material is subject to regulation as radioactive waste under the Atomic Energy Act. Also, waste material that contains accelerator-produced radioactive material or a high concentration of naturally occurring radioactive material may be considered radioactive waste.

radioactivity—

Defined as a *process*: The spontaneous transformation of unstable atomic nuclei, usually accompanied by the emission of ionizing radiation.

Defined as a *property*: The property of unstable nuclei in certain atoms to spontaneously emit ionizing radiation during nuclear transformations.

radioisotope or radionuclide—An unstable isotope that undergoes spontaneous transformation, emitting radiation. (See isotope.)

radioisotope power system—Any one of a number of technologies used in spacecraft and in national security technologies that produces heat or electricity from the radioactive decay of suitable radioactive substances such as plutonium-238. They are typically used in applications such as to enable the operation of instruments and sensors where energy sources such as solar power are undesirable or impractical due to the remoteness or extreme conditions of the operating environment.

Record of Decision (ROD)—A document prepared in accordance with the requirements of 40 CFR 1505.2 and 10 CFR 1021.315 that provides a concise public record of the U.S. Department of Energy's (DOE) decision on a Proposed Action for which an environmental impact statement was prepared. A ROD identifies the alternatives considered in reaching the decision; the environmentally preferable alternative; factors balanced by DOE in making the decision; and whether all practicable means to avoid or minimize environmental harm have been adopted, and, if not, the reason why they were not.

region of influence (ROI)—A site-specific geographic area in which the principal direct and indirect effects of actions are likely to occur.

rem (roentgen equivalent man)—A unit of dose equivalent. The dose equivalent in rem equals the absorbed dose in rad in tissue multiplied by the appropriate quality factor and possibly other modifying factors. Derived from "roentgen equivalent man," referring to the dosage of ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma-ray exposure. One rem equals 0.01 sieverts. (See absorbed dose and dose equivalent.)

remediation—The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.

Resource Conservation and Recovery Act, as Amended (RCRA)—A law that gives the U.S. Environmental Protection Agency the authority to control hazardous waste from "cradle to grave" (from the point of generation to the point of ultimate disposal), including its minimization, generation, transportation, treatment, storage, and disposal. The Resource Conservation and Recovery Act also sets forth a framework for the management of nonhazardous solid wastes. (See hazardous waste.)

risk—The probability of a detrimental effect of exposure to a hazard. Risk is often expressed quantitatively as the probability of an adverse event occurring multiplied by the consequence of that event (in other words, the product of these two factors).

risk assessment (chemical or radiological)—The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological materials.

runoff—The portion of rainfall, melted snow, or irrigation water that flows across the ground surface, and eventually enters streams.

safeguards—An integrated system of physical protection, material accounting, and material control measures designed to deter, prevent, detect, and respond to unauthorized access, possession, use, or sabotage of nuclear materials.

security—An integrated system of activities, systems, programs, facilities, and policies for the protection of Restricted Data and other classified information or matter, nuclear materials, nuclear weapons and nuclear weapons components, and/or U.S. Department of Energy or contractor facilities, property, and equipment.

sediment—Soil, sand, and minerals washed from land into water that deposit on the bottom of a water body.

seismic—Pertaining to any Earth vibration, especially an earthquake.

seismicity—The frequency and distribution of earthquakes.

shielding—With regard to radiation, any material of obstruction (bulkheads, walls, or other construction) that absorbs radiation to protect personnel or equipment.

short-term impact—In general, an impact that occurs during or for a short time after the action or activity that causes the impact.

source material—Depleted uranium, normal uranium, thorium, or any other nuclear material determined, pursuant to Section 61 of the Atomic Energy Act of 1954, as amended, to be source material, or ores containing one or more of the foregoing materials in such concentration as may be determined by regulation.

source term—The amount of a specific pollutant (chemicals, radionuclides) emitted or discharged to a particular environmental medium (air, water, earth) from a source or group of sources. It is usually expressed as a rate (amount per unit time).

special nuclear material(s)—A category of material subject to regulation under the Atomic Energy Act, consisting primarily of fissile materials. It is defined to mean plutonium, uranium-233, uranium enriched in the isotopes of uranium-233 or -235, and any other material that the Nuclear Regulatory Commission determines to be special nuclear material, but it does not include source material.

stockpile—The inventory of active nuclear weapons for the strategic defense of the United States.

stockpile stewardship program—A program that ensures the operational readiness (safety and reliability) of the U.S. nuclear weapons stockpile by the appropriate balance of surveillance, experiments, and simulations.

target—A tube, rod, or other form containing material that, on being irradiated in a nuclear reactor or an accelerator, would produce a desired end product.

technical area (TA)—Geographically distinct administrative units established for the control of LANL operations. There are currently 49 active TAs; 47 in the 41 square miles of the LANL site, one at Fenton Hill, west of the main site, and one comprising leased properties in town.

threatened species—Any plants or animals that are likely to become endangered species within the foreseeable future throughout all or a significant portion of their ranges and which have been listed as threatened by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures set out in the Endangered Species Act and its implementing regulations (50 CFR Part 424). (See endangered species.)

Toxic Substances Control Act of 1976—This Act authorizes the U.S. Environmental Protection Agency (EPA) to secure information on all new and existing chemical substances and to control any substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before they are manufactured for commercial purposes.

transuranic—Refers to any element whose atomic number is higher than that of uranium (atomic number 92), including neptunium, plutonium, americium, and curium. All transuranic elements are produced artificially and are radioactive.

transuranic waste—Radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; of (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61 (DOE 435.1).

tuff—A fine-grained rock composed of ash or other material formed by volcanic explosion or aerial expulsion from a volcanic vent.

uranium—A radioactive, metallic element with the atomic number 92; one of the heaviest naturally occurring elements. Uranium has 14 known isotopes, of which uranium-238 is the most abundant in nature. Uranium-235 is commonly used as a fuel for nuclear fission. (See natural uranium, enriched uranium, highly enriched uranium, and depleted uranium.)

vadose zone—The portion of Earth between the land surface and the water table.

volatile organic compounds—A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, chloroform, and methyl alcohol. With regard to air pollution, any organic compound that participates in atmospheric photochemical reaction, except for those designated by the U.S. Environmental Protection Agency Administrator as having negligible photochemical reactivity.

Waste Isolation Pilot Plant (WIPP)—A U.S. Department of Energy facility designed and authorized to permanently dispose of defense-related transuranic waste in a mined underground facility in deep geologic salt beds. It is located in southeastern New Mexico, 42 kilometers (26 miles) east of the city of Carlsbad.

wetland—Wetlands are "... those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 328.3).

DOE/EIS-0380
May 2008

Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

Volume 1

Chapters 1 through 11

U.S. Department of Energy

National Nuclear Security Administration

Los Alamos Site Office

Availability of the Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

To submit general questions regarding this EIS, or to request a copy, please contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

Printed with soy ink on recycled paper

COVER SHEET

Responsible Agency: U.S. Department of Energy (DOE)
National Nuclear Security Administration (NNSA)

Title: *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS) (DOE/EIS-0380)

Location: Los Alamos, New Mexico

For additional information or for copies of the SWEIS, contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Telephone: 202-586-4600, or leave a message at 1-800-472-2756

This document is available on the DOE NEPA website (www.eh.doe.gov/nepa) and the NNSA Los Alamos Site Office website (www.doeal.gov/laso/NEPASWEIS.aspx) for viewing and downloading.

Abstract**:** NNSA proposes to continue operating Los Alamos National Laboratory (LANL), which is located in Los Alamos County in north-central New Mexico. NNSA has identified and assessed three alternatives for continued operation of LANL: (1) No Action, (2) Reduced Operations, and (3) Expanded Operations. Under the No Action Alternative, NNSA would continue the historical mission support activities conducted at LANL at currently approved operational levels. Under the Reduced Operations Alternative, NNSA would eliminate some activities and limit the operations of other activities. Under the Expanded Operations Alternative, NNSA would operate LANL at the highest levels of activity currently foreseeable, including full implementation of mission assignments. Expanded Operations is NNSA's Preferred Alternative. NNSA intends to implement actions necessary to comply with the March 2005 Compliance Order on Consent (Consent Order) to address the investigation and remediation of environmental contamination at LANL, regardless of decisions it makes on other actions analyzed in the SWEIS. Under all of the alternatives, the affected environment is primarily within 50 miles (80 kilometers) of LANL. Analyses indicate little difference in the environmental impacts of the alternatives on many resource areas. The primary discriminators are public risk due to radiation exposure, collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, electrical power and water demand, waste management, and transportation. A classified appendix assesses the potential impacts of terrorist acts.

Public Comments: In preparing the Final SWEIS, NNSA considered comments received during the scoping period (January 19 to February 17, 2005) and during the public comment period on the Draft SWEIS (July 7 to September 20, 2006). Public hearings on the Draft SWEIS were held in Los Alamos, Española, and Santa Fe, New Mexico. Comments on the Draft SWEIS were requested during a period of 75 days following publication of the U.S. Environmental Protection Agency's (EPA's) Notice of Availability in the *Federal Register*. All comments, including any late comments, were considered during preparation of the Final SWEIS.

The Final SWEIS contains revisions and new information based in part on comments received on the Draft SWEIS. Vertical change bars in the margins indicate the locations of these revisions and new information. Volume 3 contains the comments received during the public comment period on the Draft SWEIS and NNSA's responses to the comments. NNSA will use the analysis presented in this Final SWEIS, as well as other information, in preparing the Record(s) of Decision (RODs) regarding the level of continued operations at LANL. NNSA will issue ROD(s) no sooner than 30 days after the EPA publishes a Notice of Availability of this Final SWEIS in the *Federal Register*.

TABLE OF CONTENTS
VOLUME 1

TABLE OF CONTENTS
VOLUME 1

VOLUME 1 – CHAPTERS 1 THROUGH 11
VOLUME 2 BOOK 1 – APPENDICES A THROUGH H
VOLUME 2 BOOK 2 – APPENDICES I THROUGH M
VOLUME 3 BOOK 1 – COMMENT RESPONSE DOCUMENT
SECTIONS 1, 2, AND 3 (PAGES 3-1 THROUGH 3-561)
VOLUME 3 BOOK 2 – COMMENT RESPONSE DOCUMENT
SECTION 3 (PAGES 3-562 THROUGH 3-1089) AND SECTION 4

Chapter 1
Introduction and Purpose and Need for Agency Action

Chapter 2
Los Alamos National Laboratory Activities and Facilities Update

Chapter 3
Alternatives for Continued Operation of Los Alamos National Laboratory

Chapter 4
Affected Environment

Chapter 5
Environmental Consequences

LIST OF FIGURES

LIST OF TABLES

Chapter 4

Chapter 5

Chapter 6

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ALARA	as low as reasonably achievable
ATSDR	Agency for Toxic Substances and Disease Registry
BCG	Biota Concentration Guide
CAP-88	Clean Air Act Assessment Package, 1988
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMR	Chemistry and Metallurgy Research (Building)
CMRR	Chemistry and Metallurgy Research Building Replacement Project
CO	carbon monoxide
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
dB	decibel
dBA	decibel A-weighted
dBC	decibel C-weighted
DCG	derived concentration guideline
DD&D	decontamination, decommissioning, and demolition
DDT	dichlorodiphenyl-trichlorethane
DHS	U.S. Department of Homeland Security
DNA	deoxyribonucleic acid
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	environmental assessment
EIS	environmental impact statement
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
FFCA	Federal Facility Compliance Agreement
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FY	fiscal year
HEPA	high-efficiency particulate air (filter)
HSWA	Hazardous and Solid Waste Amendments
ISCST3	Industrial Source Complex Short Term
LANL	Los Alamos National Laboratory
LANL SWEIS	*Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*
LANSCE	Los Alamos Neutron Science Center
LASL	Los Alamos Scientific Laboratory (now LANL)

LCF	latent cancer fatality
LLW	low-level radioactive waste
MCL	maximum contaminant level
MDA	material disposal area
MEI	maximally exposed individual
MPF	modern pit facility
MSL	Materials Science Laboratory
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act of 1969
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NMWQCC	New Mexico Water Quality Control Commission
NNSA	National Nuclear Security Administration
NOI	Notice of Intent
NO_x	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
PC	performance category
petaflops	one quadrillion floating point operations per second
PM_n	particulate matter less than or equal to *n* microns in aerodynamic diameter
PRS	potential release site
R&D	research and development
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RLWTF	Radioactive Liquid Waste Treatment Facility
RNA	ribonucleic acid
ROD	Record of Decision
ROI	region of influence
SA	supplement analysis
SHEBA	Solution High-Energy Burst Assembly
SNM	special nuclear material
SO_2	sulfur dioxide
SST	safe secure transport
SWEIS	Site-Wide Environmental Impact Statement
SWMU	solid waste management unit
TA	technical area
TEDE	total effective dose equivalent
teraflops	one trillion floating point operations per second

TFF	Target Fabrication Facility
TRU	transuranic
TSCA	Toxic Substances Control Act
TSFF	Tritium Science and Fabrication Facility
TSP	total suspended particulate
TSTA	Tritium Systems Test Assembly
UCL	upper confidence limit
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
WETF	Weapons Engineering Tritium Facility
WIPP	Waste Isolation Pilot Plant
°C	degrees Celsius
°F	degrees Fahrenheit

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons

ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

CHAPTER 1
INTRODUCTION AND PURPOSE AND NEED FOR AGENCY ACTION

1.0 INTRODUCTION AND PURPOSE AND NEED FOR AGENCY ACTION

This chapter provides an introduction to the Los Alamos National Laboratory's (LANL) ongoing role in supporting the National Nuclear Security Administration's (NNSA) missions and compliance with the National Environmental Policy Act (NEPA), and how NEPA's requirements have been met through the preparation of Site-Wide Environmental Impact Statements (SWEISs). This chapter also includes a statement of the purpose and need for the continued operation of LANL and introduces the alternatives considered reasonable for meeting the purpose and need. A discussion of decisions to be made, descriptions of related NEPA compliance reviews, and a summary of the scope of this SWEIS analysis are also presented.

NNSA[1] proposes to continue managing LANL and its resources in a manner that meets evolving national security missions and that responds to the concerns of affected and interested individuals and agencies. This SWEIS describes the environmental impacts of three alternatives for the continued operation of LANL.[2]

NEPA Compliance

Site-wide NEPA documents are identified by the U.S. Department of Energy (DOE) as those broad-scoped environmental impact statements (EISs) or environmental assessments (EAs) that are programmatic in nature and that identify and assess the individual and cumulative impacts of ongoing and reasonably foreseeable actions at a DOE site. DOE NEPA Implementing Procedures (Title 10 *Code of Federal Regulations* [CFR] 1021.330(c)) require the preparation of SWEISs for certain large multiple-facility DOE sites. These procedures were amended in 1992 to specify that an evaluation of a DOE SWEIS be performed at least every 5 years by means of a Supplement Analysis (SA). Based on the Supplement Analysis, DOE determines whether an existing SWEIS remains adequate, or whether to prepare a new SWEIS or supplement the existing SWEIS, as appropriate. NNSA has prepared this SWEIS in accordance with NEPA, as amended (42 United States Code [U.S.C.] 4321 et seq.), and with Council on Environmental Quality (CEQ) regulations and DOE NEPA Implementing Procedures codified in the *Code of Federal Regulations* at 40 CFR Parts 1500 to 1508 and 10 CFR Part 1021, respectively.

In compliance with its NEPA Implementing Procedures, DOE issued the first SWEIS and Record of Decision (ROD) for the operation of LANL (then known as the Los Alamos Scientific Laboratory, or LASL) in 1979. That EIS was entitled *Final Environmental Impact Statement, Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico* (DOE/EIS-0018). In 1999, DOE issued the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico* (*1999 SWEIS*) (DOE/EIS-0238) (DOE 1999a) and its associated ROD. A full copy of the *1999 SWEIS* ROD is provided in

[1] *NNSA is a semiautonomous agency within DOE (see the National Nuclear Security Administration Act [Title 32 of the Defense Authorization Act for fiscal year 2000, Public Law 106-65]).*
[2] *Vertical change bars in the margins indicate the locations of revisions and new information based in part on comments received on the Draft SWEIS.*

Appendix A to this document. In early 2004, NNSA undertook the required 5-year evaluation of the continuing adequacy of the *1999 SWEIS* by initiating the preparation of an SA. In mid-2004, shortly into the process of preparing the SA, NNSA determined that the criteria for preparing at least a Supplemental SWEIS had been met. Criteria identified in DOE NEPA Implementing Procedures (10 CFR 1021.314) state that a Supplemental EIS shall be prepared if there are substantial changes to the proposal or significant new circumstances or information relevant to environmental concerns. The Implementing Procedures do not explicitly define criteria that would trigger the preparation of a new EIS. However, in this circumstance, the general procedural rationale for preparing a new SWEIS would apply.

NNSA discontinued preparation of the SA in late 2004, and initiated preparation of a supplement to the *1999 SWEIS*. In January 2005, DOE announced its intention to prepare a Supplemental SWEIS through a Notice of Intent (NOI) published in the *Federal Register* (FR) (70 FR 807) (see Appendix A of this SWEIS), and held a public scoping meeting (additional information regarding the public involvement process is presented in Section 1.6). Subsequently, NNSA made a determination that the changes in the LANL environment discussed below and the proposed new actions were significant enough to warrant preparation of a new SWEIS.

Since the issuance of the *1999 SWEIS* and its ROD, the LANL environment has been changed by the 2000 Cerro Grande Fire, which burned a part of LANL, the Los Alamos townsite, and the surrounding forested area; a regional drought; and a massive bark beetle evergreen tree infestation. Additional information about the LANL environmental setting has become available as various elements of this setting, in particular the hydrology, have undergone intense investigation over the past decade or longer. LANL security requirements also have evolved in response to changes in recognized threats to facilities and materials at LANL. In addition, since 1999, DOE and NNSA have issued several EISs and EAs for LANL operations and activities. These documents deal with implementing new or changed operations, replacing facilities, conveying or transferring land out of the administrative oversight of DOE (thereby reducing the size of the LANL site), and conducting emergency actions (specifically in response to the 2000 Cerro Grande Fire).

NNSA is considering new actions for initiation at LANL over about the next 5 years that could affect several areas of LANL operations originally analyzed in the *1999 SWEIS*. While consistent with the 1999 DOE decision for operating LANL according to the *1999 SWEIS* Preferred Alternative, these proposed activities represent potentially substantial changes to some operations. They include the refurbishment or replacement of existing infrastructure so that LANL operations can continue into the future.

Jointly, the activities analyzed through NEPA compliance documents completed since 1999, newly proposed activities for LANL, existing and developing changes to the LANL environmental setting, and changes in site security conditions have led NNSA to decide to update the *1999 SWEIS* by preparing a new SWEIS rather than a Supplemental SWEIS. Preparation of a new SWEIS also responds to comments received from the public during the scoping period. This new SWEIS impact analysis tiers from the *1999 SWEIS*, as appropriate, and incorporates information from that document by reference where the information presented in that earlier document remains valid.

One of the primary benefits of updating the environmental analysis is the reevaluation of cumulative impacts associated with LANL operations. When DOE issued the *1999 SWEIS* and its associated ROD, the analyses considered operational impacts to the northern New Mexico environment of actions that would likely occur over the next 10-year period (which was identified as the "foreseeable future" for the purposes of that analysis). This SWEIS considers cumulative impacts associated with activities at LANL on the changed environment in the region. For example, significant effort that was not anticipated in 1999 has been expended since the Cerro Grande Fire to implement forest thinning and watershed protection measures on the Pajarito Plateau.

1999 SWEIS Alternatives

Four alternatives were analyzed in the *1999 SWEIS* to support the Proposed Action of continuing to operate LANL: (1) the No Action Alternative, (2) the Reduced Operations Alternative, (3) the Greener Alternative, and (4) the Expanded Operations Alternative (identified as the Preferred Alternative) which, with certain modifications to weapons-related work regarding the level of nuclear weapons component manufacturing, was selected for implementation.

The *1999 SWEIS* also analyzed Action Alternatives as they could be anticipated at that time. The alternative selected by DOE for implementation at LANL was the Expanded Operations Alternative, with certain modifications to nuclear weapons-related production work regarding the level of nuclear weapons component manufacturing. This modified Expanded Operations Alternative is currently being implemented at LANL.

LANL Support of NNSA Missions

The *1999 SWEIS* assessed impacts to each area of the human and natural environment potentially affected by anticipated operations conducted in support of national security missions, including:

- National security as it relates to the safety and reliability of the nuclear weapons stockpile and its maintenance, the stemming of the international spread of nuclear weapons material and technologies, and the production of propulsion plants for the U.S. Navy;
- Energy resources, including research and development for energy efficiency, renewable energy, fossil energy, and nuclear energy;
- Environmental quality, including treatment, storage, and disposal of DOE wastes, pollution prevention, storage and disposal of civilian radioactive wastes, and development of technologies to reduce risks and reduce cleanup costs; and
- Science, including fundamental research in physics, material science, chemistry, nuclear medicine, basic energy sciences, computational sciences, environmental sciences, and biological sciences.

The President and the Congress created NNSA in early 2000 as a semiautonomous agency within DOE. The legislation that established NNSA assigned it the following mission:

- To enhance U.S. national security through the military application of nuclear energy;
- To maintain and enhance the safety, reliability, and performance of the U.S. nuclear weapons stockpile, including the ability to design, produce, and test in order to meet national security requirements;

- To provide the U.S. Navy with safe, militarily effective nuclear propulsion plants and to ensure the safe and reliable operation of those plants;
- To promote international nuclear safety and nonproliferation;
- To reduce global danger from weapons of mass destruction; and
- To support U.S. leadership in science and technology (50 U.S.C. Chapter 41, § 2401(b)).

The Congress identified LANL as one of three national security laboratories to be administered by NNSA for DOE. As the NNSA mission is a subset of DOE's original mission assignment, most of the work performed at LANL in support of NNSA has remained unchanged in character from that performed for DOE prior to the creation of NNSA.

In 2002, the Congress created the U.S. Department of Homeland Security (DHS) and assigned it a set of national security missions. At that time, some programs were transferred from DOE and other Federal agencies to DHS. However, no changes to the overall mission assignments of DOE and NNSA occurred. In most cases in which mission support activities were reassigned to DHS, programs have continued to be conducted at the facilities previously supporting them through interagency agreements between the hosting agency and DHS.

During testimony to the House Appropriations Subcommittee on Energy and Water on March 11, 2004, the Secretary of Energy agreed to conduct a comprehensive review of the nuclear weapons complex with consideration of changes in the nuclear weapons stockpile and the current national and international security situation, as well as limitations in available resources, including funding. In January 2005, the Secretary requested the Secretary of Energy Advisory Board to form the Nuclear Weapons Complex Infrastructure Task Force, a task force reporting to the Secretary of Energy Advisory Board. The objective of the Task Force was to assess the implications of Presidential decisions on the size

SWEIS Terminology

Missions. In this SWEIS, "missions" refers to the major responsibilities assigned to DOE and NNSA (described in this section). DOE and NNSA accomplish these major responsibilities by assigning groups or types of activities to DOE's system of security laboratories, production facilities, and other sites.

Programs. DOE and NNSA are organized into Program Offices, each of which has primary responsibilities within the set of DOE and NNSA missions. Funding and direction for activities at DOE facilities are provided through these Program Offices, and similar coordinated sets of activities to meet Program Office responsibilities are often referred to as programs. Programs are usually long-term efforts with broad goals or requirements.

Capabilities. This term refers to the combination of facilities, equipment, infrastructure, and expertise necessary to undertake types or groups of activities and to implement mission assignments. Capabilities at LANL have been established over time, principally through mission assignments and activities directed by Program Offices. Once capabilities are established to support a specific mission assignment or program activity, they are often used to meet other mission or program requirements (for example, the capability for advanced complex computation and modeling that was established to support NNSA's national security mission requirements may also be used to address needs under DOE's science mission).

Projects. This term is used to describe activities with a clear beginning and end that are undertaken to meet a specific goal or need. Projects can vary in scale from very small (such as a project to undertake one experiment or a series of small experiments) to major (such as a project to construct and start up a new nuclear facility). Projects are usually relatively short-term efforts, and they can cross multiple programs and missions, although they are usually "sponsored" by a primary Program Office. In this SWEIS, this term is usually used more narrowly to describe construction activities, including facility modifications (such as a project to build a new office building or to establish and demonstrate a new capability). Construction projects considered reasonably foreseeable at LANL over about the next 5 years are discussed and analyzed in this SWEIS.

and composition of the stockpile; the cost and operational impacts of the new nuclear facility Design Basis Threat; and the personnel, facilities, and budgetary resources required to support a smaller stockpile. This review was to entail evaluation of opportunities for the consolidation of special nuclear material, facilities, and operations across the complex so as to minimize security requirements and the environmental impacts of continuing operations.

On July 13, 2005, a Task Force of the Secretary of Energy Advisory Board issued its report, *Recommendations for the Nuclear Weapons Complex of the Future* (DOE 2005d). This report contains a comprehensive review of the nuclear weapons complex, which includes LANL, and a vision for a modern nuclear weapons complex of the future that would address the needs of the nuclear weapons stockpile. In 2006, NNSA outlined its comprehensive proposal for transforming to a smaller, more efficient nuclear weapons complex by the year 2030 that would be better able and more suited to respond to future national security challenges (NNSA 2006b). The proposal included significant dismantling of retired warheads, consolidating special nuclear materials, eliminating duplicative capabilities, consolidating operations, and implementing more efficient and uniform business practices throughout the complex. In an NOI published in the *Federal Register* on October 19, 2006 (71 FR 61731), NNSA announced its intent to prepare a *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement – Complex 2030* (now called the *Complex Transformation Supplemental Programmatic Environmental Impact Statement* [*Complex Transformation SPEIS*]). The NOI outlines alternatives for continued transformation of the nuclear weapons complex to better meet future national security requirements, including a proposal to construct and operate a consolidated plutonium center within the complex. Another proposal, to construct and operate a consolidated nuclear production center, was added as a result of scoping comments. Both of these proposals are analyzed in the Draft *Complex Transformation SPEIS* (DOE 2007b) (additional discussion regarding the *Complex Transformation SPEIS* is provided in Section 1.5 of this SWEIS). On January 31, 2007, NNSA submitted a *Report on the Plan for Transformation of the National Nuclear Security Administration Nuclear Weapons Complex* (NNSA 2007a) to the Congressional Defense Committees. The report provides additional discussion of the Complex Transformation vision and the associated transformation plan, including the consolidated nuclear production center.

The alternatives analyzed in the *Complex Transformation SPEIS* would result in changes to facilities and operations at LANL. In the short term, about the next 5 years, current LANL operations are not expected to change dramatically regardless of the strategy NNSA develops for continuing the transformation of the nuclear weapons complex. However, in recognition of the uncertainties associated with future work assignments to LANL, the "foreseeable future" for the purpose of the Proposed Action in this SWEIS has been changed from the 10 years of LANL operations considered in the *1999 SWEIS* to consideration of proposals regarding LANL operations over about the next 5 years.

As part of the evaluation process for Complex Transformation, NNSA will reconsider whether to construct and operate the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. Pending completion of the *Complex Transformation SPEIS*, NNSA is deferring a decision on whether to construct the nuclear facility portion of the facility. NNSA is continuing with construction of the radiological laboratory, administrative offices and support function building of the new facility and with the design of the nuclear facility portion.

NNSA and DOE assign work to LANL based on the facilities and expertise of the staff located there, as well as other factors. LANL is a multidisciplinary, multipurpose institution primarily engaged in theoretical and experimental research and development activities with responsibility for some nuclear weapons component manufacturing activities. Detailed information regarding DOE missions and their supporting operations at LANL was included in the *1999 SWEIS*. Facilities and expertise at LANL are used to perform theoretical research (including analysis, mathematical modeling, and high-performance computing), experimental science and engineering, advanced and nuclear materials research and development, and applications (including weapons component fabrication, testing, stockpile assurance, replacement, surveillance, and maintenance). These capabilities allow research and development activities such as high explosives processing, chemical research, nuclear physics research, materials science research, systems analysis and engineering, human genome mapping, biotechnology applications, and remote sensing technologies, as applied to resource exploration and environmental surveillance, to be performed at LANL. The main roles of LANL staff in the fulfillment of NNSA mission objectives include a wide range of scientific and technological capabilities that support nuclear materials handling, processing, and fabrication; stockpile management; materials and manufacturing technologies; nonproliferation programs; and waste management activities.

Specific LANL assignments for the foreseeable future will continue to include production of war reserve products, assessment and certification of the nuclear weapons stockpile, surveillance of war reserve components and weapons systems, ensuring safe and secure storage of strategic materials, and management of excess plutonium inventories. Nuclear weapons pit[3] production work takes place at LANL on a limited scale in accordance with two RODs: the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236) ROD (61 FR 68014) and the *1999 SWEIS* ROD (64 FR 50797).

In addition to work performed to support DOE and NNSA missions, work at LANL is also conducted for other Federal agencies such as the Department of Defense and the newly created DHS, as well as for various widely divergent university programs, institutions, and corporate entities such as those involved in the environmental restoration and automotive industries. All work performed by the management and operating contractor at LANL must be compatible with the DOE and NNSA mission support work assigned to LANL and must be work that cannot reasonably be performed by the private sector. The Work-for-Others Program is one such LANL program under which cost-reimbursable work is performed by the staff of the management and operating contractor. Under the terms of the LANL contract, LANL facilities, either in whole or in part, may be used for cost-reimbursable work by the management and operating contractor. About one-fourth (25 percent) of the work performed at LANL, representing about 13 percent of the total annual LANL budget, is currently performed as cost-reimbursable work.

The management and operating contract for LANL was openly competed in 2005 for the first time in the 63-year history of the LANL site. Through 2005, the University of California had been the sole management and operating contractor for the LANL site since its creation in 1943. The new management and operating contractor, Los Alamos National Security, LLC, began

[3] *Pits are the central core of a primary assembly in a nuclear weapon and are typically composed of plutonium-239 or highly enriched uranium, or both, and other materials.*

managing LANL in June 2006. The selection of a new management and operating contractor did not change the DOE and NNSA work performed at LANL.

1.1 Background

LANL is located in northern New Mexico, within the incorporated County of Los Alamos (also referred to as Los Alamos County) (see **Figure 1–1**). The two primary residential areas within the county are the Los Alamos townsite and the White Rock residential area. These two residential areas are home to about 18,400 people. About 13,500 people work at LANL, of which a little less than half reside within the county.

LANL occupies about 40 square miles (25,600 acres [10,360 hectares]) of land on the eastern flank of the Jemez Mountains along the area known as the Pajarito Plateau. The terrain in the LANL area consists of mesa tops and canyon bottoms that trend in a west-to-east manner, with the canyons intersecting the Rio Grande to the east of LANL. Elevations at LANL range from about 7,800 feet (2,380 meters) at the highest elevation on the western side of the site to about 6,200 feet (1,890 meters) at the lowest point along the eastern boundary at the Rio Grande. LANL operations are conducted within numerous facilities located in 48 designated technical areas (TAs) and at other leased properties situated near LANL. The leased properties in the town of Los Alamos are assigned the temporary designation of "TA-0." TA-57 is located about 20 miles (32 kilometers) west of LANL at Fenton Hill on land administered by the U.S. Department of Agriculture, Forest Service. The 47 contiguous TAs (which are not numbered sequentially) have been established so that together they comprise the entirety of the LANL site (see **Figure 1–2**).

Technical Area (TA)

Geographically distinct administrative unit established for the control of LANL operations. There are currently 49 active TAs; 47 in the 40 square miles of the LANL site, one at Fenton Hill, west of the main site, and one comprising leased properties in town.

Most of LANL is undeveloped grassland, shrubland, woodland, and forest that serve to provide a buffer for security and safety and space for future expansion. As of the end of 2005, LANL's facilities comprised 8.6 million square feet (800,000 square meters) of laboratory, production, administrative, storage, service, and miscellaneous space; the total space available for operational use changes frequently as structures are demolished or built at LANL. Fifteen facilities within LANL were identified in the *1999 SWEIS* as being Key Facilities for the purpose of facilitating a logical and comprehensive evaluation of the potential environmental impacts of LANL operations. The facilities identified as "Key" for the purposes of the *1999 SWEIS* and this new SWEIS are those that house activities that are critical to meeting work assignments given to LANL and also:

- house operations that could potentially cause significant environmental impacts,
- are of most interest or concern to the public based on scoping comments received, or
- would be most subject to change as a result of programmatic decisions.

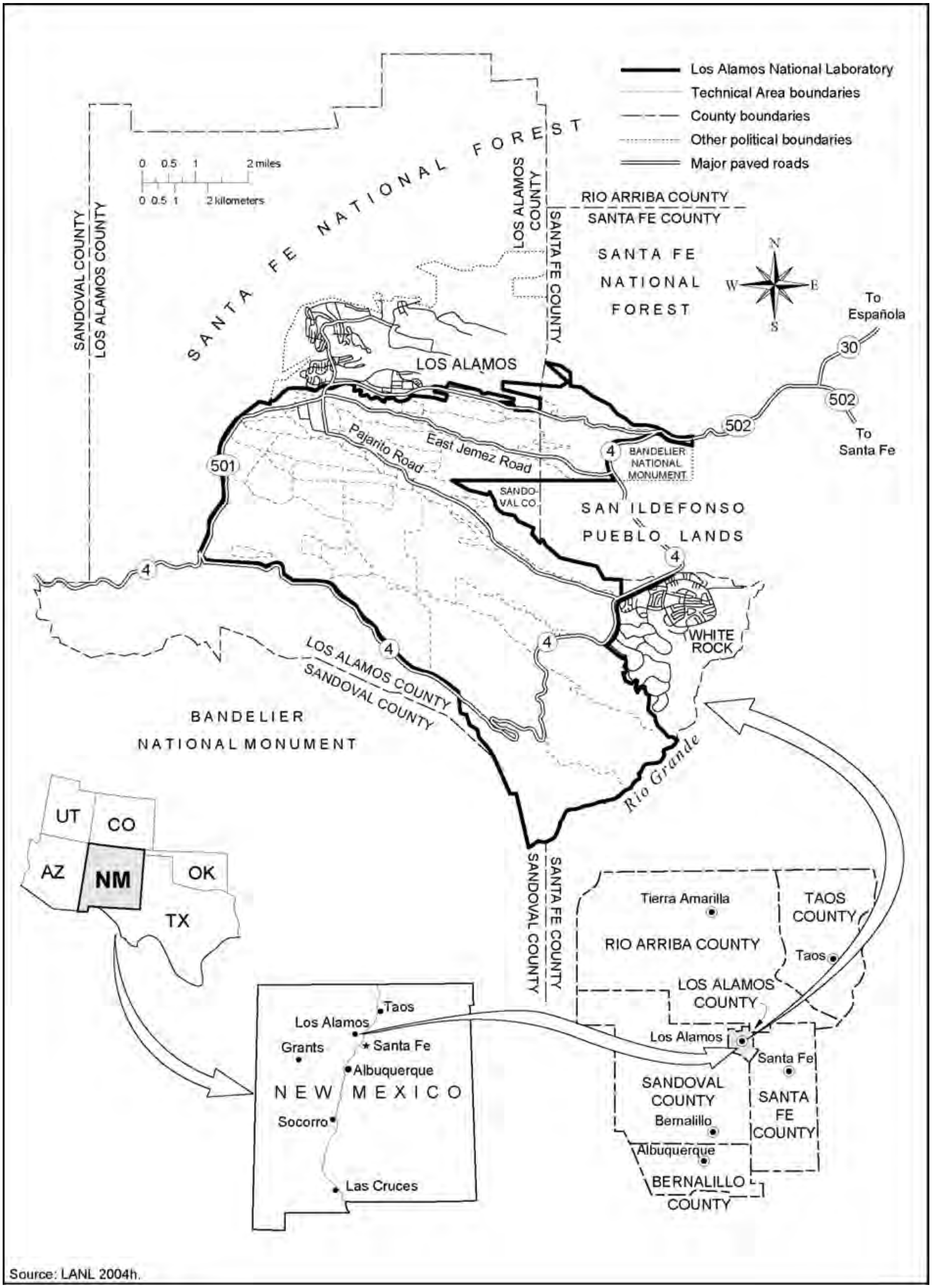


Figure 1–1 Location of Los Alamos National Laboratory Site

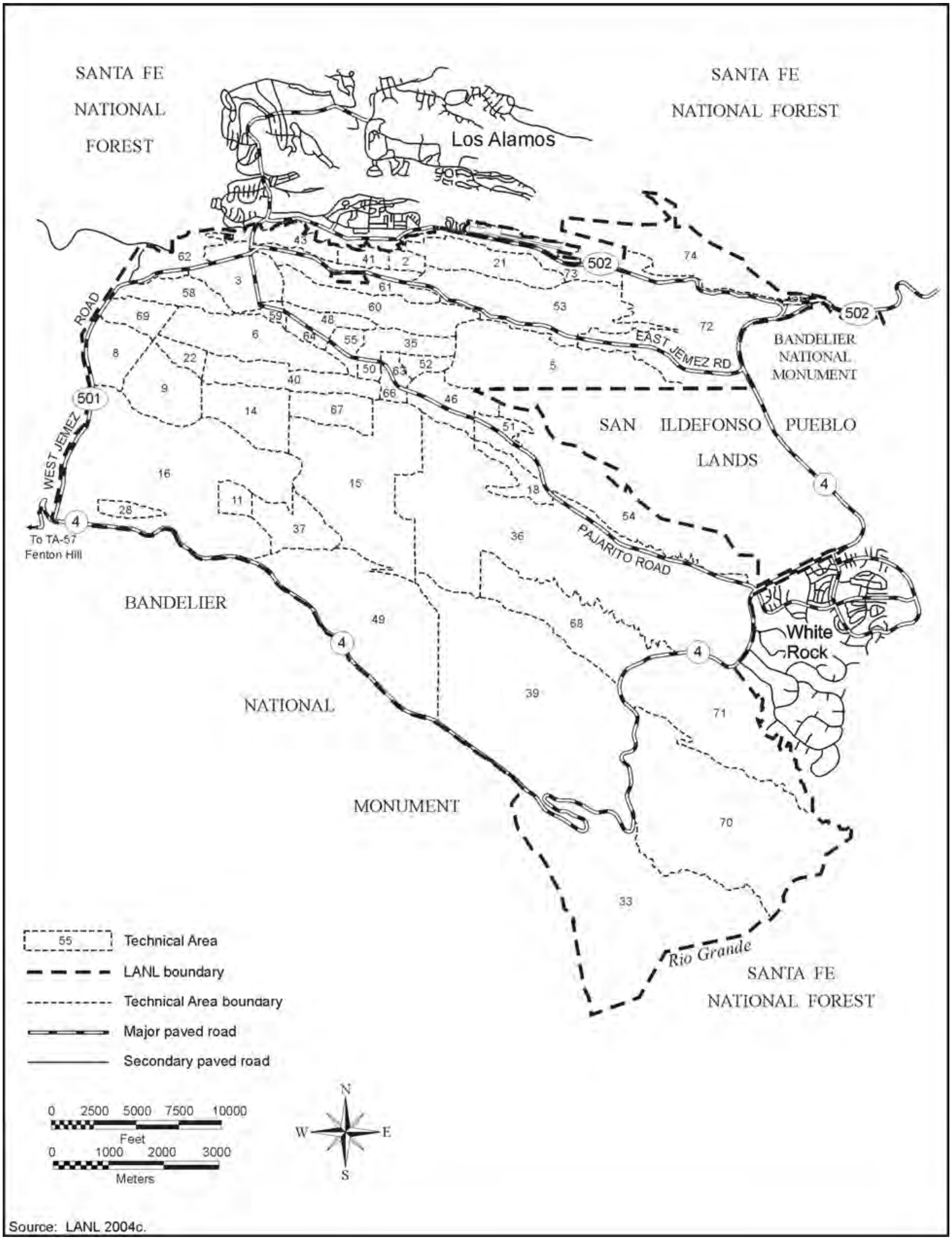


Figure 1–2 Identification and Location of Technical Areas Comprising Los Alamos National Laboratory

Taken together, the Key Facilities represent the majority of exposure risks associated with LANL operations. The operation of these 15 Key Facilities, together with functions conducted in other non-Key Facilities, formed the basis of the description of LANL facilities and operations analyzed for potential environmental impacts in the *1999 SWEIS*. For the purpose of the impact analysis provided by this new SWEIS, the identity of the LANL Key Facilities has been modified to reflect DOE decisions made after 1999 that resulted in changes to LANL facilities and operations. As seen in **Table 1–1**, most of the Key Facilities in the *1999 SWEIS* are Key Facilities in this SWEIS. The Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center) has been added as a Key Facility because of the amounts of electricity and water it may use. Security Category I and II materials and operations have been moved from the TA-18 Pajarito Site. Under either of the Action Alternatives evaluated in this SWEIS, Security Category III and IV materials and operations also would be removed from the Pajarito Site, and it would be eliminated as a Key Facility. Under the No Action Alternative, the Pajarito Site would remain a Key Facility.

Security Categories

DOE uses a cost-effective, graded approach to provide special nuclear material safeguards and security. Quantities of special nuclear material stored at each DOE site are categorized into Security Categories I, II, III, and IV, with the greatest quantities included under Security Category I, and lesser quantities included in descending order under Security Categories II through IV.

Table 1–1 Comparison of Key Facilities between the *1999 Site-Wide Environmental Impact Statement* and this New Site-Wide Environmental Impact Statement

Technical Areas	*Key Facilities* [a]	*1999 SWEIS*	*New SWEIS*
3	Chemistry and Metallurgy Research Building	✓	✓
3	Sigma Complex	✓	✓
3	Machine Shops	✓	✓
3	Materials Science Laboratory	✓	✓
3	Nicholas C. Metropolis Center for Modeling and Simulation		✓
8, 9, 11, 16, 22, 37	High Explosives Processing Facilities	✓	✓
14, 15, 36, 39, 40	High Explosives Testing Facilities	✓	✓
16, 21	Tritium Facilities	✓	✓
18	Pajarito Site (Los Alamos Critical Experiments Facility)	✓	(b)
35	Target Fabrication Facility	✓	✓
43, 3, 16, 35, 46	Bioscience Facilities (formerly the Health Research Laboratory)	✓	✓
48	Radiochemistry Facility	✓	✓
50	Waste Management Operations: Radioactive Liquid Waste Treatment Facility	✓	✓
53	Los Alamos Neutron Science Center	✓	✓
54, 50	Waste Management Operations: Solid Radioactive and Chemical Waste Facilities	✓	✓
55	Plutonium Facility Complex	✓	✓

[a] The order of these Key Facilities has been changed from that presented in the *1999 SWEIS* to match the order used in this SWEIS, which is based on Technical Areas.
[b] The Pajarito Site remains a Key Facility under the No Action Alternative only.

Nuclear and radiological facilities at LANL are identified by hazard category in accordance with the potential consequences in the event of an accident (10 CFR Part 830). At LANL, there are no Hazard Category 1 nuclear facilities; the nuclear facilities at LANL are either Hazard Category 2 or Hazard Category 3 (DOE and LANL 2005). Facilities that handle less than Hazard Category 3 threshold quantities of radioactive materials, but require identification of "radiological areas" (10 CFR Part 835), are designated radiological facilities. All of the nuclear Hazard Category 2 and 3 facilities and most of the radiological facilities are accounted for in either the analyses of Key Facilities in this SWEIS or the project-specific analyses and evaluations of environmental restoration sites provided in Appendix I (see Chapter 2, Table 2–3, for a listing of Hazard Category 2 and 3 and radiological facilities).

Nuclear Facility Hazard Categories

Hazard Category 1: Hazard analysis shows the potential for significant offsite consequences.

Hazard Category 2: Hazard analysis shows the potential for significant onsite consequences.

Hazard Category 3: Hazard analysis shows the potential for only significant localized consequences.

(10 CFR Part 830)

1.2 Purpose and Need for Agency Action

DOE's purpose and need for agency action in the *1999 SWEIS* is presented in the text box to the right. The purpose and need for action with regard to the continued operation of LANL remains unchanged. With the creation of NNSA in 2000, the President and the Congress reaffirmed the Nation's need for ongoing operations at LANL by designating LANL as one of three national security laboratories. In 2002, the need for ongoing operations at LANL was reaffirmed with the creation of DHS and the subsequent assignment of many of its mission support activities to various Federal facilities, including assignments to each of NNSA's three national security laboratories. While uncertainty remains about the future work NNSA will assign to LANL to support the Nation's security missions, the overall need to continue operation of LANL is unlikely to change over the next several years.

Purpose and Need

The purpose of the continued operation of LANL is to provide support for DOE's core missions as directed by the Congress and the President. DOE's need to continue operating LANL is focused on its obligation to ensure a safe and reliable nuclear stockpile. For the foreseeable future, DOE, on behalf of the U.S. Government, will need to continue its nuclear weapons research and development, surveillance, computational analysis, components manufacturing, and nonnuclear aboveground experimentation. Currently, many of these activities are conducted solely at LANL. A cessation of these activities would run counter to national security policy as established by the Congress and the President (DOE 1999a).

1.3 Scope and Alternatives in this New Site-Wide Environmental Impact Statement for Los Alamos National Laboratory Operations

The Proposed Action analyzed in this SWEIS is the continued operation of LANL. As defined in 40 CFR 1508.28, this new SWEIS impact analysis is based on the *1999 SWEIS*. The *1999 SWEIS* covers broad general matters related to operation of LANL. This SWEIS considers more focused environmental impact analyses of three alternatives to implement the Proposed Action: a No Action Alternative (continued implementation of the *1999 SWEIS* Preferred Alternative together with other activities for which NEPA reviews have been completed); a Reduced Operations Alternative with newly proposed decreases in certain activities; and an

Expanded Operations Alternative with newly proposed additional activities. Consistent with the concept of tiering, pertinent information from the *1999 SWEIS* is summarized and incorporated by reference into this SWEIS. Impacts from all activities, including each of the alternatives analyzed in this SWEIS and in newly proposed projects that may be analyzed in separate NEPA impact reviews as interim actions[4], are considered in the cumulative impacts analyses for LANL operations in this SWEIS.

In March 2005, the State of New Mexico, DOE, and the LANL management and operating contractor entered into a "Compliance Order on Consent" (Consent Order) (NMED 2005) that is currently being implemented to address the investigation and remediation of environmental contamination at LANL. NNSA is including impacts associated with Consent Order implementation in order to facilitate its compliance with the Order. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in this SWEIS. The activities and potential impacts of Consent Order-related activities are included under the Expanded Operations Alternative.

Implementing the Consent Order

NNSA intends to implement actions necessary to comply with the Compliance Order on Consent (Consent Order) regardless of decisions it makes on other actions analyzed in this SWEIS. Actions associated with implementing the Consent Order are included in the Expanded Operations Alternative; however, their implementation is not contingent on other actions that are part of the alternative. As explained in Chapter 1, Section 1.4, NNSA can implement individual parts of alternatives.

Due to unusual circumstances that have occurred at LANL since 1999, the environmental setting described in the *1999 SWEIS* has changed. In 2000, the Cerro Grande Fire burned 43,000 acres (17,400 hectares) of land in northern New Mexico. This fire burned about 7,700 acres (3,110 hectares) within the LANL boundaries and additional land in neighboring areas along the mountain flanks above and to the north of LANL (LANL 2004m). In total, about 40 structures at LANL were burned beyond reasonable repair or destroyed outright by the fire; an additional 200 structures suffered varying degrees of damage. Information about the Cerro Grande Fire and actions taken at LANL in direct response to the fire are detailed in the *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/SEA-03) (DOE 2000f). A variety of facility changes occurred that were not anticipated before the fire or that were expedited directly or indirectly because of the fire. These include operations that have been moved or that are planned for removal from canyon locations, buildings that were destroyed by the fire or vacated and demolished after operations were relocated, and new structures that were built during the days after the fire as part of the recovery effort. Post-fire environmental effects included an alteration of watershed areas within LANL and a reduction in the forest fuel loading due to the fire and subsequent tree thinning activities. Additionally, the southwest region of the United States is experiencing a multiyear drought period. The drought, combined with a bark

[4] *CEQ's NEPA Implementing Regulations state that "agencies shall not undertake in the interim any major Federal action covered by the program that may significantly affect the quality of the human environment unless such action: (1) is justified independently of the program; (2) is itself accompanied by an adequate environmental impact statement; and (3) will not prejudice the ultimate decision on the program. Interim action prejudices the ultimate decision on the program when it tends to determine subsequent development or limit alternatives" (40 CFR 1506.1).*

beetle infestation, has resulted in a high mortality rate of evergreen tree species within LANL and surrounding areas.

Another alteration of the LANL environmental setting occurred through the conveyance and transfer of about 3.5 square miles (2,259 acres [914 hectares]) of land pursuant to Public Law 105-119 (Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998). Conveyance of land to Los Alamos County and transfer of land to the Department of the Interior in trust for the Pueblo of San Ildefonso has reduced the size of LANL to about 40 square miles (25,600 acres [10,360 hectares]). DOE anticipates conveying additional land before the end of 2012, the deadline for conveyance and transfer of lands established in the Defense Authorization Act, which extended the deadline initially established by Public Law 105-119.

The terrorist attacks that occurred in the United States on September 11, 2001, and subsequent world events have resulted in the implementation of enhanced security measures at LANL. Steps taken to protect LANL assets have resulted or will result in changes to some aspects of the LANL natural and cultural environments. Additionally, there have been changes to both the number of LANL workers and the population around LANL compared to those on which the *1999 SWEIS* socioeconomic and other impact analyses were based. To the extent that changes to, or new information about, the existing LANL environment will affect natural and cultural resource areas and the human environment originally considered in the *1999 SWEIS*, projected impacts from implementing the No Action Alternative and the Action Alternatives over about the next 5 years at LANL are analyzed in this SWEIS.

NNSA will use this SWEIS to consider the impacts of proposed modifications to LANL activities and the cumulative impacts associated with ongoing activities at LANL on the changed LANL environment and to make decisions regarding various proposed projects. Within about 5 years, detailed planning for these proposed projects, or in some cases, the proposed projects themselves, could be initiated. The decisions to be made on the basis of this new SWEIS are discussed in Section 1.4. The following sections provide summary descriptions of the alternatives analyzed in this SWEIS. Detailed descriptions of the SWEIS alternatives, as well as alternatives considered and dismissed, are presented in Chapter 3 of this SWEIS.

1.3.1 No Action Alternative

The No Action Alternative considered in this SWEIS consists of the continued implementation of decisions stated in the *1999 SWEIS* ROD (see Appendix A), together with decisions for other LANL actions based on completed NEPA reviews (see **Figure 1–3**). A list of NEPA EIS- and EA-level analyses completed since 1999 for LANL activities is included in Section 1.5.

The No Action Alternative reflects certain evolutions in the operation of LANL as a result of the implementation of the *1999 SWEIS* Preferred Alternative over the past 7 years. For example, the level of operations has decreased in some LANL facilities, and there have been changes in the amounts of materials at risk[5] in some facilities. Some materials have been transferred from one location to another at LANL, and some materials have been removed from the site to other

[5] *Material at risk is the amount of radioactive material in a facility that needs to be considered in evaluating the potential effects of accidents that could occur at the facility.*

locations around the complex. One former Key Facility identified in the *1999 SWEIS*, the TA-18 Pajarito Site, will be eliminated over the long term as an operating facility. In its 2002 *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory (TA-18 Relocation EIS)* (DOE/EIS-0319) (DOE 2002i) and associated ROD (67 FR 79906), NNSA decided to relocate TA-18 Pajarito Site Security Category I and II operations and associated nuclear materials to the Nevada Test Site. Implementation of the relocation decision was initiated in 2004 and will be carried out over a 5-year period. Security Category I and II operations and materials have recently been removed from the TA-18 Pajarito Site. Because Security Category III and IV materials remain, the TA-18 Pajarito Site has been retained under the No Action Alternative impact analysis as a Key Facility.

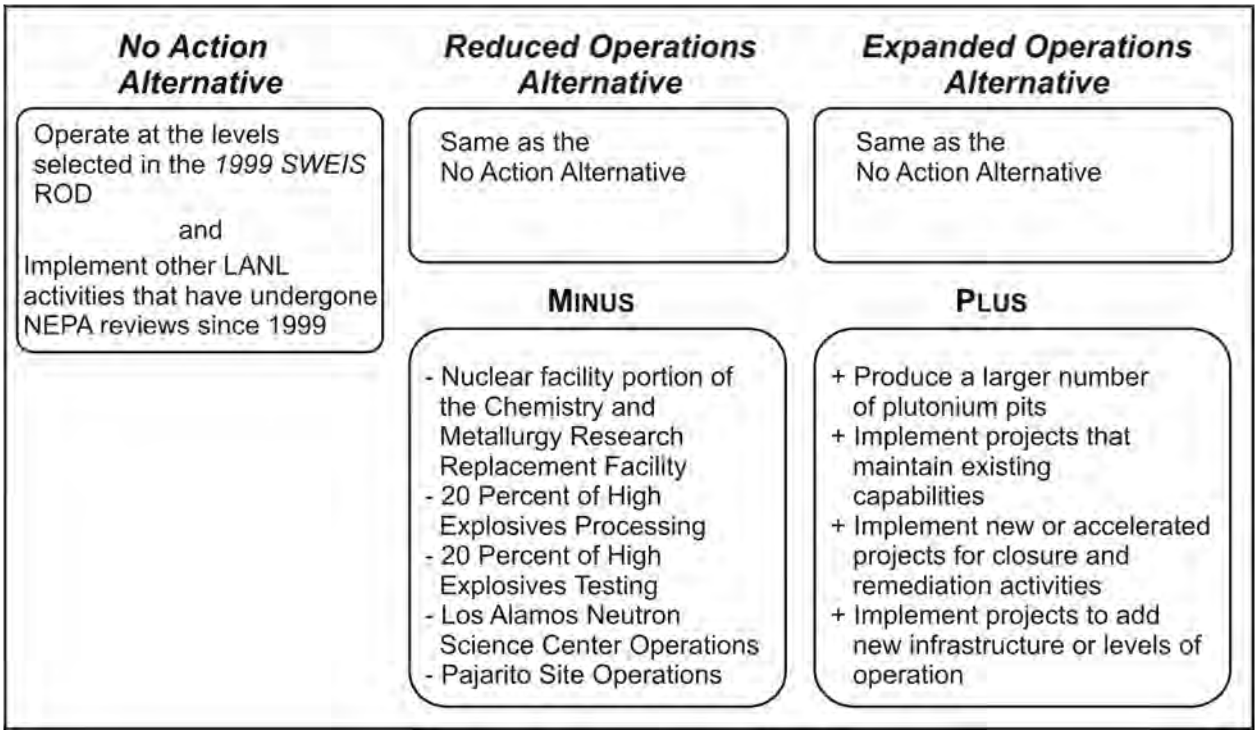


Figure 1–3 Summary Comparison of Alternatives Considered in this New Site-Wide Environmental Impact Statement

Another former Key Facility identified in the *1999 SWEIS*, the Chemistry and Metallurgy Research Building, will also be eliminated over the long term as an operating facility. In its 2004 ROD (69 FR 6967) for the *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico (CMRR EIS)* (DOE/EIS-0350) (DOE 2003d), NNSA decided to construct and operate a new Chemistry and Metallurgy Research Replacement Facility at LANL's TA-55. Implementation of the construction phase began in 2004 with site construction planning for the two primary structures of the new facility proceeding on different schedules. Planning is complete and the radiological laboratory, administrative offices and support function building (collectively known as the "Radiological Laboratory") are currently under construction. The separate nuclear facility portion, a Hazard Category 2 nuclear laboratory, is still in the early planning stages and no building construction has begun. Planning for the nuclear facility portion of this project will continue (estimated planning completion is in 2008) and will either facilitate construction of the structure at LANL, or the planning process will facilitate the construction of a structure with the same capabilities as part of a consolidated plutonium center or as an integrated part of a consolidated nuclear production center. Both the consolidated plutonium center and the consolidated nuclear production center are subjects of the *Complex Transformation SPEIS* currently in preparation. (See discussions regarding Complex Transformation and the *Complex Transformation SPEIS*, and also the previously mentioned *CMRR EIS* elsewhere in this chapter. Additionally, see discussion of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility in the following Action Alternatives discussion of the Reduced Operations Alternative).

Additional activities that are included in the No Action Alternative are those that may undergo a NEPA review and be categorically excluded from the need for preparation of either an EA or EIS. A list of DOE categorical exclusions is codified at 10 CFR 1021.410; activities conducted at LANL that are categorically excluded from further NEPA review are discussed further in Appendix L. Typically, several hundred proposed activities at LANL are categorically excluded from the need to prepare an EA or EIS each year.

Categorical Exclusions

DOE NEPA Implementing Procedures identify classes of actions that DOE has determined can be categorically excluded from the need to prepare an EA or EIS because they do not individually or cumulatively have a significant effect on the human environment. Examples of activities that could receive categorical exclusions include routine maintenance activities and shop operations; activities in support of environmental management including monitoring and small-scale remediation actions; and a broad range of research and development activities performed within existing LANL facilities.

Action Alternatives

In addition to the No Action Alternative, two Action Alternatives are analyzed in this SWEIS, both of which start with the No Action Alternative as their baseline. Newly proposed changes directed at reducing some operations conducted under the No Action Alternative at certain LANL facilities are analyzed under the Reduced Operations Alternative. Conversely, newly proposed changes reflecting expanded operations at certain LANL facilities, replacement of aging structures to accommodate ongoing operations, and actions associated with environmental cleanup above and beyond the operations included under the No Action Alternative are analyzed under the Expanded Operations Alternative.

1.3.2 Reduced Operations Alternative

The Reduced Operations Alternative analyzed in this SWEIS addresses new proposals that would reduce the overall operational level at LANL below that established for the No Action Alternative by reducing or eliminating certain operations at LANL. This Alternative includes new proposals for:

- Reducing the scope of the Chemistry and Metallurgy Research Replacement Facility Project. Construct and operate only the radiological laboratory, administrative office, and support functions building, and eliminate construction and operation of the proposed nuclear facility portion; operate the existing Chemistry and Metallurgy Research Building beyond its previously identified closure in 2010; upon cessation of operations, decommission, decontaminate, and demolish (DD&D) the building as previously decided;

- Discontinuing all accelerator operations, including all DOE and NNSA mission support work and all Work-for-Others-type operations, at the TA-53 Los Alamos Neutron Science Center (LANSCE) and placing the facility into an indefinite safe shutdown mode;

- Reducing High Explosives Processing Facilities operations conducted at TAs 8, 9, 11, 16, 22, and 37 by 20 percent from the No Action Alternative level of operations in this SWEIS;

- Reducing High Explosives Testing Facilities operations conducted at TAs 14, 15, 36, 39, and 40 by 20 percent from the No Action Alternative level of operations in this SWEIS, and eliminating all dynamic experiments using plutonium at the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility; and

- Discontinuing all TA-18 Pajarito Site operations and placing the facility into a shutdown mode.

Each of these reductions in operations would occur at LANL Key Facilities described in the *1999 SWEIS*. Operations at the DARHT Facility were analyzed in the separate *Final Environmental Impact Statement, Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility (DARHT EIS)* (DOE/EIS-0228) (DOE 1995a), for which a ROD was issued. Project and environmental impact information provided through the *DARHT EIS* was included in the preparation of the *1999 SWEIS*. The *TA-18 Relocation EIS* (DOE 2002i) analyzed relocating TA-18, Pajarito Site materials and capabilities; however, the ROD deferred a decision on the Security Category III and IV materials and the Solution High-Energy Burst Assembly (SHEBA).

The 2004 ROD for the *CMRR EIS* announced NNSA's decision to build a two-building replacement facility and, after operations transitioned into the new buildings, to decommission, decontaminate, and demolish the aging Chemistry and Metallurgy Research Building. Construction and operation of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility at LANL may not occur depending on programmatic decisions reached by NNSA regarding plutonium pit production and nuclear material consolidation that are being evaluated in the *Complex Transformation SPEIS*. In the event that NNSA decides to eliminate the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility, NNSA may select this reduction in LANL operations as one of its decisions informed by this SWEIS impact analysis. Not constructing and operating the new nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility would require NNSA to operate the existing Chemistry and Metallurgy Research Building beyond 2010. Continuing to restrict operations at the Chemistry and Metallurgy Research Building would result in the inability to meet the level of operations determined necessary for the foreseeable future at LANL in the *1999 SWEIS* ROD (NNSA 2007b).

1.3.3 Expanded Operations Alternative

The Expanded Operations Alternative analyzed in this new SWEIS reflects proposals to expand overall operational levels at LANL above those analyzed in the No Action Alternative. This alternative includes the expansion of operations at certain Key Facilities and the construction of new facilities.

The greatest operational change at a Key Facility would occur at the Plutonium Facility. The *1999 SWEIS* analyzed a production level of 50 pits per year in single-shift operations (or up to 80 pits per year in multiple-shift operations) as part of its Expanded Operations Alternative. However, DOE decided in 1999 to manufacture a nominal 20 pits per year, and announced that decision in the *1999 SWEIS* ROD. The annual production of 20 pits was identified in the Final *1999 SWEIS* as the Preferred Alternative, and the analysis of impacts for this Alternative was developed by scaling down the impacts identified for the *1999 SWEIS* Expanded Operations (which was based on an annual production rate of 80 pits) to a production rate of 20 pits per year.[6]

While recent studies suggest that the lifetime of the plutonium pit in the majority of nuclear weapons may be longer than originally thought, NNSA still needs to increase pit production. First, even with longer pit lifetimes, NNSA will need to replace considerable numbers of pits in stockpiled warheads as the stockpile ages. Second, at significantly smaller stockpile levels than today, NNSA must anticipate an adverse change in the geopolitical threat environment, or a technical problem with warheads in the operationally deployed force, either of which could require the United States to manufacture and deploy additional warheads in a relatively short time frame (NNSA 2006c, 2007a).

In this SWEIS, NNSA now proposes to increase the annual manufacturing rate from 20 pits (the rate assumed for the No Action Alternative in this SWEIS) to an annual rate that would produce up to 80 pits at LANL under the Expanded Operations Alternative. The production of pits includes the activities needed to fabricate new pits, to modify the internal features of existing pits, and to certify new pits or requalify pits. Some of the pits produced by these processes may not be certified or requalified. NNSA needs to produce about 50 certified pits annually to meet the immediate requirements of the Stockpile Stewardship Program (although the number of certified pits needed may change in the future), and may need to produce more than 50 pits in order to obtain the appropriate number of certified pits. The Expanded Operations Alternative for this SWEIS is based on an annual production rate of 80 pits per year in order to provide NNSA with some flexibility in obtaining the number of certified pits it requires each year. The annual production rate of 80 pits analyzed in the Expanded Operations Alternative is the upper limit of the annual production rate at LANL. Although NNSA has proposed further transformation of the nuclear weapons complex to meet future national security needs, NNSA has not completed the *Complex Transformation SPEIS* and therefore has not made a decision on the configuration of the future complex, including decisions regarding whether to increase its pit production capabilities above 80 pits per year at LANL or another NNSA site. Any decision to increase pit production beyond 20 pits per year would be made after NNSA issues the *Final Complex Transformation SPEIS*; such a decision would be based on the analyses in the *Complex Transformation SPEIS*, this SWEIS, and other information, including cost studies, budget projections, and national security requirements.

---

[6] As part of this scaling process, the 1999 SWEIS provided quantitative adjustments of important impacts where possible to reflect the differences between an annual production rate of 80 pits (the rate used for that SWEIS's Expanded Operations Alternative) and an annual rate of 20 pits (the rate used for the Preferred Alternative and selected by the 1999 ROD) (64 FR 50797). Where quantitative adjustments were not possible, a qualitative discussion of the important differences in impacts was provided.

A decision to increase pit production significantly above 20 pits annually would require NNSA to issue a new or revised ROD. Work continues toward implementing the decision to produce 20 pits per year announced in the *1999 SWEIS* ROD. NNSA's current proposal to produce up to 80 pits per year involves reorganizing operations within the Plutonium Facility such that no new building or other addition to the "footprint" of the facility would be required. Available production space within the facility would be used more efficiently and process efficiencies identified since 1999 would be employed. Some modifications to equipment arrangements in the Plutonium Facility might also be necessary. This approach – using only existing floor space – is not the same as the approaches analyzed in the *1999 SWEIS*, each of which would have required addition of floor space to the Plutonium Facility. In this SWEIS, NNSA is reanalyzing the potential environmental impacts of using this new approach to obtain up to 80 pits per year as outlined in the Expanded Operations Alternative. As was the case for the impact analysis used in the Expanded Operations Alternative in the *1999 SWEIS*, this SWEIS bases the analysis of impacts for its Expanded Operations Alternative on a maximum annual production rate of up to 80 pits. The No Action Alternative for this SWEIS uses the same scaling process used to develop the Preferred Alternative for the *1999 SWEIS*.

Three types of new projects are addressed in this SWEIS under the Expanded Operations Alternative, including:

- Projects that maintain existing capabilities at LANL;
- Projects that support the cleanup of LANL including the DD&D of excess buildings and implementation of the Consent Order[7] (NMED 2005); and
- Projects that add new or expand existing capabilities at LANL.

Decontamination, Decommissioning, and Demolition (DD&D)

DD&D are those actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the building or structure.

These newly proposed projects are described in the following paragraphs, and each is analyzed explicitly in the project-specific analyses included in Appendices G through J to this SWEIS.

Projects to Maintain Existing LANL Operations and Capabilities

The first type of proposed project analyzed under the Expanded Operations Alternative would continue operations at LANL at levels identical or very similar to those addressed in the *1999 SWEIS* Preferred Alternative or other LANL-specific NEPA compliance documents. Projects in the group would provide new structures for existing activities at LANL by replacing old and transportable buildings with new modern buildings. These projects include refurbishment of, and reinvestment in, certain existing buildings and structures, as well as construction of new buildings to replace aging buildings and temporary or portable structures. In cases involving new construction, the DD&D of older structures is included as part of the project

[7] NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.

for the purposes of the NEPA impact analysis and decisionmaking, although separate funding packages could be used to implement such activities.

Proposed projects of the first type include:

- Construction and operation of a new Physical Science Research Complex (formerly the Center for Weapons Physics Research) within TA-3;
- Construction of nine replacement office buildings within TA-3;
- Construction and operation of a new Radiological Sciences Institute at TA-48 for consolidating existing radiological operations including Security Category I and II nonproliferation activities, certain Security Category III and IV operations from the TA-18 Pajarito Site (SHEBA would not be included), and relocation of Wing 9 hot cell operations from the Chemistry and Metallurgy Research Building; the first phase would be construction and operation of the Institute for Nuclear Nonproliferation Science and Technology;
- Construction and operation of a Radioactive Liquid Waste Treatment Facility upgrade in TA-50;
- Refurbishment of the existing LANSCE in TA-53;
- Construction and operation of a new Radiography Facility at TA-55;
- Refurbishment of the existing Plutonium Facility Complex at TA-55;
- Construction and operation of a new Science Complex, including space for activities currently performed at the Bioscience Facilities (formerly the Health Research Laboratory); and
- Construction and operation of a new warehouse and truck inspection station in TA-72.

Buildings and structures constructed and occupied since the late 1940s often cannot adequately accommodate modern operations. Additionally, these buildings and structures were not built to current structural, health, safety, and security standards and cannot be easily or economically retrofitted to meet these standards. These older buildings also are ill-equipped to accommodate the modern office electronics and communications equipment and systems needed for workforce and equipment cooling and heating needs. NNSA is now in the process of replacing many of the old buildings and structures at LANL with modern buildings and structures.

The need to replace these aging structures provides NNSA with an opportunity to consolidate operations and eliminate underutilized and redundant structures and buildings. In general, the analyses of these new construction projects include the DD&D of a comparable amount of space in older buildings or portable structures that are no longer needed or are unsuitable for future use, in keeping with requirements established in the fiscal year 2002 Energy and Water Development Appropriations Act passed by the Congress. According to language included in that Act, space added by the construction of new facilities within the Complex must be offset by the elimination of an equal amount of excess space.

Projects for Closure and Remediation Actions

Proposed projects of the second type include various actions that would result in the DD&D of excess structures that are not directly connected to the proposed construction of new or replacement facilities or structures, and site remediation and closure. Projects also include replacements of waste management capabilities that would be displaced as a result of remediation activities. Proposed projects of the second type include:

- DD&D of TA-18 Pajarito Site buildings and structures, including relocation of operations;
- DD&D of TA-21 buildings and structures;
- Provision of waste management facilities necessitated by closure of the TA-54 Material Disposal Area[8] (MDA) G; and
- Remediation of major MDAs and other contaminated sites at LANL as required by NMED under the Consent Order.

Regarding relocation of TA-18 Pajarito Site operations, decisions for the future disposition of the Security Category III and IV materials and buildings and structures in the TA were not made following preparation of the *TA-18 Relocation EIS* (DOE 2002i). Additional planning has since been completed, and these buildings and structures are being considered for DD&D rather than reuse after current operations have been relocated. As already stated, Security Category III and IV operations would have to be moved to a new facility before certain DD&D actions could be undertaken.

TA-21 is one of the 10 land tracts identified in accordance with Public Law 105-119 for conveyance or transfer from DOE administrative control. Potential environmental impacts from contemplated reuses of TA-21 were analyzed in the *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE/EIS-0293) (DOE 1999d). LANL tritium operations located at TA-21 are either already slated to be moved to other locations at LANL or offsite to other Complex facilities, or will be discontinued entirely. The buildings and structures at TA-21 are some of the oldest at LANL and would be difficult to retrofit for most proposed beneficial reuses. TA-21 buildings and structures also include about 100,000 square feet (9,300 square meters) of highly contaminated space. Additionally, most buildings and structures located at TA-21 are situated atop or adjacent to potential release sites in the form of buried distribution lines, contaminated soil, or waste disposal areas. The demolition of these buildings or structures is necessary before the potential release sites can be adequately investigated and remediated. Investigation and

[8] A material disposal area or MDA is an area used any time between the beginning of LANL operations in the early 1940s and the present for disposing of chemically, radioactively, or chemically and radioactively contaminated materials.

remediation of potential release sites at TA-21, if necessary, must be undertaken before the site can be conveyed, transferred, or otherwise reused for other purposes.

The Expanded Operations Alternative in this SWEIS considers the environmental impacts of actions associated with remediation decisions that would not be made entirely by DOE or NNSA. In the case of the MDAs and other potential release sites, remedial actions will be mainly decided in accordance with the Consent Order (NMED 2005) and the Atomic Energy Act. For potential release sites subject to the Consent Order, NNSA and the LANL management and operating contractor will recommend a preferred remediation, but the State of New Mexico will make the final decision on the remedy to be employed. These remediation actions will have associated support actions for which NNSA must make decisions. The remediation of LANL MDAs would require the construction and operation of various new temporary ancillary structures for such purposes as waste characterization, sorting, treatment, and packaging or overpacking operations; material lay-down and storage areas; and vehicle parking and equipment storage. Support of remediation activities could also require realignment of roads and alteration of traffic patterns. Additionally, new replacement buildings and structures would be required to house ongoing operations and capabilities associated with or collocated with certain MDAs requiring remediation. The construction and operation of the following replacement buildings and structures has been proposed and is analyzed in this SWEIS:

- A new TRU (Transuranic) Waste[9] Facility (previously named the Transuranic Waste Consolidation Facility) for all transuranic waste management activities currently conducted at TA-54;
- A new temporary remote-handled transuranic waste retrieval facility for all or a portion of the remote-handled transuranic waste currently stored underground at TA-54 so that it can be retrieved, processed, and shipped to the Waste Isolation Pilot Plant (WIPP) in New Mexico for disposal; and
- A new administrative and access control building, a new low-level radioactive waste compactor building, and a new low-level radioactive waste characterization and verification building at TA-54.

Projects Associated with New Infrastructure or Levels of Operation

The third type of proposed project considered under the Expanded Operations Alternative would establish new capabilities or expand existing capabilities beyond the type or level of capabilities analyzed in the *1999 SWEIS* Preferred Alternative or other completed NEPA compliance documentation. Proposed projects of the third type include:

---

[9] *"Transuranic waste is radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61" (DOE 1999b).*

- Constructing new vehicle parking lots and roads, realignment of existing roads, and altering of traffic patterns at various locations at LANL in support of security requirements;
- Increasing the computational operating capacity of the Metropolis Center at TA-3; and
- Increasing the amount and type of sealed radioactive sources[10] (hereafter called sealed sources) received for long-term management at LANL.

These latter two projects involve Key Facilities as that term was defined in the *1999 SWEIS*. The Solid Radioactive and Chemical Waste Facilities in TA-54 and the Chemistry and Metallurgy Research Building were designated as Key Facilities in the *1999 SWEIS* and, together with other facilities such as the Radiological Sciences Institute, are proposed locations for managing sealed sources. The Metropolis Center in TA-3 is identified as a new Key Facility in this new SWEIS.

Environmental impacts of changes in physical security along Pajarito Road and in TA-3 were evaluated in the *Environmental Assessment for Proposed Access Control and Traffic Improvements at Los Alamos National Laboratory* (DOE/EA-1429) (DOE 2002k). As part of that Security Perimeter Project, the construction and activation of access control stations near each end of Pajarito Road has been completed. Another element of the Security Perimeter Project involving realignment of roads and changes to traffic patterns around TA-3, is also mostly complete. The proposed project in this SWEIS to construct new vehicle parking lots and roads, realign roads, and alter traffic patterns would provide additional security along the western section of Pajarito Road. Implementation of the project would allow restriction of certain vehicle traffic along Pajarito Road while ensuring employee access to work places in TA-35, TA-48, TA-50, TA-55, and TA-63 by means of shuttle buses, walkways, and bicycle paths. Auxiliary actions to the proposed project would also be considered. The first auxiliary action includes the construction of a bridge from TA-35 across Mortandad Canyon to TA-60 and connection to a road leading to TA-3. The second auxiliary action, which is dependent on the first auxiliary action, entails construction of a bridge across Sandia Canyon and extending the road to intersect with East Jemez Road. If implemented, these auxiliary actions would allow vehicles traveling from White Rock to TA-3 or the Los Alamos townsite to bypass the section of Pajarito Road that would have restrictions on certain vehicle traffic.

Construction and operation of the Metropolis Center were analyzed in the *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1250) (DOE 1998) and its associated Finding of No Significant Impact (FONSI) (the Metropolis Center was formerly called the Strategic Computing Complex, and the impact analysis appears under that name), which considered impacts associated with operating the computation facility at an initial capacity of a 50-teraflops platform (a teraflop is a trillion floating point operations per second). The Metropolis Center has been constructed and is currently operating a 30-teraflops platform; however, NNSA is considering

[10] *"Sealed radioactive source means a radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of nonradioactive material, or firmly fixed to a nonradioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, and radioisotope thermoelectric generators" (10 CFR Part 835).*

increases to the facility's operational capacity that could consume additional amounts of water and electrical power resources. The Metropolis Center's performance platform could exceed 100 teraflops before 2009, with dramatic increases thereafter. The proposed increase in the operating platform beyond 50 teraflops is analyzed in this SWEIS; however, the exact level of operations supported would be unknown, as it has become clear over the past 5 years that the operating platform level cannot be directly correlated to a set amount of water or electrical power consumption. Each new generation of computing capability machinery continues to be designed with enhanced efficiency in terms of both electrical consumption and cooling requirements. Therefore, the operating level that can be supported by about 15 megawatts of electrical usage and 51 million gallons (193 million liters) per year of water has been used to project associated potential environmental impacts in this SWEIS.

The acceptance of certain sealed sources at LANL for radioactive material recovery was initiated after DOE prepared an EA in 1995 that supported a FONSI (DOE 1995b). Recovery of the radioactive material from the sealed sources at the Plutonium Facility Complex, as was originally proposed, never occurred; and in 2000, NNSA proposed that those sealed sources be managed and disposed of as waste. An SA to the *1999 SWEIS* was prepared to consider that action, and a finding was reached that the *1999 SWEIS* impact analysis adequately bounded the management and disposal of those particular waste items (DOE 2000d). Another type of source contained within radioisotope thermoelectric generators was subsequently considered for management within LANL's solid waste management capabilities in 2004, and the environmental impacts were considered through preparation of an SA to the *1999 SWEIS*. A finding was again reached that the *1999 SWEIS* impact analysis adequately bounded the anticipated impacts from that action (DOE 2004a). NNSA is now proposing to broaden the range of radionuclides in sealed sources to be managed at LANL. The new nuclides being considered include some that are not actinides.[11] Management of these sealed sources could require their indefinite storage at LANL until alternate storage or disposal facilities become available. In July 2007, DOE issued an NOI to prepare an EIS to support a decision regarding the disposal of Greater-Than-Class C waste[12] and DOE waste with similar characteristics (72 FR 40135). This waste includes some of the sealed sources managed at LANL.

1.3.4 Preferred Alternative

NNSA has selected the Expanded Operations Alternative as its Preferred Alternative for the continued operation of LANL (discussed in Chapter 3 of this SWEIS). This alternative includes fabrication of up to 80 pits per year at the Plutonium Facility Complex in TA-55, as well as increased activity levels at certain other Key Facilities (such as the Chemistry and Metallurgy Research Replacement Facility) to support this level of pit production. Under the Expanded Operations Alternative, NNSA would undertake activities to facilitate compliance with the

[11] Actinides are any of the elements in the series of elements beginning with actinium (atomic number 87) and ending with lawrencium (atomic number 103). This series includes thorium, uranium, neptunium, plutonium, and americium, among others. Nonactinides, therefore, are elements that are not included among the list of actinides.

[12] Greater-Than-Class C low-level radioactive waste is defined by the U.S. Nuclear Regulatory Commission (NRC) in 10 CFR 72.3 as "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in [10 CFR 61.55]." It is generated by NRC or Agreement State licensed activities. Such waste generally requires disposal technologies having greater confinement capability or protection than "normal" near surface disposal. Such improved technologies could involve better waste forms or packaging, or disposal by methods having additional barriers against intrusion.

Consent Order and remediation of the MDAs. Capabilities, activity levels, and projects identified under the No Action Alternative that remain unchanged under the Expanded Operations Alternative would continue as described. Proposed increases in activity levels would be implemented and new capabilities would be added to existing Key Facilities. The proposed projects discussed in the appendices to this SWEIS would proceed, commensurate with funding.

However, full implementation of the Preferred Alternative may be affected by future programmatic decisions. NNSA is reconsidering its decision regarding construction and operation of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility at LANL pending completion of its NEPA analysis for transformation of the nuclear weapons complex. NNSA is deferring a decision on how to provide the necessary long-term analytical chemistry, materials characterization, and research and development capabilities that would be provided by the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. Given the uncertainty regarding the nuclear weapons program work that will be assigned to LANL in the future, NNSA expects to issue two or more RODs to implement its decisions. As discussed later in Section 1.4 of this chapter, NNSA may ultimately choose to implement only part of the Expanded Operations Alternative depending on how it decides to transform the complex.

Decisions relating to site remediation and to DD&D of facilities are expected to be in the first ROD based on this SWEIS. Specifically, these include activities that would facilitate remediation of MDAs and other contaminated sites as required by the Consent Order; the Waste Management Facilities Transition Project, including construction and operation of a new TRU Waste Facility; closure of TA-18, including relocation of Security Category III and IV material from TA-18 to other LANL locations, cessation of SHEBA operations, and the DD&D of TA-18 structures, as appropriate; TA-21 DD&D; and any activities in support of the closure of the Los Alamos County Landfill. Another decision that might be announced in the first ROD is enhancement of the operating levels at the Metropolis Center in TA-3. Projects to maintain existing capabilities at LANL that may be included in the first ROD include construction and operation of replacement office buildings in TA-3; construction and operation of the TA-50 Radioactive Liquid Waste Treatment Facility upgrade; construction and operation of the new Science Complex in TA-62; the LANSCE Refurbishment Project; and construction and operation of the new Consolidated Warehouse and Truck Inspection Station in TA-72.

Decisions regarding operations and projects that might be made in subsequent ROD(s) are initiation of a new capability at the Radiochemistry Facility (atom trapping); Security-Driven Transportation Modifications; elevated operations at the High Explosives Processing Facilities; construction and operation of the TA-3 Physical Science Research Complex; construction and operation of the Institute for Nuclear Nonproliferation Science and Technology, the first component of the new Radiological Sciences Institute at TA-48; facility refurbishments that make up the TA-55 Plutonium Facility Complex Refurbishment Project; construction and operation of a radiography facility at TA-55; and an increase up to 80 in the number of nuclear weapons pits produced within the TA-55 Plutonium Facility Complex, along with increases in the levels of operations of associated activities such as the management of solid and liquid radioactive wastes. NNSA's implementation of its decisions is subject to annual congressional funding levels. Although the SWEIS ROD(s) would indicate NNSA's commitment to a project, capability, or operational level, the actions would be taken contingent upon the level of funding allocated.

1.4 Decisions the National Nuclear Security Administration May Make on the Basis of the Site-Wide Environmental Impact Statement

This SWEIS updates the *1999 SWEIS* analysis and evaluates the impacts of newly proposed projects. The RODs based on this new SWEIS may supersede previous decisions made in 1999 regarding the level at which LANL operations will be conducted over at least the next 5 years. Analyses in this SWEIS considered levels of operations and new projects proposed for the period 2007 through about 2011, but would equally apply to actions beyond 2011 as long as the actions are bounded by the analyses in the SWEIS. The impacts analyses provided in this SWEIS will allow NNSA to reassess the potential impacts of LANL operations on workers, the public, and the environment in light of changes in the environmental circumstances that have developed since 1999.

This SWEIS also represents an opportunity to update information regarding the current status of the regional, local, and LANL-specific environmental conditions. The Cerro Grande Fire of 2000 burned over 7,700 acres (3,110 hectares) of land at LANL, resulting in changes to area watershed functions, vegetation cover functions, wildlife use, and cultural resources present in the area. The physical environment at and around LANL has also been affected by a southwestern regional drought and the attendant bark beetle infestation of evergreen trees. The Cerro Grande Fire and the bark beetle infestation have resulted in widespread vegetation mortality, particularly of evergreen trees, which will cause long-term ecological changes to the LANL area.

In addition, the new SWEIS impacts analyses give NNSA the opportunity to reassess the potential impacts of LANL operations on the public in light of changes in the size and distribution of the population near LANL, the distance to the site boundaries (and therefore, to potential public receptors), and changes in assessment methodologies adopted by DOE. The impacts analyses consider the most recent census data on the number and location of people living near LANL. The analyses also consider changes that have occurred as a result of the conveyance and transfer of certain land tracts away from the LANL reservation. Conveyance and transfer of lands have reduced the land areas that provide distance buffering between LANL operations and the public, resulting in potential changes to the locations used to assess impacts to a hypothetical "maximally exposed individual" member of the public from normal operations and postulated accidents. Assessments of risk associated with radiation exposure also reflect changes to the guidance on dose-to-risk conversion factors that have occurred since 1999.

These changes, together with information regarding impacts analyses specific to newly proposed projects at LANL that could have overarching effects, will inform NNSA regarding decisions about the continued operation of LANL over about the next 5 years. At this time, a nominal 5-year period has been selected, recognizing that a meaningful level of detail is not possible when trying to project changes in operations over a long period of time. Focusing on LANL operations over about the next 5-year window of time allows NNSA to make decisions with a reasonable expectation of being able to implement those decisions and associated mitigative measures.

The analyses of potential environmental impacts that could occur if NNSA implemented the No Action Alternative, Reduced Operations Alternative, or Expanded Operations Alternative are evaluated in this SWEIS. NNSA could choose to implement the alternatives either in whole or in part; that is, NNSA could select the level of operations for a Key Facility or whether to implement individual projects. NNSA intends to implement actions necessary to comply with the Consent Order, regardless of decisions it makes on other actions analyzed in this SWEIS; the Expanded Operations Alternative includes the analysis of the actions needed to comply with that order. Similarly, NNSA plans to complete the design for the Chemistry and Metallurgy Research Replacement Facility, but is deferring a final decision on whether to construct the nuclear facility portion at LANL. NNSA could issue a ROD or RODs to document its decisions regarding the level of LANL operations or the implementation of a project no sooner than 30 days after the Environmental Protection Agency Notice of Availability of the Final SWEIS.

Decisions NNSA may make regarding the operation of LANL are:

- *Whether to implement the No Action Alternative for continued LANL operations, either in whole or in part*. NNSA may choose to implement the No Action Alternative in its entirety, thereby deciding to continue LANL operations for about the next 5 years at levels previously selected and to implement none of the specific projects or actions that are elements of the Expanded Operations Alternative; or NNSA may elect to implement the No Action Alternative in part by taking no action on certain specific projects or actions while electing to implement others. As explained previously, a decision to postpone an action decision results in a *de facto* decision to implement the No Action Alternative for that proposed project. That No Action Alternative decision could be changed later with the issuance of a subsequent ROD regarding selection of one of the Action Alternatives for implementation.

- *Whether to implement the Reduced Operations Alternative, either in whole or in part.* The Reduced Operations Alternative includes specific actions at separate existing facilities that could be implemented individually over about the next 5 years. Proposed projects considered under this Alternative include operations at facilities that are heavily engaged in experimental activities. Reducing high explosives testing operations by 20 percent, for example, could reduce all individual experiments, or it could entirely eliminate certain experiments and reduce other experiments from their full scope to achieve a 20 percent overall work reduction. The shutdown of LANSCE could be implemented separately from reductions to high explosives processing or testing operations although, to a certain extent, these two operations may be linked. Experimental operations at all LANL facilities receive funding from a variety of sources, and the level of operations at any time highly depends on the level of funding received for a particular year. Reductions due solely to a lack of funding could reach the level of reductions called for by this Alternative; however, choosing to implement this Alternative in whole or in part would permanently reduce the level of subject operations.

- *Whether to implement the Expanded Operations Alternative, either in whole or in part*. The Expanded Operations Alternative includes specific actions at separate existing facilities that could be implemented individually over about the next 5 years. Proposed projects considered under this Alternative include construction and demolition activities, as well as the expansion of certain operations at existing LANL facilities. Environmental remediation actions for potential release sites subject to cleanup under the Hazardous Waste Amendments to the Resource Conservation and Recovery Act will be determined by the State of New Mexico in accordance with the provisions of the Consent Order (NMED 2005). NNSA, however, will need to make decisions regarding how to implement the remediation actions selected by the State of New Mexico. This SWEIS provides environmental impact information about the methods of remediation to facilitate the State of New Mexico's decisionmaking process for those decisions that it will make, and for the benefit of the reader with regard to understanding potential remediation action options in context with the overall operation of LANL over the next 5 years and beyond. NNSA intends to implement actions necessary to comply with the Consent Order regardless of whether other actions in the Expanded Operations Alternative are implemented. Similarly, the County of Los Alamos has made a decision to close the municipal landfill located at LANL but operated by the county; however, accommodating further necessary actions associated with this decision, such as monitoring actions around the landfill site and down-canyon from the site within the LANL boundary, may require implementation decisions by NNSA.

In addition to the environmental impact information provided by this SWEIS, other considerations that are not evaluated through the NEPA compliance process will also influence NNSA's final project decisions. These considerations include cost estimate information, schedule considerations, safeguards and security concerns, and programmatic considerations of impacts. In accordance with CEQ NEPA Regulations §1500.1 (c), "Ultimately, of course, it is not better documents, but better decisions that count. NEPA's purpose is not to generate paperwork – even excellent paperwork – but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. These regulations provide the direction to achieve this purpose" (40 CFR Parts 1500 to 1508).

There are decisions related to the operation of LANL that NNSA will not make based on the Final SWEIS impact analyses. As already stated, decisions about the final remediation actions to be implemented at LANL MDAs and other potential release sites subject to the Consent Order will not be made by NNSA, but by the New Mexico Environment Department (NMED 2005). Similarly, the County of Los Alamos, as the landfill operator, has already made the decision to close the municipal solid waste landfill located at LANL.

NNSA will not make decisions to remove mission support assignments from LANL or alter the operational level of those capabilities that are ongoing at the site in favor of capabilities that have not been explicitly identified in the alternatives analyzed in this SWEIS. NNSA will not consider a LANL "shutdown" or "true No Action Alternative" or a "Greener Alternative" (alternatives considered but not evaluated further in this SWEIS are discussed in Chapter 3, Section 3.5). As noted previously, programmatic changes to the DOE nuclear weapons complex are the subject of a separate NEPA impact analysis. At this time, a shutdown alternative is not reasonable for NEPA analysis.

1.5 Relationships to Other Department of Energy National Environmental Policy Act Documents and Information Sources

Various NEPA compliance reviews undertaken since issuance of the *1999 SWEIS* and its associated ROD have resulted in decisions to implement proposed projects at LANL. Some of these actions have already been implemented, and some actions are proceeding through the detailed planning stages toward implementation in the near future. These NEPA compliance reviews were used to identify operational changes and environmental impacts for this new SWEIS impact analysis. Using the *1999 SWEIS* and its associated ROD as a starting point, these additional NEPA reviews include:

- *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Certain Unwanted Radioactive Sealed Sources at Los Alamos National Laboratory* (DOE/EIS-0238-SA-01) (2000). This SA was prepared to evaluate a proposal to modify the Off-Site Source Recovery Project from one that accepted the sealed sources and chemically reclaimed the radioactive material to one that accepted the sealed sources and managed them as radioactive waste.

- *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Transuranic Waste Characterization at Los Alamos National Laboratory* (DOE/EIS-0238-SA-02) (2002). This SA was prepared to evaluate a modification to the management methods for transuranic waste by installing and operating modular units for the characterization of this type of waste.

- *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Bolas Grande Project* (DOE/EIS-0238-SA-03) (2003). This SA was prepared to evaluate the cleanout and disposal of certain large containment vessels that were used for testing purposes. These vessels have been stored at TA-55 and would be taken to the Chemistry and Metallurgy Research Building for cleanout prior to being taken to TA-54 for disposal.

- *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Recovery and Storage of Strontium-90 (Sr-90) Fueled Radioisotope Thermal Electric Generators at Los Alamos National Laboratory* (DOE/EIS-0238-SA-04) (2004). This SA was prepared to evaluate a proposal to recover, store, and manage as waste certain radioisotope thermal electric generators containing sealed sources as part of the Off-Site Source Recovery Project.

- *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Proposed Horizontal Expansion of the Restricted Airspace up to 5,000 Feet at Los Alamos National Laboratory* (DOE/EIS-0238-SA-05) (2004). This SA was prepared to evaluate a proposal to slightly expand the horizontal extent of the restricted airspace up to 5,000 feet (1,500 meters) above LANL.

- *Final Supplement Analysis for Pit Manufacturing Facilities at Los Alamos National Laboratory, Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (DOE/EIS-0236-SA/06) (2006). This SA was prepared to evaluate certain conditions and new information associated with proposed pit manufacturing at LANL.

- *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE/EIS-0283) (1999). This EIS was prepared to analyze environmental impacts with regard to disposition of surplus plutonium at locations around the DOE nuclear weapons complex, including LANL. Plutonium declared excess to national security needs could be stored and dispositioned in accordance with the strategy selected for implementation in the amended ROD for this EIS. LANL was identified as the site for fabrication of mixed oxide fuel to be used in testing.

- *Supplement Analysis, Fabrication of Mixed Oxide Fuel Lead Assemblies in Europe*, (DOE/EIS-0229-SA3) (2003). This SA evaluated the impacts of transporting plutonium oxide from LANL to France for fabrication into four mixed-oxide fuel lead assemblies for a nuclear reactor. The analysis also includes the return to LANL of excess mixed-oxide materials and out-of-specification materials loaded in fuel rods that are welded closed. These materials are to be stored at LANL until they are needed as feed for mixed-oxide fuel production in the United States.

- *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE/EIS-0293) (1999). This EIS was prepared to analyze the environmental impacts associated with the future use of each of 10 tracts of land administered by DOE at LANL that were proposed for transfer to the Department of the Interior in trust for the Pueblo of San Ildefonso or conveyance to the County of Los Alamos in accordance with the provisions of Public Law 105-119.

- *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE/EIS-0319) (2002). This EIS reviewed the environmental impacts expected from a proposal to relocate capabilities and materials from TA-18 at LANL to one of several locations around the Complex. The ROD issued as a result of this EIS was to transfer Security Category I and II nuclear equipment and related materials to the Device Assembly Facility at the Nevada Test Site. A decision on the disposition of Security Category III and IV materials was deferred and is addressed in the project-specific analyses of this SWEIS.

- *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico (CMRR EIS)* (DOE/EIS-0350) (2003). This EIS examined the potential environmental impacts associated with the Proposed Action of consolidating and relocating the mission-critical chemistry and metallurgy research capabilities from an aging building to a new modern building (or buildings). The ROD (69 FR 6967) selected a location for a Chemistry and Metallurgy Research Replacement Facility adjacent to the

Plutonium Facility Complex in TA-55. Design and construction of the radiological laboratory, administrative office, and support portion of the new facility is proceeding; however, decisions to be made by NNSA that will be supported by the *Complex Transformation SPEIS* could result in changes to the Chemistry and Metallurgy Research Replacement Facility as described in the 2003 *CMRR EIS* and its associated 2004 ROD. Specifically, NNSA will decide whether to construct the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility at LANL or incorporate the capabilities into a consolidated plutonium center or a consolidated nuclear production center either at LANL or another DOE site. Decisions reached by NNSA on Complex Transformation are anticipated to take 10 to 20 years to fully implement. During that period there will remain a continuing need for analytical chemistry and material characterization, and actinide research and development support capabilities and capacities that are currently housed in the Chemistry and Metallurgy Research Building at LANL. NNSA is continuing design efforts for the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility, but actions to proceed beyond the design stage will not occur until programmatic decisions regarding Complex Transformation are made.

- *Supplement Analysis, Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico, Changes to the Location of the CMRR Facility Components* (DOE/EIS-0350-SA-01) (2005). This SA was prepared to evaluate placement of certain buildings related to the Chemistry and Metallurgy Research Building Replacement Project in the same vicinity, but at locations other than those detailed in the *CMRR EIS* ROD.

- *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/SEA-03) (2000). This special environmental analysis (SEA) documented the impacts of actions take by NNSA (or on behalf of NNSA or with NNSA funding) to address the emergency situation caused by the 2000 Cerro Grande Fire. This SEA describes actions and their impacts, mitigation measures taken for actions that rendered their impacts not significant or that lessened the adverse effects, and provides an analysis of cumulative impacts.

- *Environmental Assessment for the Parallex Project Fuel Manufacture and Shipment* (DOE/EA-1216) (1999). This EA evaluated the activities necessary to fabricate 59.2 pounds (26.8 kilograms) of mixed-oxide fuel at TA-55 at LANL and ship it to the U.S.-Canada border. The mixed-oxide fuel would be used in a Canadian research reactor.

- *Environmental Assessment for the Proposed Construction and Operation of the Nonproliferation and International Security Center* (DOE/EA-1238) (1999). This EA analyzed construction and operation of a Nonproliferation and International Security Center at TA-3 at LANL that provides office and light laboratory space.

- *Environmental Assessment for Electrical Power System Upgrades at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1247) (2000). This EA analyzed the effects of upgrading the LANL electrical power supply system to increase its reliability for meeting current and future needs.

- *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1250) (1998). This EA analyzed the effects of the construction and operation of a three-story, 303,000-square foot (28,100-square meter) Strategic Computing Complex at TA-3 at LANL. Following construction, this building was renamed the Nicholas C. Metropolis Center for Modeling and Simulation.

- *Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory, Los Alamos, New Mexico, Environmental Assessment* (DOE/EA-1269) (1999). This EA analyzed the environmental consequences of the construction and operation of a decontamination and volume reduction system for processing transuranic waste removed from underground storage at LANL.

- *Environmental Assessment for the Wildfire Hazard Reduction and Forest Health Improvement Program at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1329) (2000). This EA analyzed the environmental consequences resulting from implementation of a selected forest management practices program within the boundaries of LANL. Selected practices included mechanical and manual thinning of the forests. A subsequent FONSI added use of prescribed burns as a selected management practice.

- *Environmental Assessment for Leasing Land for the Siting, Construction, and Operation of a Commercial AM Radio Antenna at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1332) (2000). This EA analyzed the environmental impacts of leasing approximately 3 acres (1.2 hectares) of land located in the southeastern portion of TA-54 for the siting, construction, and operation of a commercial AM radio broadcasting antenna.

- *Environmental Assessment for the Proposed Construction and Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1364) (2002). This EA was prepared to assess environmental consequences resulting from construction and operation of a Biosafety Level 3 laboratory facility in TA-3 at LANL. Additional NEPA analysis is being performed to further evaluate the potential impacts of operating the facility.

- *Environmental Assessment for Construction and Operation of a New Office Building and Related Structures within TA-3 at Los Alamos National Laboratory* (NNSA/EA-1375) (2001). This EA was prepared to assess the environmental consequences resulting from construction and operation of a multistoried office building (the National Security Sciences Building) to house about 700 personnel who would move from Building 3-43; a one-story lecture hall; and a separate multilevel parking structure at TA-3 at LANL.

- *Environmental Assessment for the Proposed Construction and Operation of a New Interagency Emergency Operations Center at Los Alamos National Laboratory* (DOE/EA-1376) (2001). This EA was prepared to evaluate the impacts of the construction and operation of a new Interagency Emergency Operations Center at TA-69 at LANL. The new Center was designed to withstand, to the extent practical, any anticipated emergency such that emergency response actions would not be compromised by the emergency itself.

- *Environmental Assessment for Atlas Relocation and Operation at the Nevada Test Site* (DOE/EA-1381) (2001). This EA was prepared to assess the environmental consequences resulting from implementation of a proposal to relocate a hydrodynamic test machine, the Atlas Pulsed Power Machine, from LANL to the Nevada Test Site where it would be set up and operated.

- *Environmental Assessment for the Proposed TA-16 Engineering Complex Refurbishment and Consolidation at Los Alamos National Laboratory* (DOE/EA-1407) (2002). This EA was prepared to assess the environmental consequences of the proposed construction of new buildings and the remodeling of existing buildings to allow consolidation of the Engineering Sciences and Applications Division operations and offices in a "campus-like" cluster of facilities at TA-16. The Proposed Action also included infrastructure changes and the demolition or removal of older buildings and transportables.

- *Environmental Assessment for the Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory* (DOE/EA-1408) (2002). This EA was prepared to analyze the environmental impacts resulting from future disposition of certain flood and sediment retention structures built within the boundaries of LANL in the wake of the Cerro Grande Fire. Aboveground portions of these structures would be removed as the watersheds return to prefire conditions.

- *Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1409) (2002). This EA was prepared to analyze the proposed issuance of an easement to the Public Service Company of New Mexico to construct, operate, and maintain approximately 15,000 feet (4,500 meters) of 12-inch (30-centimeter) coated steel natural gas transmission mainline on NNSA-administered land within LANL along Los Alamos Canyon.

- *Environmental Assessment of the Proposed Disposition of the Omega West Facility at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1410) (2002). This EA was prepared to analyze the environmental consequences of removing the Omega West Facility, a research reactor, and the remaining support structures from Los Alamos Canyon in TA-2.

- *Environmental Assessment for Proposed Access Control and Traffic Improvements at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1429) (2002). This EA was prepared to analyze the environmental consequences resulting from the construction of eastern and western bypass roads around the LANL TA-3 area and the installation of vehicle access controls and related improvements to enhance security along Pajarito Road and into the LANL TA-3 core area.

- *Environmental Assessment for the Installation and Operation of Combustion Turbine Generators at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1430) (2002). This EA was prepared to evaluate the environmental impacts of installing and operating two new simple-cycle, gas-fired combustion turbine generators, each with an approximate output of 20 megawatts of electricity, as standalone structures within the Co-Generation Complex at TA-3 (TA-3 Power Plant).

- *Environmental Assessment for the Proposed Los Alamos National Laboratory Trails Management Program, Los Alamos, New Mexico* (DOE/EA-1431) (2003). This EA was prepared to assess the potential environmental consequences of initiating a LANL Trails Management Program that would maintain existing trails, develop new trails, and reclaim closed trails, making them available for public use.

- *Environmental Assessment for the Proposed Consolidation of Certain Dynamic Experimentation Activities at the Two-Mile Mesa Complex, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1447) (2003). This EA evaluated the environmental impacts of constructing and operating offices, laboratories, and shops within the Two-Mile Mesa Complex, located at the conjunction of TA-6, TA-22, and TA-40, where work would be consolidated from other locations at LANL.

- *Environmental Assessment for Proposed Corrective Measures at Material Disposal Area H within Technical Area 54 at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1464) (2004). This EA was prepared to assess the potential environmental consequences of implementing corrective measures at MDA H. The corrective measure options analyzed in this EA addressed a range of potential containment and excavation options and provided a bounding analysis of the potential environmental effects of implementing any corrective measure at MDA H.

- *Environmental Assessment for the Proposed Closure of the Airport Landfills within Technical Area 73 at Los Alamos National Laboratory* (DOE/EA-1515) (2005). This EA was prepared to evaluate a proposal to conduct a voluntary corrective action involving the closure of two former solid waste disposal areas at the Los Alamos Airport within TA-73 at LANL.

- *Final Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production* (DOE/EA-1532) (2005). This EA analyzed the potential effects of a proposal to consolidate tritium production operations by relocating to Sandia National Laboratories, New Mexico, the tritium target loading operations conducted at LANL.

As already stated, decisions to implement projects based on these impact analyses, together with the decision to implement the Preferred Alternative analyzed in the *1999 SWEIS*, form the basis of the No Action Alternative analyzed in this SWEIS. As such, the impacts projected for each action either implemented or to be implemented at LANL based on these NEPA compliance reviews are considered and incorporated by reference into this SWEIS impact analysis. Similarly, routine maintenance, construction, and support activities that are necessary to maintain the availability, viability, and safety of LANL, and that individually and cumulatively have negligible effects on the environment, are also incorporated into this SWEIS analysis.

Consideration of Future Projects and Emerging Actions Affecting Los Alamos National Laboratory

In addition to the actions for which NEPA analyses have been completed since 1999 and the project-specific actions that are analyzed in this SWEIS, there are interim actions that NNSA could implement for LANL during the time that this SWEIS is under development. In conformance with CEQ regulations regarding interim actions, these actions would be justified independently from the analyses in this SWEIS, would be supported by separate environmental analyses, and would not prejudice the decisions to be made regarding the level of operations at LANL by limiting alternatives (40 CFR 1506.1). Actions that are undergoing separate NEPA review while the SWEIS is being developed are summarized below. Additional actions that have not been sufficiently developed at this time could also be identified and would undergo the appropriate level of NEPA analysis.

- *Draft Environmental Impact Statement for the Operation of the Biosafety Level 3 (BSL-3) Facility at the Los Alamos National Laboratory* (DOE/EIS-0388D). In 2002, NNSA issued the *Environmental Assessment for the Proposed Construction and Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EA-1364), and reached a FONSI (DOE 2002c). The facility, containing two Biosafety Level 3 and one Biosafety Level 2 laboratories, was constructed in TA-3. Due to the need to consider new circumstances and information relevant to the actual construction of the Biosafety Level 3 Facility and its future operation, NNSA withdrew the 2002 FONSI as it applies to operating this facility. NNSA has since determined that an EIS should be prepared that reevaluates the proposed operations of the facility. The Draft BSL-3 EIS is currently being prepared. The outcome of that EIS would not affect NNSA's ability to implement any of the alternatives analyzed in this SWEIS.

- *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems (Consolidation EIS)* (DOE/EIS-0373D). This Draft EIS evaluates the environmental impacts of the Proposed Action and alternatives for consolidating radioisotope power system nuclear operations at a single site to reduce the security threat in a cost-effective manner, improve program flexibility, and to reduce interstate transportation of special nuclear material. The nuclear operations infrastructure required to produce radioisotope power systems currently exists, or is planned to exist, at three separate locations: Oak Ridge National Laboratory in Tennessee, LANL in New Mexico, and Idaho National Laboratory in Idaho. The Proposed Action would consolidate radioisotope power system nuclear operations at Idaho National Laboratory, thus eliminating safety, security, and transportation issues. The Proposed Action also would remove radioisotope power system nuclear operations work from TA-55; under the *Consolidation EIS* No Action Alternative, the operations would remain at TA-55. However, the elimination of radioisotope power systems operations would not be necessary to implement any of the alternatives analyzed in this SWEIS.

Future projects that could occur at multiple sites or throughout the complex may also undergo NEPA review during the timeframe of this analysis. Projects that could potentially affect activities at LANL include:

- *Complex Transformation Supplemental Programmatic Environmental Impact Statement (Complex Transformation SPEIS)* (DOE/EIS-0236-S4). On January 11, 2008, NNSA announced the availability of the Draft *Complex Transformation SPEIS* which analyzes the environmental impacts from the continued transformation of the United States' nuclear weapons complex over the next 10 to 20 years. NNSA's proposed action is to continue currently planned modernization activities: NNSA would select a site to consolidate plutonium research and development, surveillance, and pit manufacturing; consolidate special nuclear materials throughout the complex; consolidate, relocate, or eliminate duplicative facilities and programs and improve operating efficiencies; identify one or more sites for conducting NNSA flight test operations; and accelerate nuclear weapons dismantlement activities. With regard to future pit production at LANL, the *Complex Transformation SPEIS* assesses alternatives that could result in decisions to produce pits at LANL at higher levels than are assessed in the LANL SWEIS. Two options of an upgrade alternative for pit production are assessed: one that would produce 80 pits annually, and one that would produce 125 pits annually with a potential surge capacity of 200 pits annually. In addition, LANL is assessed as a potential location for a consolidated plutonium center or for a consolidated nuclear production center; either of which entails consolidation of special nuclear materials storage and production of 125 pits with a potential surge capacity of 200 pits annually. The impacts of constructing and operating a consolidated nuclear production center at LANL are included in the cumulative impacts section of this SWEIS.

  The *Complex Transformation SPEIS* also evaluates consolidating other activities that are currently part of the mission work assignments at LANL, including hydrotesting, high explosives research and development, tritium research and development, and major environmental testing. Depending upon decisions made for Complex Transformation, NNSA may decide to reduce certain operations at LANL, including its 2004 decision to construct and operate the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility at this site.

- *Global Nuclear Energy Partnership Programmatic Environmental Impact Statement* (*GNEP PEIS)* (DOE/EIS-0396). DOE issued a Notice of Intent for the *GNEP PEIS* on January 4, 2007 (72 FR 331). GNEP would encourage expansion of domestic and international nuclear energy production while reducing nuclear proliferation risks, and reduce the volume, thermal output, and radiotoxicity of spent nuclear fuel before disposal in a geologic repository. The PEIS includes evaluation of a proposed advanced fuel cycle facility that would support research and development associated with the GNEP program. LANL is one of the DOE sites being considered for the advanced fuel cycle facility. DOE held a scoping meeting for the *GNEP PEIS* on March 1, 2007, in Los Alamos, New Mexico. Another dozen scoping meetings were held across the country during the scoping period, which ended June 4, 2007. DOE intends to issue a *Draft GNEP PEIS* in 2008.

- *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste* (*GTCC EIS*). In July 2007, DOE issued an NOI to prepare an EIS to address disposal of low-level radioactive waste generated by activities licensed by the Nuclear Regulatory Commission or an Agreement State that have radionuclides in concentrations exceeding 10 CFR 61 Class C limits (72 FR 40135). This EIS would also consider DOE waste having similar characteristics. Currently there is no location for disposal of Greater-Than-Class C waste and DOE is responsible for such disposal under the Low-Level Radioactive Waste Policy Amendments Act (Public Law 99-240). LANL is being considered as one of eight candidate DOE disposal sites for Greater-Than-Class C waste in the *GTCC EIS*, along with a generic commercial disposal facility option in arid and humid environments. DOE is evaluating several disposal technologies in the *GTCC EIS* including geologic repositories, intermediate depth boreholes, and enhanced near surface disposal facilities. Certain sealed sources managed by LANL under the Off-Site Source Recovery Project could be candidates for disposal in a site selected by DOE following completion of the EIS. The Off-Site Source Recovery Project would continue to collect and manage sealed sources independent of any decisions that would result from the *GTCC EIS*.

1.6 Public Involvement

The process of preparing an EIS provides opportunities for public involvement (see **Figure 1–4**). These opportunities include the scoping process and the public comment period for the EIS. The scoping process is required by 40 CFR 1501.7 while the public comment period is required by 40 CFR 1503.1. Section 1.6.1 summarizes the scoping process, major comments received from the public, and changes made by NNSA in response to the public comments. Section 1.6.2 summarizes the public comment period process, major comments raised by the public, and NNSA's responses to those comments.

1.6.1 Scoping Process

As a preliminary step in the development of an EIS, regulations established by the CEQ (40 CFR 1501.7) and DOE require "an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a Proposed Action." The purpose of this scoping process is: (1) to inform the public about a Proposed Action and the Alternatives being considered, and (2) to identify and clarify issues relevant to the EIS by soliciting public comments.

On January 5, 2005, NNSA published an NOI to prepare a Supplemental SWEIS in the *Federal Register* (70 FR 807) (see Appendix A). NNSA provided the public an opportunity to participate in the scoping process through a public scoping meeting held on January 19, 2005, in Pojoaque, New Mexico, and through receipt of comments via the U.S. Postal Service, a special DOE Internet address, a toll-free phone line, and a facsimile phone line. The public scoping period ended February 17, 2005. Approximately 225 comments were received from citizens, interested groups, local officials, and representatives of Native American Pueblos in the vicinity of LANL during the scoping process. All comments received were reviewed for consideration by NNSA in proceeding with this NEPA analysis.

Summary of Major Scoping Comments

Multiple comments were made regarding the type of NEPA document that NNSA should prepare. There were comments calling for development of a new SWEIS rather than a supplement to the *1999 SWEIS*. Justifications for a new SWEIS included changes in operations and the environment, issuance of the Consent Order (NMED 2005), concerns about inadequacies of the *1999 SWEIS*, contaminants in the environment, and others. Regarding the scope of the document, comments included the desire to see a Reduced Operations Alternative, a Greener Alternative, and a "true No Action Alternative". In response, NNSA prepared this SWEIS instead of a Supplemental SWEIS, as originally proposed. This SWEIS includes analysis of a Reduced Operations Alternative to assess the impacts of continued operation of LANL, with certain facilities operating at lower levels. Two alternatives that were suggested for inclusion in the new SWEIS are not analyzed. A "true No Action Alternative," understood to mean a cessation of LANL operations, is not included, nor is a distinct "Greener Alternative." The reasons these alternatives were considered and dismissed from further evaluation are discussed in Chapter 3, Section 3.5.

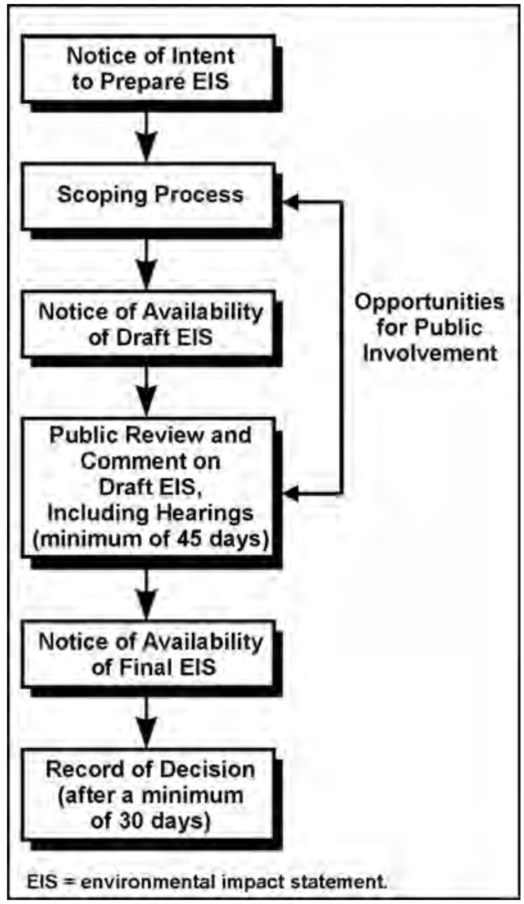


Figure 1–4 National Environmental Policy Act Process

Other public comments focused on ensuring that certain facilities, processes, and activities at LANL were included in the SWEIS. In general, all facilities, processes, and other activities at LANL have been included. Operation of the Biosafety Level 3 Facility is being addressed in a separate EIS; however, a summary of the potential impacts is included in the cumulative impacts section of this SWEIS.

A range of comments on environmental changes since the release of the *1999 SWEIS* were also received, including general questions on New Mexico's drought and the impacts of the Cerro Grande Fire. Other comments stressed that the most recent environmental monitoring and hydrological data be incorporated and addressed. Chapter 4 summarizes the results of a number of studies performed following the Cerro Grande Fire to determine the impacts the fire had on the movement of contaminants. Appendix F presents a comparison of levels of environmental contamination based on composite samples of groundwater, stormwater runoff, sediments, and soil as measured over the years since the Cerro Grande Fire to similar sample results presented in the *1999 SWEIS*. In addition, the most recent publicly available environmental reports have been incorporated into the analyses of this SWEIS.

NNSA received comments from local Native American Tribes that reflected concerns related to LANL operations and human and environmental health problems in their communities. They believe health issues were not properly addressed in the *1999 SWEIS* or ROD and would like to see a more detailed analysis. NNSA believes this SWEIS conforms to the established NEPA requirements and practices for analyzing and presenting these impacts and made no specific changes in response to these comments.

Other concerns identified by commentors in the scoping process were related to analyzing the impacts of reduced air monitoring, improving the air quality and soil analysis, increasing the discussion of cleanup activities, addressing land conveyance and transfer, and questioning the scope of the accident analyses. NNSA addressed all of these topics in the Draft SWEIS and in this Final SWEIS.

Certain groups of comments from the scoping process were not included in the analysis of this SWEIS. These included comments regarding accountability of LANL management, the transfer of LANL management, worker turnover, and worker morale.

1.6.2 Public Comments on the Draft LANL SWEIS

Once the Draft EIS is completed, regulations require that it be issued publicly to obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards; appropriate State and local agencies; Native American Tribal Governments, when the effects may be on a reservation; and the public, which consists of those persons or organizations who may be interested or affected (40 CFR 1503.1).

NNSA issued a notice of availability for the Draft SWEIS in July 2006 (71 FR 38638). The formal public comment period, originally scheduled for 60 days, lasted 75 days, beginning on July 7, 2006 and ending on September 20, 2006. During this comment period, public hearings were held in Los Alamos, Española, and Santa Fe, New Mexico. In addition, Federal agencies, state and local governmental entities, Native American Tribal Governments, and the general public were encouraged to submit comments via the U.S. mail, e-mail, a toll-free telephone number, and a toll-free fax line. Approximately 1,600 comments were received. NNSA considered all comments, including those received after the comment period ended, in evaluating the accuracy and adequacy of the Draft SWEIS and to determine whether its text needed to be corrected, clarified, or otherwise revised.

Upon receipt, all comment documents (e-mail, letter, telefax, transcribed phone messages) are entered into a tracking system for management during the comment response process. The transcript from each public hearing is also entered into the system as a comment document. All comment documents are included in the Administrative Record. The text of each comment document is delineated into individual, sequentially numbered comments and responses are developed for each comment, as appropriate. A copy of each comment document, including transcripts, along with NNSA's response to each comment, is included in Volume 3, *Comment Response Document*, Section 3, *Public Comments and NNSA Responses,* of the SWEIS.

Summary of Major Issues

Several topics raised by public comments on the Draft SWEIS are of broad interest or concern, or require a detailed response. The following discussion presents a summary of these major issues and NNSA's responses. Many of these issues are presented in more detail in the Comment Response Document, Section 2, *Major Issues*, of the SWEIS.

Opposition to Nuclear Weapons and Pit Production *– Commentors expressed general opposition to nuclear weapons and pit production. Nuclear weapons are seen as unnecessary, immoral, unethical, and violating international nonproliferation treaties, and should be eliminated. Some commentors also called into question the need for pit production because of the apparent long life of plutonium pits.*

NNSA acknowledges that there is wide-spread opposition to the production of nuclear weapons and their components; however, nuclear deterrence will continue to be an important element of national security policy for the foreseeable future. LANL's national security responsibilities are to support NNSA's core mission which includes ensuring a safe and reliable nuclear stockpile; a cessation of these activities would be counter to national security policy as established by the Congress and the President. Therefore, as discussed in Chapter 3, Section 3.5, ending these activities at LANL is not considered in the SWEIS. Maintaining an existing nuclear weapon stockpile for safety and security reasons is not in violation of any current nonproliferation treaty to which the United States is a signatory. Stockpile stewardship capabilities at LANL are currently viewed by the United States as a means to further the Nation's nonproliferation objectives. Continued confidence in the Nation's nuclear stockpile capabilities is likely to remain important in arms control negotiations as the size of the stockpile continues to be reduced in accordance with international treaties. Regarding pit lifetime, NNSA reviewed pit lifetime studies and concluded that the degradation of plutonium in the majority of nuclear weapons will not affect warhead reliability for a minimum of 85 years; however, the production rate of 80 pits per year analyzed in this SWEIS provides a bounding scenario and would, if implemented, give NNSA flexibility to meet current security needs.

NEPA Process *– Commentors expressed a variety of concerns related to the implementation of the NEPA process for the LANL SWEIS, including an inadequate scoping process, inadequate time to review the Draft SWEIS, inadequate timing and number of public hearings, lack of availability of references for public review, and the need to include not-yet completed technical studies.*

In implementing the NEPA process, NNSA provided reasonable opportunities for the public to provide input, including a scoping period following issuance of an NOI and a comment period following publication of the Draft SWEIS. NNSA announced a scoping period and scoping meeting based on the plans to prepare a supplement to the *1999 SWEIS*. Subsequently, NNSA determined that it would prepare a new SWEIS rather than a supplemental SWEIS, consistent with the sentiment expressed in some scoping comments. NNSA believes that the scoping comments apply equally to a supplement to the previous SWEIS or to a new SWEIS. For review of the Draft SWEIS, NNSA originally provided for a 60-day comment period; in response to requests for additional time, the comment period was extended by 15 days for a total of 75 days. The number and location of public hearings was consistent with prior public outreach for LANL

NEPA documents; in addition, all public announcements regarding the Draft SWEIS identified a number of other means by which the public could provide comments (U.S. mail, e-mail, fax, or toll-free phone message). References used in the Draft SWEIS were available to the public in reading rooms in Los Alamos, Santa Fe, and Albuquerque, New Mexico, also consistent with past practices. Commentors noted that the Draft SWEIS had referenced a draft public health assessment prepared by the Agency for Toxic Substances and Disease Registry; this study has since been finalized and is reflected in the Final SWEIS. Other concerns were that updates to seismic hazards analysis and the TA-54 Area G performance assessment should be included in the SWEIS. To the extent possible, the most recent technical documents, including an update to the seismic hazard analysis, completed in 2007, are considered in the Final SWEIS analyses. Information under development that is not available for use in the Final SWEIS, such as the updated Area G performance assessment, will be considered as it becomes available. In accordance with the NEPA process, the SWEIS impact analyses will be reviewed and supplemented as necessary in response to new information.

Alternative Missions *– Commentors suggested changing LANL's mission of supporting stockpile stewardship activities to another, non-weapons related mission. Examples of alternative missions suggested by commentors include development of renewable resources including solar, wind, and biomass; development of environmental cleanup technologies; addressing global climate change; development of the use of hydrogen fuel cells; and development of anti-terrorism and nonproliferation tools.*

As indicated above, the purpose of the continued operation of LANL is to provide support for NNSA's core mission as directed by the Congress and the President, which includes maintaining a safe and reliable nuclear weapons stockpile. A cessation of these activities would be counter to national security policy and therefore, is not considered in the SWEIS. Certain of the research areas identified by commentors are currently performed at LANL and therefore are part of the No Action Alternative. These research activities, including research related to national health issues, waste minimization, and environmental issues, and international nuclear safety, would continue to be conducted regardless of the alternative selected.

Modernization of the Nuclear Weapons Complex *– Commentors requested to delay completion of the LANL SWEIS until the Complex Transformation SPEIS is completed because it has a broader view of the need for, and level of, pit manufacturing. Comments also included requests to address environmental impacts from implementation of the Reliable Replacement Warhead Program in this SWEIS since reliable replacement warheads would be produced at TA-55 within the next 5 years. Commentors also requested the removal of references to a modern pit facility from the SWEIS.*

This LANL SWEIS focuses on continuing site-specific activities and new projects that may be initiated within about 5 years at LANL, whereas the *Complex Transformation SPEIS* addresses programmatic issues of modernization and consolidation of the nuclear weapons complex over a much longer timeframe and across the nuclear weapons complex. As such, the timing of and analyses in the LANL SWEIS are largely independent of the *Complex Transformation SPEIS*. An exception is the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. In conjunction with its Complex Transformation planning, NNSA is reconsidering its previous decision to construct this facility. Regarding the analysis of environmental impacts from producing reliable replacement warheads, the alternatives analyzed in this SWEIS are independent of any decision to produce a reliable replacement warhead. Capabilities such as production of plutonium components are required regardless of such a decision. If a reliable replacement warhead is approved by the President and funded by the Congress as part of a national strategy for providing a nuclear deterrent, it would enable a shift to production that requires fewer hazardous operations. The environmental impacts analyzed in the LANL SWEIS are based on the existing stockpile stewardship program and corresponding life extension programs. Since the reliable replacement warhead design is expected to reduce the use of radioactive and hazardous materials, analysis of the current stockpile should reasonably bound the potential impacts of the reliable replacement warhead if it goes into production.

When NNSA announced its intent to prepare the *Complex Transformation SPEIS*, it also announced cancellation of proposals to construct a modern pit facility. Consequently, analyses in this SWEIS no longer include a modern pit facility in the cumulative impacts analysis.

***Water Resources** – Commentors expressed concern about the impacts of LANL operations on groundwater in the regional aquifer and surface water in the Rio Grande, and consequently, the safety of the drinking water to local and downstream users.*

Monitoring of groundwater has been performed at LANL for many decades and at numerous locations within and around LANL. The locations include springs, drinking water supply wells, shallow monitoring wells, intermediate-depth monitoring wells, and a variety of different monitoring well types for the regional aquifer. LANL, in consultation with the New Mexico Environment Department, will continue a phased approach to determining which wells are needed and in what locations to satisfy long-term monitoring needs. The information presented in the SWEIS relies on the best information available, and primarily on data from the types of wells and screens that have high quality results. Some contaminants are present onsite at levels above applicable standards and guidelines. Elevated levels are investigated to confirm the validity of the results, determine the source and extent of the contamination, and evaluate needed control and cleanup technologies. Confusion regarding the presence of contaminants in samples caused by the presentation of data in Appendix F of this SWEIS has been addressed by better explaining the purpose, development, and use of the data and contrasting them with the data on detected contaminants reported in the annual LANL environmental surveillance reports. There have been concerns regarding neptunium-237 in the regional aquifer. The values of neptunium-237 listed in Appendix F reflect the conservative statistical interpretation of the analyses. The minimum detectable activity for this radioisotope was found to be greater than the reported values using laboratory gamma spectrometry analytical methods. This indicates that neptunium was not present, and that the results were an artifact of the analytical method. An alternate analytical method, alpha spectrometry, has been shown to have a significantly lower minimum detection level for neptunium-237 and was used to measure groundwater samples in and around LANL in 2006. The results of these environmental sample measurements to date have shown no neptunium-237 present in regional aquifer groundwater. Plutonium-239, plutonium-240, and strontium-90 have been detected in samples from Los Alamos water supply wells taken on only one or two dates, indicating an error by the analytical laboratory. This conclusion was confirmed by reanalysis of numerous samples and contradictory results from field and laboratory duplicate samples.

Remediation of water resources containing or potentially containing contaminants is carried out consistent with DOE and external regulatory requirements. For example, the 2005 Consent Order requires investigations to fully characterize the nature, extent, fate, and transport of contaminants subject to the Consent Order that have been released to surface water, groundwater, and other environmental media. Following the investigations, corrective measures are evaluated, proposed, authorized, and implemented as needed, to meet quantitative surface water and groundwater cleanup levels prescribed in Section VIII of the Consent Order.

Sampling in 2005 and 2006 indicates that chromium contamination is present in the regional aquifer in a limited area beneath Sandia and Mortandad Canyons and in perched groundwater beneath Mortandad Canyon. Chromium contamination was not detected in water-supply wells. The LANL contractor has prepared an *Interim Measures Work Plan for Chromium Contamination in Groundwater* (LANL 2006d). An interim measures investigation report prepared in 2006 provides a basis for follow-on work (LANL 2006k). The report found that the main source of hexavalent chromium was chromium-treated cooling water from a TA-3 power plant at the head of Sandia Canyon during its operations between 1956 and 1972. Additional data collection from other regional groundwater monitoring wells is needed to further assess the extent of LANL-derived chromium contamination. Recommendations included additional data collection on chromium and other chemicals for use in risk assessments and the selection of corrective action remedies.

Despite the detection of polychlorinated biphenyls in stormwater runoff within the LANL site boundaries, available data show no discernible impacts on polychlorinated biphenyls concentrations in the Rio Grande.

***Offsite Contamination** – Commentors expressed concern about offsite contamination from past and proposed LANL operations. Some commentors were concerned that increased activities would lead to new contamination. They questioned increasing pit production when LANL had not controlled releases in the past. Other commentors stated concerns that contaminants could appear outside the site boundaries and affect residents of nearby communities or those living down wind or down river from LANL, and others questioned the use of 50 miles as the range for evaluating offsite impacts.*

Chapter 6 of this SWEIS describes the environmental laws and regulations that apply to LANL operations. LANL operations do result in emissions to the air and discharges of surface water, but all of these emissions and discharges are in accordance with regulations established to protect public health and safety. The LANL contractor demonstrates compliance through environmental monitoring and reporting, which includes statistical analysis and other methods to determine which results are indicative of the actual presence of a contaminant. Chapter 4 describes the current environment and presents, for resource areas with annually measurable parameters, recent data that show compliance status with regulations and permits. Compliance status is based on data contained in the annual environmental surveillance reports that are required for DOE sites and are publicly available.

Contamination in Foodstuffs

Because ingestion of foodstuffs constitutes an important pathway by which radionuclides and other contaminants can be transferred to humans, a wide variety of domestically produced edible vegetables, fruits, grains, and animal products is sampled from the area surrounding LANL and analyzed for a variety of radionuclides. These samples are used to compare the levels of radioactive and nonradioactive contaminants in foodstuffs at onsite and perimeter locations to regional levels, to determine trends over time, and to estimate the radiation doses and chemical exposures to individuals who consume them. Foodstuff monitoring in the region regularly shows no contamination resulting from LANL operations.

LANL Impact on the Rio Grande

Waters and sediments along the Rio Grande historically have shown relatively small impacts from LANL operations. All base flow samples from the Rio Grande had pollutant concentrations below drinking water standards and standards for the protection of aquatic life, wildlife habitat, and irrigation. None of the radionuclides commonly associated with LANL operations was detected, except for uranium; uranium concentrations (0.5 to 2 milligrams per liter) were consistent with naturally occurring levels in regional waters and well below the Federal drinking water standard of 30 milligrams per liter. In 2005, radionuclide concentrations in bottom sediments from the Cochiti Reservoir, the first reservoir on the Rio Grande downstream from LANL, were lower than in other post-Cerro Grande Fire years. Plutonium-239, plutonium-240, and cesium-137 concentrations showed increases for 1 to 2 years following the Cerro Grande Fire, but concentrations in 2005 were comparable with pre-fire levels. Plutonium-239 and plutonium-240 concentrations in 2005 were near or below analytical detection limits. Metals concentrations in the bottom sediments were not sufficiently different from background concentrations to warrant discussion. The residual high-explosives organic compound 2, 4-dinitrotoluene was detected in Cochiti Reservoir bottom sediments at an estimated concentration of 2.8 milligrams per kilogram, considerably below the U.S. Environmental Protection Agency (EPA) Region VI soil screening level of 120 milligrams per kilogram. This compound was not detected in earlier analyses.

Use of 50-Mile (80-kilometer) Radius Region of Influence

A 50-mile (80-kilometer) radius is commonly used in EISs because this distance has been shown to encompass the significant impacts to the public. Samples measured at varying distances from emissions sources show that the concentration of radionuclides decreases with the distance from the source.

Waste Management – *Commentors were concerned about the large quantities of wastes projected in the SWEIS, particularly for the Expanded Operations Alternative. Commentors questioned the continued generation of waste, particularly when significant legacy waste remains onsite and remediation work is incomplete; where the ultimate disposition of the waste would occur; and the impacts associated with waste storage and disposal, including the impacts from potential accidents. Commentors also questioned the continued practice of onsite disposal of low-level radioactive waste in unlined trenches, citing its impacts on water resources and a general opposition to onsite disposal.*

Although LANL has instituted a pollution prevention and waste minimization program (see Chapter 4, Section 4.9), operation of LANL in support of DOE's core missions will generate radioactive and other wastes. NNSA will continue to manage waste in a manner that minimizes environmental and human health impacts and complies with regulatory requirements and DOE policies and procedures. Mixed low-level radioactive waste and solid and chemical wastes will be shipped to offsite treatment or disposal facilities. Disposal capacity is adequate for these wastes. Low-level radioactive waste may be disposed of onsite or at offsite commercial or DOE disposal facilities, while transuranic waste will be disposed of at WIPP. Increased pit production, as analyzed in the Expanded Operations Alternative, would not result in a significant increase in the volume of waste. The primary contribution to the large increase in waste volume under this alternative would be from environmental remediation involving complete removal of buried wastes located in MDAs and other contaminated media. In this case, the transuranic waste volume projected from postulated removal of all MDAs could increase the volume beyond that assumed to come from LANL in the WIPP Supplemental EIS. Decisions about disposal of this transuranic waste, if generated, would be made within the context of the needs of the entire DOE complex. Regarding the use of unlined pits, future use of lined pits rather than unlined pits for low-level radioactive waste disposal at LANL is being evaluated as part of the required review and update of the Area G performance assessment.

Some wastes would be managed at LANL that cannot be accepted at WIPP or other currently operating and authorized disposal facilities, including commercial sealed sources containing radionuclides in concentrations exceeding the Class C limits in 10 CFR Part 61 and DOE sealed sources containing non-defense transuranic isotopes with similar characteristics. These wastes would be safely stored until they can be disposed of pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). DOE has issued an NOI to prepare an *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste* (72 FR 40135). Several options for disposal of this waste and other DOE waste having similar characteristics are being considered, including disposal at LANL.

***Water Use** – Commentors expressed concerns that implementation of the Expanded Operations Alternative would require the use of too much water and could exceed available water rights.*

Total and consumptive water use at LANL have actually decreased since 1999, in part due to water conservation efforts. DOE transferred 70 percent of its water rights for LANL, and leases the remaining 30 percent, to Los Alamos County. DOE is now a County water customer, and is billed and pays for the water it uses in accordance with a water service contract. LANL operational water demands would remain within DOE's water use target ceiling quantity. Water demands at LANL combined with the larger and growing demands of other Los Alamos County users could require up to 98 percent of the currently available water rights.

***Consent Order and Environmental Restoration** – Noting that activities to implement the March 2005 Compliance Order on Consent (Consent Order) were included only in the Expanded Operations Alternative, commentors were concerned that NNSA considered compliance with the Consent Order optional. Commentors doubted that cleanup was being addressed and thought that cleanup should be completed before NNSA contemplated increased pit production or generated additional waste at LANL.*

NNSA does not consider compliance with the Consent Order to be optional and is not linking Consent Order compliance with decisions about pit production, proposed new projects or activities, other increased operational levels, or waste generated from other LANL activities. NNSA could choose to implement the alternatives analyzed in this SWEIS either in whole, in part, or in combinations. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in this SWEIS. Chapter 2, Section 2.2.6, summarizes the progress made in environmental restoration since 1999. Appendix I analyzes options related to future cleanup actions that could be undertaken.

Depleted Uranium and the Dual Axis Radiographic Hydrodynamic Test Facility – *Commentors expressed concern about open burning of uranium and the effects this would have on air, water, soil, and human health. Some commentors mentioned that large amounts of depleted uranium have been used in the past and might remain in the environment, and that a more comprehensive monitoring program to monitor open burning and detonation sites is needed. Others questioned the use of foam and its effect on emissions.*

There are no experiments or activities at LANL that would involve the burning of depleted uranium. High explosives and explosives-contaminated materials (not including depleted uranium) are burned or detonated in accordance with a Resource Conservation and Recovery Act (RCRA) permit as a hazardous waste treatment to render the materials safe for disposal. The State of New Mexico open burning permits that would allow a variety of experiments and testing have been withdrawn. Experiments at the Dual Axis Radiographic Hydrodynamic Test Facility are subject to specific monitoring requirements. Sampling is performed to better understand the levels of contamination at the firing sites, the success of decontamination efforts, and the success of mitigation techniques that are applied to specific experiments. LANL monitoring programs are regularly reviewed and adjusted to take into account the latest trends in results. Past emission levels analyzed through the existing LANL monitoring programs and those projected in this SWEIS would not be expected to cause adverse impacts on human health or the environment. The use of aqueous foam was implemented at the Dual Axis Radiographic Hydrodynamic Test Facility to reduce the amount of particulates released. The use of foam is estimated to reduce fine particulates by 50 to 95 percent depending on the individual shot. The foam breaks down and is rinsed to a sump from which it is pumped and sent to the Radioactive Liquid Waste Treatment Facility for treatment. This additional, non-hazardous waste was included in the waste analysis in this SWEIS.

Environmental Justice – *Commentors expressed concerns about the adequacy of the Environmental Justice analysis in the SWEIS, indicating that it does not meet the requirements of Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. They also were concerned that environmental justice was not properly addressed in cumulative impacts and that the special pathways were not adequately analyzed. Some commentors took exception to statements in the SWEIS that there are no disproportionately high and adverse impacts to low-income and minority populations.*

NNSA acknowledges that different approaches can be used to assess the environmental justice impacts from continuing to operate LANL. As discussed in Chapter 5, Section 5.11, Environmental Justice, NNSA has met the objectives of Executive Order 12898 to investigate environmental justice impacts that would be potentially high and adverse and would disproportionately affect one group over another. An analysis of the radiological doses from emissions associated with normal operations at LANL to minority and low income populations and individuals was added to the Environmental Justice impacts section of the SWEIS. Under all of the alternatives the doses to members of minority populations or low-income populations were slightly less than for the members of the population that do not belong to these groups. In response to comments on the Draft LANL SWEIS, NNSA added additional discussion to Chapter 5, Section 5.13, to address the potential for environmental justice cumulative impacts. As discussed in Chapter 5, Section 5.11, and Appendix C, NNSA looked at potential exposures through special pathways as part of its human health impacts analysis. The special pathways analysis considers ingestion of native vegetation (pinyon nuts and Indian Tea [Cota]), locally grown produce and farm products, groundwater, surface water, fish (game and non-game), game animals, other foodstuffs and incidental consumption of soils and sediments (on produce, in surface water, and ingestion of inhaled dust); adsorption of contaminants in sediments through the skin; and inhalation of plant materials. Even considering these special pathways, NNSA did not find disproportionately high and adverse health impacts to minority or low-income populations. While NNSA recognizes commentors objections to the conclusion that the analysis in this SWEIS has not identified any disproportionately high and adverse human health or environmental impacts on minority or low-income populations under any of the actions or alternatives analyzed in the SWEIS, NNSA believes this is the correct conclusion. Chapter 5, Section 5.11, has been expanded to include more detailed discussion of the environmental justice analysis.

Comparison to Rocky Flats Plant – *Commentors oppose continued or expanded levels of pit production and associated activities at LANL, concerned that these activities would result in health and safety problems. Commentors cited past performance at the Rocky Flats Plant as being indicative of NNSA's continued and future operations, inferring that similar activities at LANL would result in similar environmental contamination and human health effects.*

A number of factors including much lower pit production levels, a heightened awareness of safety and environmental issues, newer facilities and technologies, more stringent environmental and nuclear safety regulations, a higher level of scrutiny by regulators and independent oversight organizations, and more controlled operational and management practices support the conclusion that LANL operations are not comparable to operations at the Rocky Flats Plant. The Rocky Flats Plant produced thousands of pits per year until it ceased operation in 1989. Under the SWEIS Expanded Operations Alternative, LANL would produce a maximum of 80 pits per year.

The Plutonium Facility in TA-55 is a newer facility than those at the Rocky Flats Plant. The Plutonium Facility has increased safety margins, stronger structural components, firebreaks and automatic fire suppression systems, and more automatic alarms and process controls. Specifically with respect to filtration of process emissions and the problems with the Rocky Flats design, the Plutonium Facility has implemented structural designs for fire containments, multiple stages of high-efficiency particulate air (HEPA) filtration, and firebreaks to prevent, isolate, and confine potential fires from spreading through air filtration systems, thus minimizing potential releases to the environment. Additional upgrades, repairs, and replacements of equipment and components are proposed under the TA-55 Refurbishment Project as part of the SWEIS Expanded Operations Alternative to ensure the facility safety envelope is maintained as the facility and its systems and components age.

Recommendations of the Defense Nuclear Facilities Safety Board (DNFSB) – *Commentors expressed their opinion that LANL is not in compliance with DOE and DNFSB safety regulations and recommendations; some commentors claimed that some LANL facilities are up to six years behind on preparing and submitting their safety documentation to DOE; and certain commentors stated that such lack of compliance poses an unacceptable risk to workers, the public and the environment. Commentors stated that the draft SWEIS should fully incorporate, analyze, consider, and resolve the serious safety issues raised by the DNFSB.*

The DNFSB was created by the Congress in 1988 as an independent oversight organization within the Executive Branch to provide advice and recommendations to the Secretary of Energy regarding protection of public health and safety at defense nuclear facilities. As such, the DNFSB independently oversees activities affecting nuclear safety within the nuclear weapons complex. DNFSB reviews safety issues and formally reports its findings and recommendations to the highest levels of NNSA regarding the safety of nuclear weapons complex facilities. Procedures are in place for NNSA to review and respond to DNFSB recommendations, and to implement recommendations at the sites as appropriate. NNSA and the LANL contractor have reviewed DNFSB reports and responded with commitments to update and improve safety basis documentation. The Los Alamos Site Office Safety Authorization Basis Team assures the development and approval of adequate controls to support operations at LANL in a safe manner. LANL nuclear facility operations are authorized and approved by NNSA based on its evaluation of the acceptability of existing relevant safety documentation.

The environmental impacts of potential accident scenarios, including accidents caused by human error during the performance of high hazard operations, as well as from other types of initiating events, are analyzed in the SWEIS. Safe operation is an intrinsic part of the activities proposed and analyzed in the SWEIS. Nonetheless, NNSA identifies possible operational accidents, natural events, or intentional destructive acts and analyzes their impacts of as part of the NEPA process so that this information is available to NNSA in deciding whether to proceed with a proposed action. NNSA has recently revised its oversight practices at LANL to increase the focus of its resources on nuclear safety and security.

Plutonium Inventory Discrepancies – *During the scoping process and again during the review of the Draft LANL SWEIS, commentors contended that there were historical differences in plutonium inventories, leading to the conclusion that there was a loss of control of the plutonium materials and that inventory systems were inaccurate.*

The issue of historical differences in the plutonium inventories has been raised previously. DOE addressed this issue in a 1996 report that notes there are differences in the quantity of plutonium according to the accounting books and the quantity measured by a physical inventory.[13] The report explains that inventory differences are primarily due to various measurement uncertainties

[13] In 1996 DOE issued the report Plutonium: The First 50 Years (DOE 1996). This report notes that there are differences in the quantity of plutonium according to the accounting books and the quantity measured by a physical inventory. It explains that "inventory differences are not explained as losses but are explained as follows: (1) high measurement uncertainty of plant holdup (plutonium materials remaining in process tanks, piping, drains, ventilation ducts, and other locations); (2) measurement uncertainties because of the wide variations of material matrix; (3) measurement uncertainties due to statistical variations in the measurement; (4) lack of measurement technology to accurately measure material; (5) measurement uncertainties associated with waste due to material concentration and matrix factors; (6) unmeasured material associated with accidental spills; and (7) recording, reporting, and rounding errors."

(DOE 1996). More recently, NNSA addressed allegations of plutonium discrepancies at LANL. The letter responding to this issue states that "the apparent discrepancy is related to the different tracking and reporting procedures for site security and waste management organizations." The letter concludes that "because of the differences between the tracking and reporting of the site security and waste management organizations, comparisons of the information contained in these two systems cannot be used to draw conclusions concerning the control and accountability of special nuclear material" (NNSA 2006a).

1.7 Changes from the Draft Environmental Impact Statement

In preparing the Final LANL SWEIS, NNSA made revisions in response to comments received from other federal agencies, state and local government entities, Native American Pueblos, and the public. In addition, the SWEIS was changed to provide additional environmental baseline information, include additional analyses, correct inaccuracies and make editorial corrections, and clarify text. NNSA also updated information due to events or notifications made in other documents since the Draft SWEIS was provided for public comment in July 2006. The following summarizes the more important changes made to the SWEIS.

Incorporation of the Updated Environmental and Other Information

Information was updated in the Final SWEIS to reflect the most recent environmental data from *Environmental Surveillance at Los Alamos during 2005 (*LANL 2006h) and information from the 2005 SWEIS Yearbook (LANL 2006g). Data from these reports were incorporated into Chapters 2, 3, 4, and 5 as well as certain appendices. Resource areas most affected include air emissions and water discharges, human health, infrastructure (including electrical and water usage), and waste management. Other new information incorporated into the SWEIS analyses include a biological assessment, an update to the seismic hazard analysis, and new NMED stream water quality standards.

Appendix F was revised to more clearly indicate the purpose and use of the data included and how they relate to the information reported in annual environmental surveillance reports. The data analysis in Appendix F is for the purpose of providing perspective relative to similar data presented in the *1999 SWEIS* and for use in SWEIS impacts analyses. Affirmed detection of contaminants in the environment is presented in the LANL environmental surveillance reports. Appendix F was updated to include an additional year of radionuclide measurements in environmental media in and around LANL. In addition, Appendix F discusses the monitoring results for nonradiological chemicals that are part of the LANL environmental surveillance program. Information on nonradiological contaminants for the period of 2001 through 2005 has been provided for hexavalent chromium, 1,4-dioxane, and polychlorinated biphenyls. In addition, the perchlorate environmental surveillance information was updated to include the results from the most recent year of reporting.

Chapter 5, Section 5.8.2.3 was updated to include 2005 water use data in the trend analysis. The projected demand on available water rights administered by Los Alamos County decreased from 101 percent to 98 percent, leading to the conclusion in the Final SWEIS that the water rights would not be exceeded if the Expanded Operations Alternative were implemented. A more detailed discussion regarding water use is provided in Chapter 4, Section 4.8.2.3.

Presentation of Impacts from Consent Order Activities

The summary of impacts in Chapter 3 has been revised to more readily show the impacts associated with activities necessary to comply with the Consent Order. Under the Expanded Operations Alternative, in addition to showing the impacts for the entire alternative, where practical, the impacts from implementing the Consent Order have been shown separately and could be added to each alternative; the impacts for the balance of the Expanded Operations Alternative are also shown. This presentation of the impacts makes it possible for a reader to see how alternatives compare without the influence of Consent Order activities and reinforces the idea that the NNSA can select all or part of the Expanded Operations Alternative; however, NNSA does not consider compliance with the Consent Order to be optional.

Environmental Justice

The Environmental Justice analysis in Chapter 5 was expanded to include radiological doses from LANL operations for the following populations within 50 miles (80 kilometers) of LANL: white (non-Hispanic), all (total) minorities, American Indians, Hispanic of any race, and low-income populations. These data show that the total minority, American Indian, Hispanic, and low-income populations would not be subjected to disproportionately high and adverse dose impacts from operations at LANL.

Removal of References to a Modern Pit Facility

References to a modern pit facility in the Draft LANL SWEIS were made in the context of ensuring that reasonably foreseeable future actions were addressed in accordance with the CEQ NEPA regulations regarding cumulative impacts. In October 2006, NNSA issued an NOI to prepare the *Complex Transformation SPEIS*. In addition to announcing its intent to prepare an assessment of the environmental impacts from the continued transformation of the nuclear weapons complex, NNSA announced cancellation of the previously planned *Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (DOE/EIS-236-S2). Therefore, the Final LANL SWEIS does not include a modern pit facility in the discussion of cumulative impacts in Chapter 5, Section 5.13.

Accident Analyses

The accident analysis has been revised to account for 2006 updates to accident scenarios for certain nuclear facilities that resulted in higher consequences and risks than the previous scenarios. Revising the accident analysis also addressed a comment received regarding an accident scenario involving a fire in the Plutonium Facility Complex. Details of the revised scenarios are included in Appendix D. The new accident scenarios were for the Radioassay and Nondestructive Testing Facility, the Waste Characterization, Reduction, and Repackaging Facility, and the Plutonium Facility Complex. The new accident scenarios included one scenario for each of the individual facilities, two scenarios involving the Waste Characterization, Reduction, and Repackaging Facility and the Plutonium Facility Complex during a seismic event, and one scenario involving the Waste Characterization, Reduction, and Repackaging Facility in the event of a wildfire. Relevant results of these new accident scenarios are reported in Chapter 5, Section 5.12.

The discussion of the site-wide seismic accidents was revised to account for new information from the updated seismic hazard analysis (LANL 2007a). The new study indicates that the seismic hazard is higher than previously understood; that is, the likelihood of earthquakes capable of producing strong ground shaking at the LANL site is greater than previously estimated. This would result in changes to the maximum risks to the maximally exposed individual (MEI), the noninvolved worker and the offsite population under the two seismic accidents.

Terrorism

The SWEIS has been revised to more fully address the issue of terrorism. Chapter 4, Section 4.6 has been expanded to include a description of the safeguards and security that are in place at LANL to protect facilities and special nuclear materials from malevolent acts. Chapter 5, Section 5.12, has been revised to include a discussion of the process of assessing vulnerabilities of facilities to hostile acts. These vulnerability assessments guide the enhancement of safeguards and security at the site. A classified appendix to the SWEIS assesses the potential impacts of terrorist acts.

Transportation Analysis

The transportation analysis was revised to address three specific areas. Responding to comments expressing concerns regarding increased pit production, the SWEIS transportation analysis was revised to provide a clearer distinction between the shipment requirements for production rates of 20 and 80 pits per year. In addition, the impact analysis was revised to bound the impacts of transporting uranium-233 between Oak Ridge National Laboratory and LANL and between LANL and the Nevada Test Site in support of the criticality safety program. A unit basis transportation impacts assessment is also included in Appendix J to provide a basis for assessing impacts of the future transport of sealed sources to and from LANL in support of the Off-Site Source Recovery Project.

Alternatives for Upgrading the Radiography Facility

The Appendix G, Section G.6, project-specific analysis for providing a radiography facility in TA-55 has been revised to remove any options that considered use of all or part of the previous Nuclear Materials Storage Facility (Building 55-41). Based on evaluations of the structure of Building 55-41, a determination was made that extensive and costly structural upgrades to the building to bring it into compliance with requirements for managing special nuclear material would be needed – roof panel members would need to be replaced and other structural components would need to be repaired, replaced, or reconfigured. This structure was never used for storage of nuclear materials and a determination was made in 2006 to demolish the structure. As an uncontaminated structure, the resulting demolition debris could be reused as fill or sent to a solid waste landfill. In addition to the no action option, Section G.6 analyzes an option of constructing a new radiography facility in TA-55.

Location of the Proposed TRU Waste Facility

The impacts analysis included in Appendix H, Section H.3, Waste Management Facilities Transition, has been revised with respect to the TRU Waste Facility. The function of the facility would primarily be to support operations at the Plutonium Facility Complex, including managing transuranic waste from the Radioactive Liquid Waste Treatment Facility. Therefore, a number of locations along the west end of the Pajarito Road corridor near the waste-producing facilities are being considered. The analysis has been revised to evaluate the impacts of a range of locations in the TAs along Pajarito Road. For certain resource areas such as human health impacts, releases from normal operations, and facility accident impacts, analyses account for the largest impacts that would be expected. For other impacts that would be more site specific such as land use, visual impacts, and effects on ecology and cultural resources, the analyses distinguish among the group of TAs being considered.

Revision of the Reduced Operations Alternative

The Reduced Operations Alternative and impacts analyses were revised to include a possible reduction in scope of the Chemistry and Metallurgy Research Replacement Facility as described in the 2003 *CMRR EIS* and NNSA's subsequent 2004 ROD (69 FR 6967). The Chemistry and Metallurgy Research Replacement Facility would be limited to the construction and operation of the radiological laboratory, administrative offices, and support facility building. The decision whether to construct the nuclear facility portion will be postponed until completion of the *Complex Transformation SPEIS*. Under this scenario the existing Chemistry and Metallurgy Research Building would continue to operate beyond 2010 to provide analytical chemistry and materials characterization research and development activities.

1.8 Content of this New Site-Wide Environmental Impact Statement

As indicated in earlier sections of this chapter, the body of this SWEIS focuses on the rollup of past and future operational impacts and tiers from the *1999 SWEIS*. Information used in the SWEIS analyses also tiers from *LANL SWEIS Yearbooks* prepared for the years 1998 through 2005 to track LANL operational impacts. The *SWEIS Yearbooks* are published annually to compare impact projections from the *1999 SWEIS* with actual operations data. The purpose of the *Yearbooks* is to provide facilities and upper management at LANL with a guide for evaluating whether activities are expected to remain within the SWEIS operating envelope, and to facilitate the preparation of this SWEIS, subsequent 5-year review impact analyses, and other NEPA compliance reviews. Additional LANL documents and information sources identified and discussed in detail later in this SWEIS have also been used to support the review of LANL operational impacts. These data sources include *LANL Environmental Surveillance Reports*, LANL site planning processes, various studies and reports generated for the environmental restoration activities at LANL, information from the post-Cerro Grande Fire recovery efforts, and similar sources of information. Various NEPA reviews for proposed LANL actions that have been categorically excluded or were analyzed through EAs and EISs have resulted in actions undertaken since 1999 or in commitments for project implementation over about the next 5 years. These NEPA reviews were also used to identify past and projected operational changes and environmental impacts. A list of the pertinent EAs and EISs affecting LANL operations is provided in Section 1.5.

Chapter 2 of this SWEIS contains summary descriptions of changes at the site and its facilities and facility performance in implementing the 1999 ROD for continuing operations at LANL. Chapter 2 also includes updates and recharacterizes the status of the facilities and their activities that were first identified in the *1999 SWEIS* to establish a comprehensive LANL site operations baseline for the impact analyses presented later in this SWEIS. This chapter also sets the stage for the impacts analyses in this new SWEIS by comparing LANL operational impacts since 1999 to the projected operational impacts in the *1999 SWEIS*. This comparison of projected and actual impacts provides a benchmark for understanding the percentage of total impacts that have already occurred in those instances where impacts were aggregated for the full 10-year period of interest.

Chapter 3 presents the alternatives analyzed in this SWEIS along with projections of LANL operations for the No Action and Action Alternatives, thereby further defining the alternatives for the reader. A summary of the impacts associated with each alternative is also presented in this chapter.

Chapters 4 and 5, respectively, describe the affected environment at LANL as it appears today and the environmental consequences of continued LANL operations. Environmental consequences are addressed under natural and cultural resource topics for both the No Action and the Action Alternatives. They include the following resource areas:

- Land use and visual resources;
- Geology and soils, including paleontological resources;
- Water resources, including surface and groundwater – this includes updating information on the understanding of the groundwater regime;
- Air quality and noise;
- Ecological resources, including terrestrial resources, wetlands, aquatic resources, and threatened and endangered species;
- Radiological and hazardous chemical impacts on human health during routine normal operations and accidents;
- Cultural resources, including archaeological resources, historic buildings and structures, and traditional cultural properties;
- Socioeconomics, including regional economic characteristics, demographic characteristics, housing and community services, and local transportation;
- Site infrastructure;
- Waste management and pollution prevention;
- Transportation;
- Environmental justice.

In addition to these areas, Chapter 5 addresses cumulative impacts, mitigation, unavoidable impacts, irreversible and irretrievable commitment of resources, and impacts on long-term productivity.

The remaining chapters contain supporting information. Chapter 6 of this SWEIS updates information on applicable laws, regulations, other similar requirements and consultations. Chapters 7, 8, and 9 provide a list of references, the glossary, and an index, respectively. The list of preparers and the SWEIS distribution list are presented in Chapters 10 and 11.

As already discussed, Appendix A to this SWEIS contains the full text of the LANL SWEIS ROD issued in 1999 and the *Federal Register* NOI to prepare the Supplemental SWEIS; it also contains the Notice of Availability for the Draft LANL SWEIS, the notice of comment period extension, and the NOI for preparing the *Complex Transformation SPEIS* (then called the *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement – Complex 2030)*. Appendices B, C, and D, respectively, discuss the methodologies used to assess air quality impacts, human health impacts anticipated from normal operations, and projected impacts from facility accidents. Appendix E updates information on groundwater in the vicinity of LANL, and Appendix F updates information on environmental contamination in a manner that allows comparison to similar information in the *1999 SWEIS*. Appendices G through J provide detailed project-specific information and impact analyses for the projects listed previously as part of the Expanded Operations Alternative. Appendix K presents the methodology and results of the transportation analyses, and Appendix L describes types of activities that are routinely conducted at LANL and are categorically excluded from the need for an EA or EIS.

Volume 3 is the Comment Response Document for this LANL SWEIS. Section 1 of Volume 3 provides an overview of the Draft SWEIS public comment process. Section 2 identifies the major issues from the public comments and NNSA responses. Section 3 shows the public comment documents with the individual comments delineated and corresponding NNSA responses in a side-by-side format. Section 4 presents the references for this volume.

Chapter 2
Los Alamos National Laboratory Activities and Facilities Update

2.0 LOS ALAMOS NATIONAL LABORATORY ACTIVITIES AND FACILITIES UPDATE

This chapter provides an updated description of the activities and facilities at Los Alamos National Laboratory (LANL) and how they may have changed or been modified since publication of the *Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE/EIS-0238) (DOE 1999a).

The *1999 SWEIS* described ongoing activities and facilities at LANL, focusing on 15 Key Facilities that housed operations which had a potential to cause significant environmental impacts, were of most interest or concern to the public, or were subject to change as a result of programmatic decisions. Since publication of the *1999 SWEIS*, several new facilities (including one new Key Facility) have been constructed, and a major wildfire (the Cerro Grande Fire of 2000, which burned approximately 7,700 acres [3,110 hectares] within LANL boundaries) has altered baseline environmental conditions at LANL, among other changes.

Chapter 2 describes the changes that have occurred at LANL since publication of the *1999 SWEIS*, highlighting the major physical and operational changes that have occurred to the overall LANL site, as well as the 49 individual Technical Areas (TAs), 15 Key Facilities, and several important non-Key Facilities. Discussions of changes to the Key and non-Key Facilities include addressing each facility's performance in implementing the *1999 SWEIS* Record of Decision (ROD) and other changes that have occurred since the publication of the *1999 SWEIS*.

Technical Area (TA)

Geographically distinct administrative unit established for the control of LANL operations. There are currently 49 active TAs; 47 in the 40 square miles of the LANL site, one at Fenton Hill, west of the main site, and one comprising leased properties in town.

Chapter 2 describes activities and notable changes at the site-wide level, TA level, and Key Facility level, as appropriate, and is organized as follows. At the site-wide level, Section 2.1 presents an overview of activities, and Section 2.2 describes site-wide changes that have occurred at LANL since publication of the *1999 SWEIS*. At the TA and Key Facility level, Sections 2.3 and 2.4 describe changes that have occurred within the 49 TAs and 15 Key and other important non-Key Facilities. Section 2.5 presents an overview and summary assessment of actual impacts compared to impact projections made in the *1999 SWEIS*. The chapter and this section conclude with a summary comparison table of actual impacts and performance changes by resource or impact area to projected modified Expanded Operations Alternative impacts that were presented in the *1999 SWEIS* (in the ROD, the U.S. Department of Energy [DOE] selected the Expanded Operations Alternative, but modified the level of plutonium pit production from 50 pits per year to 20 pits per year). The table also includes a brief performance assessment by each resource or impact area of whether actual impacts have exceeded or fallen within those projected in the *1999 SWEIS*.

This chapter also sets the stage for the impacts analysis included in this new Site-Wide Environmental Impact Statement (SWEIS) by comparing LANL's operational impacts since 1999 to the operational impacts projected in the *1999 SWEIS*. This comparison of projected and actual impacts provides a benchmark for understanding the percentage of total impacts that has already occurred in those instances where impacts were aggregated for the full 10-year period of interest. In addition, this chapter updates and recharacterizes the status of the Key Facilities and activities that were first identified in the *1999 SWEIS* to establish a comprehensive LANL site operations baseline for the impact analyses presented in Chapter 5 of this SWEIS.

2.1 Overview of Los Alamos National Laboratory Activities Since Publication of the *1999 SWEIS*

Research and development activities are dynamic by their very nature, and continual change within the limits of facility capabilities, authorizations, and operating procedures is normal. All facilities at LANL, including those that are proposed, under construction, preoperational, operational, or idle, have been categorized according to hazards inherent to their actual operations or planned use. The following sections examine how these activities and facilities have changed since publication of the *1999 SWEIS*, particularly their unique associated hazards.

LANL Facilities: A Framework for Analysis

As of September 2005, LANL had more than 2,000 structures with approximately 8.6 million square feet (800,000 square meters) under roof, spread over approximately 40 square miles (25,600 acres [10,360 hectares]) (104 square kilometers) of land owned by the U.S. Government and administered by DOE and the National Nuclear Security Administration (NNSA). Most of LANL is undeveloped to provide a buffer for security, safety, and expansion possibilities for future use. Approximately half of the square footage at LANL is considered laboratory or production space; the remaining square footage is considered administrative, storage, service, and other space.

An analysis of potential environmental impacts of future operations at LANL requires detailed knowledge of the specific activities occurring at specific sites over a known span of time. This knowledge enables a careful, detailed projection of the potential effects of these activities on the surrounding environment. In order to present a logical, comprehensive evaluation of the potential environmental impacts at LANL, the *1999 SWEIS* developed a framework for analyzing the types and levels of activities performed across the entire site. This framework assisted in analyzing the impacts of activities in specific locations (TAs) and the impacts related to specific programmatic operations (Key Facilities and capabilities). The following sections will use this framework to describe the current status of the LANL TAs and Key Facilities and to identify the capabilities existing within each Key Facility. The focal point for impact analysis throughout this new SWEIS is the level of operations related to each capability within the LANL Key Facilities. Fifteen Key Facilities were identified in the *1999 SWEIS* that were determined to be critical to meeting LANL's mission assignments and that: (1) housed operations that have a potential to cause significant environmental impacts, or (2) were of most interest or concern to the public (based on comments in the SWEIS public hearings), or (3) would be more subject to change than other LANL facilities because of (DOE) programmatic decisions. Subsequent chapters presented in this SWEIS will also use this framework to outline the differences among the three alternatives evaluated and their associated potential environmental impacts. The alternatives will be evaluated in terms of activity levels within the capabilities of each Key Facility. **Figure 2–1** provides a diagram of this conceptual framework.

As previously noted, this chapter describes activities and notable changes at the site-wide level; the TA level; or the Key Facility level, as appropriate. For Key Facilities, specific facility performance indicators are described, including radioactive air emissions, discharges to National Pollutant Discharge Elimination System (NPDES)-permitted outfalls, and volumes of radioactive liquid and solid wastes generated. To the greatest extent possible, projects, activities, and other changes are described in the context of Key Facilities to provide the greatest level of detail. A number of events or projects that have taken place at LANL since issuance of the *1999 SWEIS* are not tied to a Key Facility, however, and therefore are better described as either site-wide or TA-related. Projects or changes that were site-wide in nature are addressed in Section 2.2; changes that occurred in a specific TA are addressed in Section 2.3; and changes and performance indicators associated with specific Key Facilities are discussed in Section 2.4.

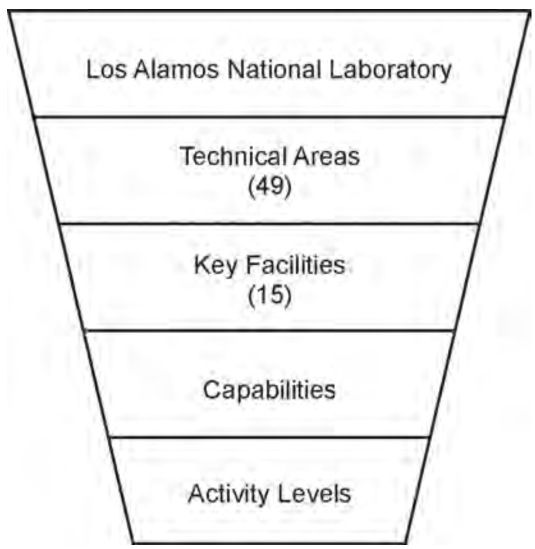


Figure 2–1 Conceptual Framework for Analysis

2.2 Site-Wide Changes at Los Alamos National Laboratory Since Publication of the *1999 SWEIS*

Major ongoing activities at LANL have been discussed in detail in *SWEIS Yearbooks* 1999 through 2005 and have been incorporated by reference. *SWEIS Yearbooks* from calendar years 1999 through 2005 provide detailed information on LANL site operations during each calendar year, and specifically address the following:

- Facility and process modifications or additions,
- Types and levels of operations during the calendar year,
- Operations data for the Key and non-Key Facilities, and
- Site-wide effects of operations for each calendar year.

The *SWEIS Yearbook – 2002* (LANL 2003h) is a special edition that was prepared to assist NNSA in evaluating the need for preparing a new SWEIS for LANL. The *SWEIS Yearbook – 2002* summarizes the data routinely collected from 1998 through 2002 and provides additional information, table summaries, and trend analyses. The *SWEIS Yearbook – 2002* also indicates LANL's programmatic progress in moving toward the projections provided in the *1999 SWEIS*.

The *1999 SWEIS* analyzed the potential environmental impacts of scenarios for future operations at LANL. The associated ROD (64 *Federal Register* [FR] 50797) was used not to predict specific operations, but to establish boundary conditions for operations. The ROD and the *1999 SWEIS* that supported it provided an environmental operating envelope both for specific facilities and for LANL as a whole. According to the ROD, if operations at LANL were to routinely exceed the operating envelope, DOE would evaluate the need for a new SWEIS. As long as overall LANL operations remain at or below the level analyzed in the *1999 SWEIS*, the environmental operating envelope remains valid. Thus, the levels of operation projected in the *1999 SWEIS* and the ROD should not be viewed as goals to be achieved, but rather as upper operational levels (LANL 2004f).

The *1999 SWEIS* and ROD projected a total of 38 facility construction and modification projects for LANL. Twenty-two projects have now been completed: six in 1998, eight in 1999, two in 2000, four in 2002, one in 2003, and one in 2004. The numbers of projects started or continued each year were 10 in 1999, 7 in 2000, and 6 in both 2001 and 2002.

A major modification project, the rerouting of effluents and elimination of NPDES outfalls, was completed in late 1999, bringing the total number of permitted outfalls down from the 55 identified in the *1999 SWEIS* to 20. During 2000, Outfall 03A-199, which serves the TA-3-1837 cooling towers, was included in the new NPDES permit issued by the U.S. Environmental Protection Agency (EPA) on December 29, 2000. This brings the total number of permitted outfalls up to 21. During 2005, only 17 of the 21 outfalls sustained effluent flows (LANL 2006g).

Each *SWEIS Yearbook* reports chemical usage and calculated emissions (expressed as kilograms per year) for the Key Facilities, based on an improved chemical reporting system. The 2004 chemical usage amounts were extracted from LANL's chemical inventory rather than from the Automated Chemical Inventory System used in the past. The quantities used represent chemicals procured or brought onsite from 1999 through 2004. Information regarding actual chemical use and estimated emissions for each Key Facility is presented in Appendix A of each *LANL SWEIS Yearbook* (LANL 2003h, 2004f, 2005f, 2006g). Additional chemical use and emissions reporting data can be found in the annual Emissions Inventory Report required by New Mexico. The most recent report is *Emissions Inventory Report Summary for Los Alamos National Laboratory for Calendar Year 2005* (LANL 2006i).

With a few exceptions, the capabilities identified in the *1999 SWEIS* for LANL have remained constant since 1999. These exceptions include:

- Movement of the Nonproliferation Training/Nuclear Measurement School, which was briefly located at TA-18 and returned to TA-3 (the Chemistry and Metallurgy Research Building) in 2004, where it will stay until the Chemistry and Metallurgy Research

Building is no longer available or until a new Security Category III and IV facility is built at TA-48 as part of the Radiological Sciences Institute's Institute for Nuclear Nonproliferation Science and Technology;

- Relocation of the Decontamination Operations Capability from the Radioactive Liquid Waste Treatment Facility to the Solid Radioactive and Chemical Waste Facilities in 2001;
- Redefinition of capabilities at the Bioscience Key Facility (formerly identified as the Health Research Laboratory Key Facility); and
- Loss of Cryogenic Separation Capability at the Tritium Key Facilities in 2001 (LANL 2004f).
- Transfer of neutron tube target loading from the Tritium Key Facilities to Sandia National Laboratories in 2006 (DOE 2003b).

In addition, following the events of September 11, 2001, the U.S. Department of Homeland Security (DHS) requested that LANL be used to support its missions. Activities undertaken at LANL for DHS are primarily the same actions that were performed for DOE prior to the reassignment of programs to DHS.

All currently operating capabilities are listed and described in detail as a part of the No Action Alternative discussed in Chapter 3 of this SWEIS. Since 1998, fewer than the 96 capabilities identified for LANL in the *1999 SWEIS* have been active. During 1998, only 87 capabilities were active. The nine capabilities with no activity were Manufacturing Plutonium Components at the Plutonium Complex; both Uranium Processing and Nonproliferation Training at the Chemistry and Metallurgy Research Building; Accelerator Transmutation of Wastes at the Los Alamos Neutron Science Center (LANSCE); Biologically Inspired Materials and Chemistry, Computational Biology, and Molecular and Cell Biology at the Bioscience Facilities; and both Size Reduction and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities (LANL 2003h).

During 1999, 91 capabilities were active. The five inactive capabilities were Fabrication and Metallography at the Chemistry and Metallurgy Research Building; both Accelerator Transmutation of Wastes and Medical Isotope Production at LANSCE; and both Size Reduction and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities (LANL 2003h).

During 2000, 88 capabilities were active. The eight inactive capabilities were Fabrication of Ceramic-Based Reactor Fuels at the Plutonium Complex; Diffusion and Membrane Purification at the Tritium Facilities;[1] both Destructive and Nondestructive Assay and Fabrication and Metallography at the Chemistry and Metallurgy Research Building; both Accelerator Transmutation of Wastes and Medical Isotope Production at LANSCE; and both Size Reduction and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities (LANL 2003h).

[1] *In these years, no research experiments were conducted on gaseous tritium movement and penetration through materials; however, the capability was used for effluent treatment.*

During 2001, 87 capabilities were active. The nine inactive capabilities were both Manufacturing Plutonium Components and Fabrication of Ceramic-Based Reactor Fuels at the Plutonium Complex; both Cryogenic Separation and Diffusion and Membrane Purification at the Tritium Facilities;[1] both Destructive and Nondestructive Assay and Fabrication and Metallography at the Chemistry and Metallurgy Research Building; both Accelerator Transmutation of Wastes and Medical Isotope Production at LANSCE; and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities (LANL 2003h).

During 2002 and 2003, 88 capabilities were active. The eight inactive capabilities were Manufacturing Plutonium Components at the Plutonium Complex; both Cryogenic Separation and Diffusion and Membrane Purification at the Tritium Facilities;[1] both Destructive and Nondestructive Assay and Fabrication and Metallography at the Chemistry and Metallurgy Research Building; both Accelerator Transmutation of Wastes and Medical Isotope Production capabilities at LANSCE; and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities (LANL 2003h, 2004f).

During 2004, 88 different capabilities remained active. The eight inactive capabilities were Cryogenic Separation at the Tritium Facilities; both Destructive and Nondestructive Assay and Fabrication and Metallography capabilities at the Chemistry and Metallurgy Research Building; Characterization of Materials at the Target Fabrication Facility; both Accelerator Transmutation of Wastes and Medical Isotope Production capabilities at LANSCE; and both Size Reduction and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities (LANL 2005f).

During 2005, 79 capabilities were active. The 17 inactive capabilities were Cryogenic Separation at the Tritium Facilities; both Destructive and Nondestructive Assay and Fabrication and Metallography at the Chemistry and Metallurgy Research Building; Characterization of Materials at the Target Fabrication Facility; Accelerator Transmutation of Wastes at LANSCE; Size Reduction and Other Waste Processing at the Solid Radioactive and Chemical Waste Facilities; Radioactive Liquid Waste Pretreatment at TA-21 or in Room 60 at TA-50; and all nine TA-18 capabilities (Dosimeter Assessment and Calibration, Detector Development, Materials Testing, Subcritical Measurements, Fast-Neutron Spectrum, Dynamic Measurements, Skyshine Measurements, Vaporization, and Irradiation) (LANL 2006g).

While there were activities under nearly all capabilities, the levels of these activities were mostly below the levels projected by the ROD. For example, the LANSCE linear accelerator generated an H-beam to the Lujan Center for 4,206 hours in 2005 at an average current of 125 microamps, compared to 6,400 hours at 200 microamps as projected by the ROD. Similarly, no criticality experiments were conducted at the Pajarito Site, compared to the 1,050 experiments projected by the ROD (LANL 2006g).

From 1999 through 2005, only three of LANL's facilities operated at levels approximating those projected in the *1999 SWEIS*: the Materials Science Laboratory, the Bioscience Facilities (formerly the Health Research Laboratory), and the non-Key Facilities. The two Key Facilities (the Materials Science Laboratory and the Bioscience Facilities) are more akin to the non-Key Facilities and represent the dynamic nature of research and development at LANL. More importantly, none of these facilities are major contributors to the parameters that lead to significant potential environmental impacts. The remaining 13 Key Facilities all conducted operations at or below projected activity levels for the modified Expanded Operations Alternative of the *1999 SWEIS* (LANL 2006g).

2.2.1 Cerro Grande Fire

The period between 1999 and 2005 saw environmental change on the Pajarito Plateau. Perhaps the most widespread and pervasive change in the region was drought. The first serious manifestation of the drought was an increase in wildfire activity in the region. The first of those wildfires was the 2000 Cerro Grande Fire, which affected buildings and the landscape at LANL. The fire burned north and east across LANL and onto San Ildefonso Pueblo property. By the time the fire was fully contained, it had consumed close to 43,000 acres (17,400 hectares), of which about 7,700 acres (3,110 hectares) (27 percent of LANL land) was on LANL property. The LANL response to the Cerro Grande Fire included burned area rehabilitation and monitoring efforts, enhanced vegetation and wildlife monitoring, and implementation of the *Wildfire Hazard Reduction Project Plan* (LANL 2001b). Additionally, several flood retention structures were constructed to minimize the danger of flooding due to the loss of vegetation and to allow the vegetation to regrow. In most areas, burned trees were removed and remaining forest was thinned to reduce the wildland fire potential and to make the forest viable and self-sustaining. The following is an overview of infrastructure changes and recovery efforts at LANL since the Cerro Grande Fire. More detailed facility-specific information is provided later in this chapter.

Across LANL, structures were destroyed by the Cerro Grande Fire or were rendered uninhabitable and needed to be replaced. Large amounts of construction and demolition debris required cleanup. High intensity fires often consume standing vegetation as well as the organic soil layers and associated seed bank. In addition, a common characteristic of high burn severity is a development of hydrophobic (water-repellent) soils. Together, these factors can lead to a potential for major runoff, soil erosion, downslope flooding, and degradation of water quality. All of these factors were considered in dealing with the effects of the Cerro Grande Fire. For further information on impacts from the Cerro Grande Fire, see Chapter 4.

The effects of the Cerro Grande Fire were minimal on the following Key Facilities: the Chemistry and Metallurgy Research Building (TA-3-29), Sigma Complex (TA-3-66), the Machine Shops (TA-3-102), Materials Science Laboratory (TA-3-1698), and the Tritium Facilities. No direct fire damage occurred, and recovery was limited to cleaning or replacement of air system filters. The Cerro Grande Fire caused notable effects on the other 11 Key Facilities. The effects of the fire on each of these Key Facilities are detailed in the facility performance portions of Section 2.4.

2.2.2 Land Conveyance and Transfer

Land use at LANL is a high-priority issue. Most of the undeveloped land is either required as buffer zones for operations or is unsuitable for development due to terrain restraints. Increases in available lands as a result of cleanup performed by environmental restoration activities and demolition of vacated buildings could affect strategic planning. To date, however, environmental restoration activities have not substantially added to the amount of land available for reuse (for further information, see Chapter 4, Section 4.1.1).

In 2002, the first congressionally mandated conveyances of land to Los Alamos County and transfer of land to the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) were accomplished. As of the end of 2006, 2,259 acres (914 hectares) have been effectively removed from LANL and made unavailable for LANL operations or use. Included are about 153 acres (62 hectares) conveyed to Los Alamos County and 2,106 acres (852 hectares) transferred to the Department of the Interior (in trust for the Pueblo of San Ildefonso). In addition, these conveyances and transfers changed LANL's boundaries (see Chapter 4, Figure 4–6). An assessment of the impacts of the boundary changes showed that the decrease in distances between postulated accident release sites and receptors would have little or no impact on the estimated public and worker doses presented in the *1999 SWEIS*. For further information on land conveyances and transfers, see Chapter 4.

2.2.3 LANL Security Enhancements

In response to the events of September 11, 2001, security at LANL was enhanced to protect personnel, property, and program projects. One security upgrade was installation of a temporary Truck Inspection Station located at the lower end of East Jemez Road. The purpose of the station is to screen all large vehicles coming into LANL to ensure they have the proper authority to be on DOE property. The station became operational in April 2002.

Another upgrade was construction of access control stations (called vehicle access portals) on Pajarito Road. Access to most of Pajarito Road is now restricted to DOE badge holders only; at least one occupant of a motor vehicle must present a valid DOE badge. Bicyclists without a valid DOE security badge are not allowed to use Pajarito Road. Walkers, joggers, work crews, and others on foot on Pajarito Road must display a valid security badge.

Under the Security Perimeter Project, access control stations were constructed on East Jemez and West Jemez Roads to screen vehicles entering TA-3. NNSA will enact a graded closure of the core area based on security levels in effect. Currently, the general public is allowed access via the East and West Jemez Road access control stations.

2.2.4 Operational Stand Down

During a July 7, 2004, special inventory associated with an upcoming experiment, two items of Classified Removable Electronic Media were discovered missing from the Weapons Physics Directorate. An immediate search did not locate the items. It was later determined that the "missing" Classified Removable Electronic Media may never have existed. In addition to these security incidents, several safety incidents also occurred at LANL, including one involving a student researcher who was injured in a laser experiment and another involving sulfuric acid. Two days later (July 16, 2004) the Director of LANL ordered a suspension of operations to allow the workforce to reaffirm its commitment to safety and security and compliance with all policies and procedures.

The resumption efforts included reviews (called management self-assessments), corrective action plans, and LANL readiness reviews. Resumption of Level 3 (high-risk) activities additionally included conduct of an independent review by NNSA. Level 1 activities (actions that present little risk to safety and security) were 100 percent resumed as of August 18, 2004. All Level 2 (moderate-risk) operations and more than 70 percent of all Level 3 (high-risk) work resumed by the end of 2004. Resumption of all activities was accomplished by the end of January 2005 (LANL 2004n).

2.2.5 Off-Site Source Recovery Project

The Off-Site Source Recovery Project has the responsibility to identify, recover, and store excess and unwanted sealed radiological sources on behalf of NNSA in cooperation with the U.S. Nuclear Regulatory Commission (NRC). From 1979 through 1999, DOE recovered excess and unwanted radioactive sealed sources containing plutonium-239 and beryllium on a case-by-case basis as requested by NRC. Since 1999, the Off-Site Source Recovery Project has assisted NNSA in managing actinide-bearing sealed sources that have been identified as potential threats to national security. Since the issuance of the *1999 SWEIS*, the Off-Site Source Recovery Project has been operating at various times at the following Key Facilities: the Chemistry and Metallurgy Research Building, the Pajarito Site, the Solid Radioactive and Chemical Waste Facility, and the Plutonium Facility Complex. DOE has determined that many of the actinide sources are eligible for disposal at the Waste Isolation Pilot Plant (WIPP) and is in the process of characterizing, packaging, and transporting them for disposal. As of February 2008, about 15,300 sources had been brought to LANL; about 3,500 of these were subsequently sent offsite for disposition.

2.2.6 Environmental Restoration Project

DOE established an environmental restoration project in 1989 to characterize and, if necessary, remediate over 2,100 potential release sites at LANL that were known or suspected to be contaminated from historical LANL operations. Many of the potential release sites remain under DOE control; however, some are located on lands that have been conveyed to Los Alamos County or transferred to private ownership. Remediation and cleanup efforts are regulated by and coordinated between the New Mexico Environment Department (NMED) and DOE. Environmental restoration activities include drafting and finalizing characterization and remediation reports, conducting characterization and remediation field work, and formal tracking of all work performed.

On May 2, 2002, NMED issued a Determination of Imminent and Substantial Endangerment to Health and the Environment, as well as a draft order compelling investigation and cleanup of environmental contamination at LANL. After receiving public comments, NMED revised its Determination and issued a final order on November 26, 2002. On behalf of DOE and the University of California (the LANL management and operating contractor at the time), the U.S. Justice Department filed a lawsuit challenging the final order. As the LANL management and operating contractor, the University of California filed a separate lawsuit. The DOE, the State of New Mexico, and the University of California subsequently negotiated a Compliance Order on Consent (Consent Order) (NMED 2005), which was issued for public comment on September 1, 2004.

The comment period for the Consent Order closed on October 1, 2004. NMED delayed finalizing the Consent Order until surface water and watershed issues were addressed in a separate Federal Facilities Compliance Act agreement under the Clean Water Act; that agreement was signed on February 3, 2005. The final Consent Order, approved by the three parties on March 1, 2005, is now the primary document recognized as defining the regulatory requirements and schedules for environmental remediation at LANL.

The Consent Order requires a site-wide investigation and cleanup to be conducted at LANL pursuant to stipulated procedures and schedules. The Consent Order also requires the installation of wells, piezometers, and other subsurface units to provide site characteristic or environmental information; the collection and investigation of sample data; and the preparation and submittal of investigative reports for various potential release sites. Following the investigation phase for a potential release site and upon a determination by NMED that corrective measures are needed to protect human health and the environment, a corrective measures evaluation report must be prepared. After NMED authorizes a corrective measure for a potential release site, the corrective measures must be implemented. Cleanup of soil, groundwater, and surface water throughout this process must meet standards documented in Section VIII of the Consent Order. Upon completing the remedy, a remedy completion report must be prepared and submitted to NMED for approval.

During 2005, LANL drafted and finalized numerous characterization and remediation plans and reports for NMED in accordance with the Consent Order, including the Interim Facility-Wide Groundwater Monitoring Plan. In addition, accelerated characterization and remediation activities were implemented at sites that could be affected by upcoming infrastructure construction projects. For example, in 2005, LANL's Canyons Project focused on investigations in Mortandad and Pajarito Canyons to evaluate the nature and extent of contamination in sediment, biota, and groundwater (among other goals). Completed characterization and remediation plans and reports are listed in the *2005 SWEIS Yearbook*, as are ongoing field activities (LANL 2006g).

Environmental restoration may generate a large amount of waste during cleanup activities, which are scattered over the entire LANL site. The *1999 SWEIS* forecast that environmental restoration activities would contribute 60 percent of the chemical wastes, 35 percent of the low-level radioactive waste, and 75 percent of the mixed low-level radioactive waste generated at LANL over the 10-year period from 1996 through 2005. The LANL environmental restoration program originally identified 2,124 potential release sites, including 1,099 potential release sites which were subsequently listed in Model VIII of the LANL Hazardous Waste Facility Permit, which was issued by EPA in March 1990, and 1,025 potential release sites that were not listed in Module VIII. Based on prior "no further action" approvals and consolidation of sites, only 829 potential release sites remained at the end of 2005. Approximately 774 units have been approved for no further action, including 146 units that have been removed from LANL's Hazardous Waste Facility Permit (LANL 2006g). Some of the major completed remediation activities are shown in **Table 2–1**. In addition, during 2005, LANL received certificates of completion (which replace the former no further action determinations) from NMED for eight sites (LANL 2006g).

Table 2–1 Major Remediation Activities Completed Since the *1999 SWEIS*

Location	*Decommissioning Activity*	*Year*
TA-16-387	Cleanup of flash pad at TA-16	2000
TA-16-394	Closure of burn tray at TA-16	2000
TA-00	Cleanup of contaminated sediments in the South Fork of Acid Canyon	2001
TA-21, TA-51, and TA-54	Characterization and removal of inactive septic tanks	2002
TA-16	MDA P clean closure	2002
TA-53	Remediation of surface impoundment at TA-53	2002
TA-3	Support for several planned construction projects	2003, 2005
TA-21	"Cold dump" cleanup	2003
TA-21	Cleanup of contaminated soils and sediments below outfall in TA-21 (SWMU-21-011 [K])	2003
TA-61	Removal of French drain at Omega West	2003
TA-33	Cleanup of a former drum storage area (SWMU 33-013)	2005

TA = technical area, MDA = material disposal area, SWMU = solid waste management unit.
Sources: LANL 1999c, 2000f, 2001e, 2002e, 2003h, 2004f, 2005f, 2006g.

Waste quantities generated since issuance of the *1999 SWEIS* ROD generally have been below the projections made in the *1999 SWEIS*, with the exception of mixed low-level radioactive waste generated in 2000 and chemical wastes generated in 2000 and 2001. Projections were exceeded in those years due to recovery efforts from the Cerro Grande Fire. In addition, in 1999, the chemical waste projections were exceeded due to disposal of extensive amounts of soil during the cleanup of material disposal area (MDA) P.

The major concern following the Cerro Grande Fire pertaining to LANL's environmental restoration activities was the threat of erosion at burned-over potential release sites and the movement of contaminants downstream. The LANL environmental restoration organization began an assessment of the 600 potential release sites within the burn area to accomplish the following:

- *Evaluate and stabilize sites touched by fire*. The Potential Release Site Assessment Team determined that over 300 potential release sites were touched by fire. Assessments for these sites were completed by May 2000, and erosion control measures (called best management practices) were needed for 91 of the 300 potential release sites. These best management practice installations were completed in July 2000, and included contour raking, placement of water barriers (straw wattles), diversion of stream channels, and other measures to divert surface water from the potential release sites (LANL 2001g).
- *Conduct baseline sampling to characterize postfire, preflood conditions (before seasonal rains) in fire-impacted watersheds*. The Contaminant Transport Team completed a Baseline Characterization Sampling Plan in June 2000. Preflood fieldwork, including collection of sediment, surface water, and alluvial groundwater samples, was completed in July 2000. Postflood fieldwork was carried out in August and September 2000, as necessary.

- *Evaluate, stabilize, or remove sites subject to flooding*. The Accelerated Actions Team identified 77 potential release sites in fire-impacted canyons that were potentially vulnerable to postfire flooding. The majority of these sites were in Los Alamos Canyon (TA-2 and TA-41) and Pajarito Canyon (TA-18 and TA-27) and included outfalls, storm drains, septic systems, and other structures (including those associated with the Omega West Reactor at TA-2). Few of the sites assessed actually required corrective actions, except for several in TA-2 where excavation, soil removal, and site restoration activities were completed during July and August 2000.

Fire rehabilitation and flood mitigation efforts are ongoing at LANL and will continue until areas prone to erosion are stabilized. Sites that had controls installed continue to be inspected and maintained as part of the LANL stormwater program (LANL 2005c).

In 2004, LANL submitted the Los Alamos and Pueblo Canyons Investigation Report to NMED to address, among other things, the results of the Cerro Grande Fire on concentrations of contaminants of potential concern in canyon media. The report found that, for contaminants released from LANL solid waste management units and areas of concern, the human health risks were below NMED's and DOE's target levels for present and foreseeable future land uses, and that adverse ecological effects had not been observed in terrestrial and aquatic systems in the watershed (LANL 2006g).

2.3 Technical Areas Changes Since the *1999 SWEIS*

LANL is divided into 49 separate TAs, including TA-0 (which comprises leased space within the Los Alamos townsite) (see **Figure 2–2**) and TA-57 at Fenton Hill. These TAs compose the basic geographic configuration of LANL. While the number of structures changes with time (there is frequent addition or removal of temporary structures and miscellaneous buildings), the current breakdown is about 952 permanent buildings, 373 temporary structures (trailers and transportables), and 897 miscellaneous structures such as sheds and utility structures. Together, these structures contain approximately 8.6 million square feet (800,000 square meters). Collectively, between 2001 and 2004, 360,000 gross square feet were removed from all TAs through a variety of funding initiatives. Structures at LANL include such constructed items as meteorological towers, water tanks, manholes, small storage sheds, and electrical transformers. Portions of LANL's resources are specialized facilities that have been built and maintained at LANL over the last 50 years. **Table 2–2** provides a brief overview of current activities conducted at each of LANL's TAs.

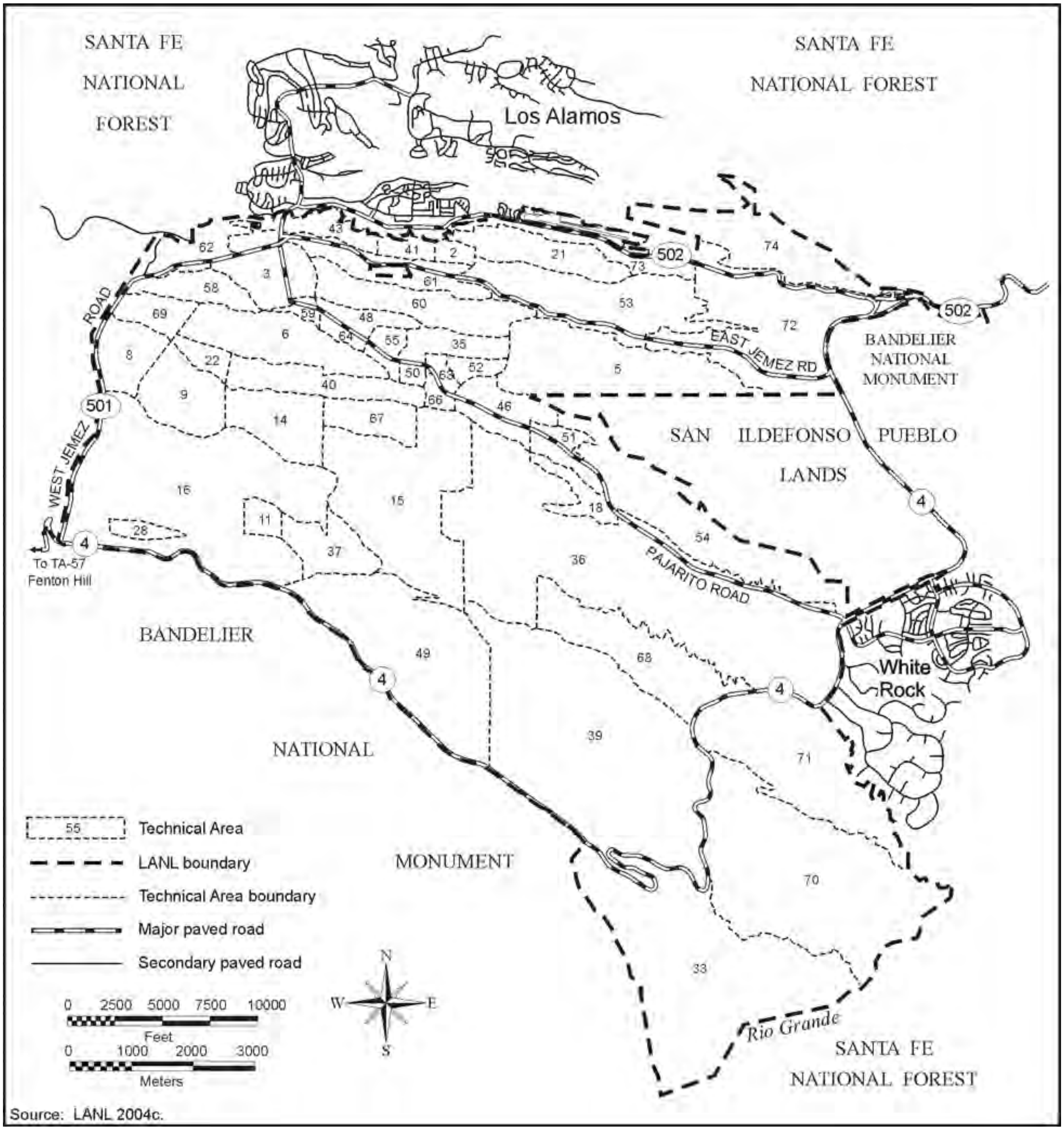


Figure 2–2 Technical Areas at Los Alamos National Laboratory

Table 2–2 Overview of Los Alamos National Laboratory Technical Areas and Activities [2]

Technical Area	*Activities*
TA-0 (Offsite Facilities)	This TA designation is assigned to structures leased by DOE and NNSA that are located outside LANL's boundaries. There are approximately 58 LANL facilities with this designation, with about 235,000 square feet (22,000 square meters) of space. The University of California and the Community Reading Room; the Bradbury Science Museum; the White Rock Environment, Safety, and Health Training Center; and other various office suites are located in the Los Alamos townsite and White Rock.
TA-2 (Omega Site or Omega West Reactor)	This TA encompasses approximately 4 acres (1.6 hectares) in Los Alamos Canyon. It once contained a building that housed an 8-megawatt nuclear research reactor, the Omega West Reactor. The reactor and all support buildings and ancillary structures have been demolished.
TA-3 (Core Area or South Mesa Site)	This TA is LANL's main TA, housing approximately half of LANL's employees and total floor space. It is the entry point to LANL, and is located on South Mesa. It houses most of the administrative and public access activities, as well as a mixture of laboratory activities including experimental sciences, biological work, work with special nuclear material, materials synthesis, metallic and ceramic processing and fabrication, theoretical and computational research and physical support operations. TA-3 contains major facilities such as the Chemistry and Metallurgy Research Building; the Sigma Complex; the Machine Shops; the Materials Science Laboratory; the Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center); and the Los Alamos Research Park. The Chemistry and Metallurgy Research Building capabilities will be moved to TA-55 as a part of the Chemistry and Metallurgy Research Building Replacement Project. It is also the location proposed for operating the existing Biosafety Level 3 Facility.
TA-5 (Beta Site)	This largely uncleared TA is located between East Jemez Road and the San Ildefonso Pueblo and contains physical support facilities, an electrical substation, test wells, several archaeological sites, and environmental monitoring and buffer areas.
TA-6 (Two-Mile Mesa Site)	Located in the northwestern part of LANL, this TA is mostly undeveloped and contains a meteorological tower, gas cylinder staging buildings, and aging vacant buildings that are awaiting authorization for disposal.
TA-8 (GT-Site [Anchor Site West])	This TA, located between West Jemez Road and Anchor Ranch Road, is a testing site where all modern nondestructive dynamic testing techniques are maintained to ensure the quality of materials in items ranging from test weapons components to high-pressure dies and molds. The principal techniques used at this site include radiography (x-ray machines with a potential of up to 1,000,000 volts and a 24-megaelectronvolts betatron), radioisotope techniques, ultrasonic and penetrant testing, and electromagnetic test methods.
TA-9 (Anchor Site East)	This TA is located on the western edge of LANL. Fabrication feasibility and the physical properties of explosives are explored at this site, and new organic compounds are investigated for possible use as explosives. Storage and stability problems are also studied.
TA-11 (K-Site)	TA-11 is a remote TA. Facilities at this site are used for testing explosives components and systems, including vibration analysis and drop-testing materials and components under a variety of extreme physical environments. These facilities are arranged so that testing may be controlled and observed remotely, allowing devices that contain explosives, radioactive materials, and nonhazardous materials to be safely tested and observed.
TA-14 (Q-Site)	Located in the northwestern part of LANL, this TA is one of 14 firing areas. Most operations are remotely controlled and involve detonations, certain types of high explosives machining, and permitted burning. Tests are conducted on explosives charges to investigate fragmentation impact, explosives sensitivity, and thermal responses of new high explosives. This site is currently permitted to treat waste through open detonation or open burning under the Resource Conservation and Recovery Act (RCRA).

[2] *Names in parentheses are common or historical names that are sometimes used to refer to the Technical Areas.*

Technical Area	***Activities***
TA-15 (R-Site)	This TA, located in the central portion of LANL, is used for high explosives research, development, and testing, mainly through hydrodynamic testing and dynamic experimentation. TA-15 is the location of two firing sites, the Dual Axis Radiographic Hydrodynamic Test Facility, which has an intense high-resolution, dual-machine radiographic capability, and Building 306, a multipurpose facility where primary diagnostics are performed. The Pulsed High Energy Radiation Machine Emitting X-Rays Facility, a multiple-cavity electron accelerator capable of producing a very large flux of x-rays, was disabled in 2004. The machine was decommissioned in 2007, and decontamination and demolition will occur in the future. TA-15 is also used to investigate weapons functioning and systems behavior in nonnuclear testing.
TA-16 (S-Site)	TA-16, located in the western part of LANL, is the site of the Weapons Engineering Tritium Facility, which is a state-of-the-art tritium processing facility, and the High Explosives Wastewater Treatment Facility. The TA's high explosives research, development, and testing capabilities include high explosives processing; powder manufacturing; casting, machining, and pressing; inspection and radiography of high explosives components to guarantee integrity and ensure quality control; test device assembly; and chemical analysis. There are also some biological laboratories here.
TA-18 (Pajarito Site)	This TA is located in Pajarito Canyon about 4 miles (6 kilometers) southeast of TA-3. The Los Alamos Critical Experiment Facility, a general-purpose nuclear experiments facility, is housed on this site along with other experimental facilities. Currently, the primary focus of the Los Alamos Critical Experiment Facility is the design, construction, research, development, and application of critical experiments, as well as training related to criticality safety and radiation detection and instrumentation applications. In December 2002, NNSA decided to relocate all TA-18 Security Category I and II materials and activities to the Nevada Test Site; this transfer is in process.
TA-21 (DP-Site)	TA-21 is on the northern border of LANL, next to the Los Alamos townsite. The TA has two primary research areas: DP West and DP East. DP West is the former radioactive materials (including plutonium) processing facility that has been partially decontaminated, decommissioned, and demolished (DD&D). DP East consists of two tritium facilities. Current plans include closing TA-21 and consolidating tritium operations at the Weapons Engineering Tritium Facility in TA-16. The Tritium Systems Test Assembly has been deactivated and will undergo DD&D, and the Tritium Science and Fabrication Facility operations ended in 2006.
TA-22 (TD-Site)	This TA, located in the northwestern portion of LANL, houses the Los Alamos Detonator Facility. Construction of a new Detonator Production Facility began in 2003. Research, development, and fabrication of high-energy detonators and related devices are conducted at this facility.
TA-28 (Magazine Area A)	TA-28, located near the southern edge of TA-16, was an explosives storage area. The TA contains five empty storage magazines that are in the process of being decontaminated and decommissioned.
TA-33 (HP-Site)	TA-33 is remotely located at the southeastern boundary of LANL, where experiments that do not require daily oversight, but do require isolation, are located. The National Radioastronomy Observatory's Very Long Baseline Array telescope is located at this TA.
TA-35 (Ten Site)	This TA, located in the north central portion of LANL, is used for nuclear safeguards research and development, primarily in the areas of lasers, physics, fusion, materials development, and biochemistry and physical chemistry research and development. The Target Fabrication Facility, located at this TA, conducts precision machining and target fabrication, polymer synthesis, and chemical and physical vapor deposition. Additional activities at TA-35 include research in reactor safety, optical science, and pulsed-power systems, as well as metallurgy, ceramic technology, and chemical plating. This was formerly the site of the Atlas Project. The Atlas Removal Project has been completed at this site, and the building is now available as storage space. Additionally, there are some Biosafety Level 1 and 2 laboratories at TA-35.
TA-36 (Kappa-Site)	TA-36 is in a remotely located area in the eastern portion of LANL that is fenced and patrolled. It has four active firing sites that support explosives testing. The sites are used for a wide variety of nonnuclear ordnance tests pertaining to warhead designs, armor and armor-defeating mechanisms, explosives vulnerability to projectile and shaped-charge attack, warhead lethality, and determining the effects of shock waves on explosives and propellants.
TA-37 (Magazine Area C)	This TA is used as an explosives storage area. It is located at the eastern perimeter of TA-16.

Technical Area	Activities
TA-39 (Ancho Canyon Site)	TA-39 is located at the bottom of Ancho Canyon. The behavior of nonnuclear weapons is studied here, primarily by photographic techniques. Also studied are the various phenomenological aspects of explosives, interactions of explosives, explosions involving other materials, shock wave physics, equation-of-state measurements, and pulsed-power systems design.
TA-40 (DF-Site)	TA-40, centrally located within LANL, is used for general testing of explosives or other materials and development of special detonators for initiating high explosives systems. Fundamental and applied research includes investigating phenomena associated with the physics of high explosives and research in rapid-shock-induced reactions. This TA is also used for investigating the physics and chemistry of detonators and shock wave propagation.
TA-41 (W-Site)	TA-41, located in Los Alamos Canyon, is no longer used and many buildings have been decontaminated and decommissioned. Remaining structures include historic properties.
TA-43 (the Bioscience Facilities, formerly called the Health Research Laboratory)	TA-43 is adjacent to the Los Alamos Medical Center at the northern border of LANL. Two facilities are located within this TA: the Bioscience Facilities (formerly called the Health Research Laboratory) and NNSA's Los Alamos Site Office. The Bioscience Facilities have Biosafety Level 1 and 2 laboratories and are the focal point of bioscience and biotechnology at LANL. Research performed at the Bioscience Facilities includes structural, molecular, and cellular radiobiology; biophysics; radiobiology; biochemistry; and genetics.
TA-46 (WA-Site)	TA-46, located between Pajarito Road and the San Ildefonso Pueblo, is one of LANL's basic research sites. Activities have focused on applied photochemistry operations and have included development of technologies for laser isotope separation and laser enhancement of chemical processes. The Sanitary Wastewater Systems Plant is located within this TA.
TA-48 (Radiochemistry Site)	TA-48, located in the north-central portion of LANL, supports research and development in nuclear and radiochemistry, geochemistry, production of medical radioisotopes, and chemical synthesis.
TA-49 (Frijoles Mesa Site)	TA-49, located near Bandelier National Monument, is used as a training area and for outdoor tests on materials and equipment components that involve generating and receiving short bursts of high-energy, broad-spectrum microwaves. A fire support building located near the entrance to the TA, with an upgraded helipad, is operated by the U.S. Forest Service.
TA-50 (Waste Management Site)	TA-50 is located near the center of LANL. The site supports LANL's waste management activities for several types of waste, including storing solid and liquid low-level radioactive waste, low-level mixed waste, transuranic waste, and hazardous waste. Major facilities at TA-50 include the Radioactive Liquid Waste Treatment Facility; the Waste Characterization, Reduction, and Repackaging Facility; and the Actinide Research and Technology Instruction Center.
TA-51 (Environmental Research Site)	Located on Pajarito Road in the eastern portion of LANL, TA-51 is used for research and experimental studies on the long-term impacts of radioactive materials on the environment. Various types of waste storage and coverings are studied at this TA.
TA-52 (Reactor Development Site)	TA-52 is located in the north central portion of LANL. A wide variety of theoretical and computational research and development activities related to nuclear reactor performance and safety, as well as to several environmental, safety, and health activities, are carried out at this site.
TA-53 (Los Alamos Neutron Science Center)	TA-53 is located in the northern portion of LANL and includes LANSCE, which houses one of the largest research linear accelerators in the world and supports both basic and applied research programs. Basic research includes studies of subatomic and particle physics, atomic physics, neutrinos, and the chemistry of subatomic interactions. Applied research includes materials science studies that use neutron spallation and contribute to defense programs. LANSCE has also produced medical isotopes for the past 20 years.
TA-54 (Waste Disposal Site)	TA-54, located on the eastern border of LANL, is one of the largest TAs at LANL. Its primary function is management of solid radioactive and hazardous chemical wastes, including storage, treatment, decontamination, and disposal operations.
TA-55 (Plutonium Facility Complex Site)	TA-55, located just southeast of TA-3, includes the Plutonium Facility Complex and is the chosen location for the Chemistry and Metallurgy Research Building Replacement Project. This facility provides chemical and metallurgical processes for recovering, purifying, and converting plutonium and other actinides into many compounds and forms. Additional capabilities include the means to ship, receive, handle, and store nuclear materials, as well as to manage the wastes and residues produced by TA-55 operations. Relocated chemistry and metallurgy research, actinide chemistry, and materials characterization capabilities may be provided at the site through the Chemistry and Metallurgy Research Building Replacement Project currently under construction.

Technical Area	***Activities***
TA-57 (Fenton Hill Site)	TA-57 is located about 20 miles west (32 kilometers) of LANL on the southwest edge of the Valles Caldera in the Jemez Mountains. This TA lies within an area of land administered by the U.S. Forest Service. The primary purpose of the TA is observation of astronomical events. TA-57 houses the Milagro Gamma-Ray Observatory and a suite of optical telescopes. Drilling technology research is also performed in this TA.
TA-58 (Two-Mile North Site)	TA-58, located near LANL's northwest border on Two-Mile Mesa North, is a forested area reserved for future use because of its proximity to TA-3. The TA houses a few LANL-owned storage trailers and a temporary storage area.
TA-59 (Occupational Health Site)	This TA is located on the south side of Pajarito Road, adjacent to TA-3. TA-59 facilities provide LANL support services in the areas of health physics, risk management, industrial hygiene and safety, policy and program analysis, air quality, water quality and hydrology, hazardous and solid waste analysis, and radiation protection. The Medical Facility at TA-59 includes a clinical laboratory. Institutional-level analytical support for environmental samples and bioassay samples is also provided.
TA-60 (Sigma Mesa)	TA-60 lies between Mortandad Canyon and Sandia Canyon southeast of TA-3. The site is primarily used for physical support and infrastructure activities and includes the Nevada Test Site Test Fabrication Facility and a test tower. Because of the moratorium on testing, these buildings have been placed in indefinite safe shutdown mode.
TA-61 (East Jemez Site)	TA-61, located in the northern portion of LANL, contains physical support and infrastructure facilities, including a sanitary landfill operated by Los Alamos County and sewer pump stations.
TA-62 (Northwest Site)	TA-62, located next to TA-3 and West Jemez Road in the northwest corner of LANL, serves as a forested buffer zone. This TA is reserved for future use.
TA-63 (Pajarito Service Area)	TA-63, located in the north-central portion of LANL, contains physical support and infrastructure facilities. The facilities at this TA serve as localized storage and physical support office space.
TA-64 (Central Guard Site)	This TA is located in the north-central portion of LANL and provides offices and storage space.
TA-66 (Central Technical Support Site)	TA-66 is located on the southeast side of Pajarito Road in the center of LANL. The Advanced Technology Assessment Center, the only facility at this TA, provides office and technical space for technology transfer and other industrial partnership activities.
TA-67 (Pajarito Mesa Site)	TA-67 is a forested buffer zone located in the north central portion of LANL. No operations or facilities are currently located at the site.
TA-68 (Water Canyon Site)	TA-68, located in the southern portion of LANL, is a testing area for dynamic experiments and also contains environmental study areas.
TA-69 (Anchor North Site)	TA-69, located in the northwestern corner of LANL, serves as a forested buffer area. The new Emergency Operation Center, completed in 2003, is located here.
TA-70 (Rio Grande Site)	TA-70 is located on the southeastern boundary of LANL and borders the Santa Fe National Forest. It is a forested TA that serves as a buffer zone.
TA-71 (Southeast Site)	TA-71 is located on the southeastern boundary of LANL and is adjacent to White Rock to the northeast. It is an undeveloped TA that serves as a buffer zone for the High Explosives Test Area.
TA-72 (East Entry Site)	TA-72 is located along East Jemez Road on the northeastern boundary of LANL. The site contains LANL's small arms firing range, which is used by protective force personnel for required training and practice purposes.
TA-73 (Airport Site)	TA-73 is located along the northern boundary of LANL, adjacent to NM 502. Los Alamos County manages, operates, and maintains the community airport under a leasing arrangement with DOE. Use of the airport by private individuals is permitted with special restrictions.
TA-74 (Otowi Tract)	TA-74 was a forested area in the northeastern corner of LANL. Large parts of this TA have been either conveyed to Los Alamos County or transferred to the Department of the Interior (in trust for the Pueblo of San Ildefonso) and are no longer part of LANL.

TA = technical area, NNSA = National Nuclear Security Administration, NM = New Mexico.

Several TAs at LANL have experienced facility changes recently. Changes occurring at LANL TAs since publication of the *1999 SWEIS* include:

- **TA-2—**The 1940s-era Omega West Reactor Building has been completely decontaminated, decommissioned, and demolished (DD&D). The land has been reclaimed and revegetated.

- **TA-3—**New facilities have been constructed since the *1999 SWEIS*, including the Los Alamos Research Park, which was constructed on land leased from DOE to allow a wide range of companies to work within the same geographic location on projects that will benefit both private industry and LANL; the Metropolis Center, which houses one of the world's fastest supercomputers; and the Nonproliferation and International Security Center, which was built to increase the efficiency and effectiveness of support to the NNSA Office of Nonproliferation and International Security by consolidating personnel at a central LANL location.

  The Los Alamos Research Park was constructed on undeveloped land leased to Los Alamos County for 50 years in 1999. While located within TA-3, this Research Park is operated by the county and is not subject to the administrative control of DOE except as provided through the lease agreement. Currently, one building has been constructed (along with parking structures). Construction of the first building in the Los Alamos Research Park began in 2000 and was completed in March 2001. As described in the *Environmental Assessment for the Lease of Land for the Development of a Research Park at Los Alamos National Laboratory* (DOE 1997b), up to 10 structures may eventually be constructed, consuming an estimated 1.3 megawatts peak electric demand, 39 billion British Thermal Units of natural gas, and 17 million gallons (64,352,001 liters) of water annually.

  The Metropolis Center (formerly called the Strategic Computing Complex) and the Nonproliferation and International Security Center were constructed on previously disturbed land containing parking lots or other structures. As previously discussed, most other facility construction, modifications, and upgrades were conducted within existing facilities. The following sections describe major constructions at TA-3.

  Construction of the Metropolis Center (TA-3-2327) began in 1999 and was completed at the end of 2001. Occupancy by about 300 designers, computer scientists, code developers, and university and industrial scientists was completed in 2002. When expansion of the original facility is completed, it will require an estimated 51 million gallons (193 million liters) of cooling water per year and will have a maximum electricity load requirement of 15 megawatts. The impacts of this project were initially addressed in the *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 1998), which considered the construction and operation of this facility with an initial computing capacity of up to 50 teraflops (50 trillion floating point operations per second). NNSA has subsequently determined that a capability of at least 100 teraflops would be required to effectively support the mission requirements of this facility, and estimates that an operational level as high as 1,000 teraflops (1 petaflops) might be required in the future.


The Nonproliferation and International Security Center (left) and the Strategic Computing Complex at TA-3

Construction of the Nonproliferation and International Security Center (TA-3-2322) began in March 2001. Occupancy began in March 2003. The building houses laboratories, a machine shop for fabrication of satellite parts, a high-bay fabrication area, an area for the safe handling of sealed radioactive sources, and offices. Since workers have been relocated from other LANL buildings, there have been no increases in LANL's generation of sewage or solid or chemical wastes, or its overall demand for utilities. The impacts of this project were addressed in the *Environmental Assessment for the Proposed Construction and Operation of the Nonproliferation and International Security Center* (DOE 1999c).

Additional new construction at TA-3 since 1999 includes the Security Systems Support Facility; the Decision Applications Office Building; the new Materials Sciences and Technology Office Building; the LANL Center for Integrated Nanotechnologies; the new LANL Medical Facility; and the Biosafety Level 3 Facility, which is not yet operational. Construction is complete on the National Security Sciences Building, which will replace the old Administration Building. Two of three planned parking structures were constructed to complement the new office space in TA-3 (NNSA 2001). Several buildings were removed from TA-3, including the Sherwood Building, the Scyllac Building, the Assembly Rack Towers, and the old Environment, Safety, and Health Clinic, as well as a number of trailers. Access control stations have been constructed and operations have been initiated, allowing NNSA to control vehicle access into TA-3.

- **TA-16—**Several new facilities have been constructed in this TA, including the Tritium Science and Engineering Office Building, the Weapons Engineering Office Building, and the Weapons Plant Support Building. In addition, several major demolition projects totaling over 100,000 square feet (9,290 square meters) have taken place at TA-16, including the 220, 340, and 370 complexes and the old steam plant.

- **TA-18—**This TA has operated for many years as a major training facility for nuclear specialists in areas such as criticality management and safety, emergency response in support of counterterrorism activities, nonproliferation programs, and criticality experiments in support of stockpile stewardship. This TA is currently undergoing decommissioning consistent with the ROD for the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (67 FR 79906). Efforts are underway to remove the majority of special nuclear material from this area and to relocate certain operations to the Nevada Test Site by 2008 (Security Category I and II nuclear materials have been removed from this TA).

- **TA-21—**In the past, this TA has supported tritium research, but this work is being consolidated at TA-16 or offsite at another NNSA facility. Part of TA-21 has been conveyed per Public Law 105-119 requirements.

- **TA-41—**This TA was previously used for a variety of administrative and technical activities, but is no longer used. Many buildings have been decontaminated and decommissioned.

- **TA-55—**The Plutonium Facility Complex is located in this TA. Security Category I and II nuclear materials removed from TA-18 are being stored here pending transfer to the Device Assembly Facility at the Nevada Test Site.

- **TA-61—**This TA is the location of the Los Alamos County Landfill, which currently handles municipal solid waste from both Los Alamos County and LANL. The landfill is scheduled to cease operation in 2008 under the direction of NMED.

2.4 Key Facilities and Non-Key Facilities Changes Since the *1999 SWEIS*

Taken together, the 15 Key Facilities at LANL represent the majority of environmental risks associated with LANL operations. Specifically, information in the *1999 SWEIS* projected that these Key Facilities would produce:

- More than 99 percent of all radiation doses to the public,

- More than 99 percent of all radiation doses to the LANL workforce,

- More than 90 percent of all radioactive liquid waste generated at LANL, and

- More than 90 percent of all radioactive solid waste generated at LANL.

This remains true for operations-related activities at LANL Key Facilities today (LANL 2005f). Facility cleanouts and DD&D, however, as well as environmental restoration activities, account for large quantities of waste requiring management. **Figure 2–3** shows the location of the 15 Key Facilities at LANL.

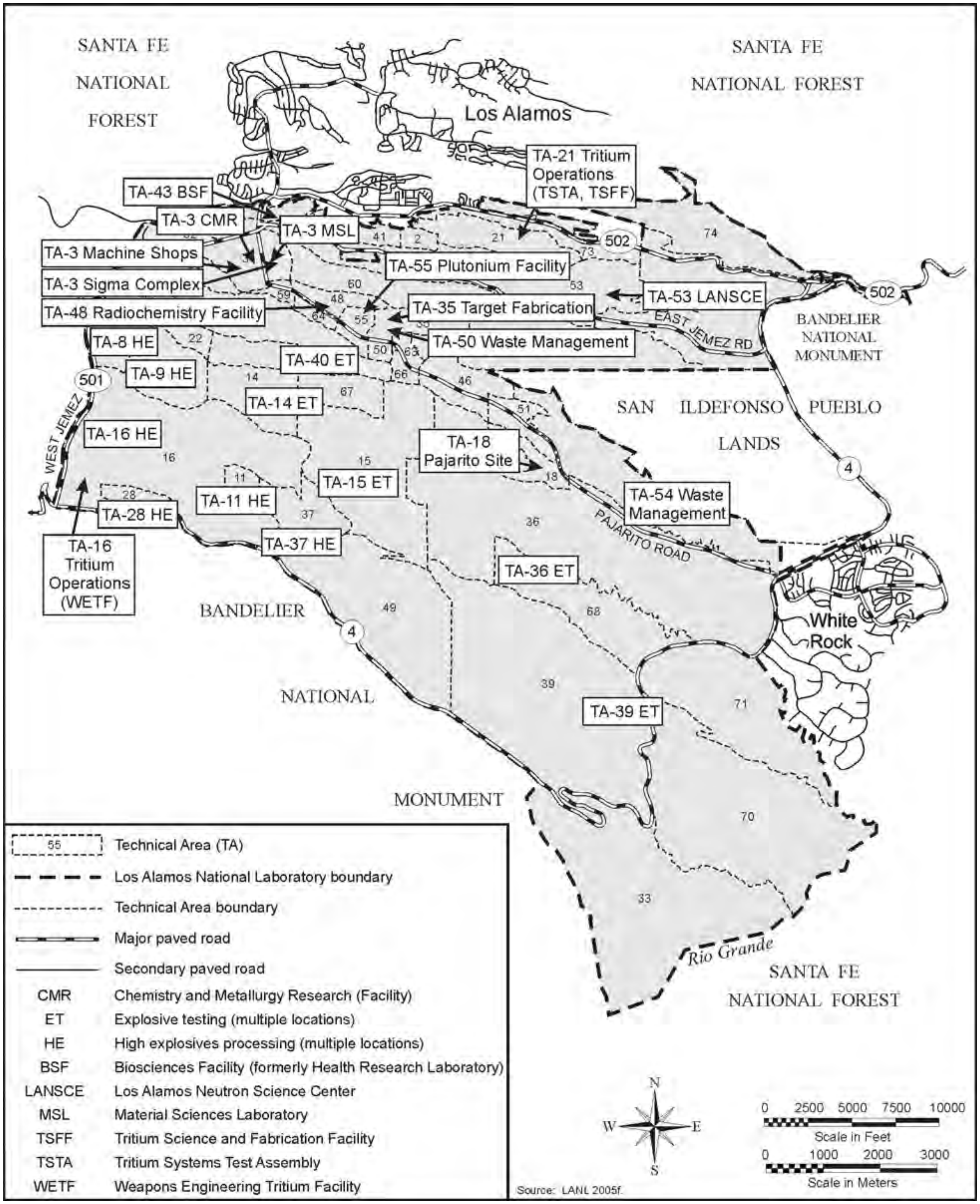


Figure 2–3 Los Alamos National Laboratory Key Facilities

Definition of a Key Facility

The definition of each Key Facility hinges upon operations,[3] capabilities, and location, and is not necessarily confined to a single structure, building, or TA. In fact, the number of structures[4] constituting a Key Facility ranges from one, such as the Metropolis Center, to more than 400 for LANSCE. Key Facilities may also exist in more than a single TA, as is the case with the High Explosives Testing and High Explosives Processing Key Facilities. *SWEIS Yearbooks* discuss each of the 15 Key Facilities from three aspects: substantial facility construction and modifications, types and levels of operations, and operations data by calendar year from publication of the *1999 SWEIS* through 2005. Each of these three aspects is given perspective by comparing them to projections made in the *1999 SWEIS*. This comparison provides an evaluation of whether or not data resulting from LANL operations continue to fall within the environmental envelope established in the *1999 SWEIS* ROD. The remainder of LANL facilities are called "non-Key," not because they are any less important to critical research and development activities, but because they did not fit the criteria of a Key Facility.

This SWEIS also describes changes that have occurred at non-Key Facilities. Although operations at non-Key Facilities do not individually contribute substantially to environmental impacts, non-Key Facilities represent a substantial fraction of LANL facilities. Non-Key Facilities comprise all or the majority of the facilities at 30 of the 49 TAs located on about 14,200 acres (5,750 hectares) of LANL's 25,600 acres (10,360 hectares) of land. Non-Key Facilities house about half the LANL workforce and include such important buildings and operations as the Center for Integrated Nanotechnology, the National Security Sciences Building and, the TA-46 Sanitary Wastewater System Plant.

Nuclear and Radiological Facility Designations

As previously noted in Chapter 1, Key Facilities in the *1999 SWEIS* included 42 of the 48 Hazard Category 2 and Category 3 nuclear structures at LANL.[5] Subsequently, DOE and LANL have reclassified some buildings so that there are now fewer Hazard Category 2 and 3 nuclear structures.

---

[3] As used in the 1999 SWEIS and SWEIS Yearbooks, facility operations include three categories of activities: research, production, and services to other LANL organizations. Research is both theoretical and applied. Examples include modeling of the subatomic investigations and collaborative efforts with industry. Production involves delivery of a product to a customer, such as radioisotopes to hospitals and the medical industry. Examples of services provided to other LANL facilities include utilities and infrastructure support, analysis of samples, environmental surveys, and waste management.
[4] Structures may be buildings or any other engineered object such as test stations, manholes, and trailers.
[5] The identification of nuclear facilities is based upon the official list maintained by the Los Alamos Site Office; information in this SWEIS is as of October 2005 (DOE and LANL 2005).

Table 2–3 presents the Key and non-Key Facilities identified in the *1999 SWEIS*, the structures currently listed as nuclear facilities, and their nuclear hazard categories (DOE and LANL 2005). There are now 15 structures or areas, 11 potential release sites, as well as the site-wide transportation capability, making a total of 27 nuclear facilities on the list. Many of the facilities that were classified as nuclear facilities in 1999 have been downgraded to radiological facilities[6] due to reductions in the amount of radioactive material in these facilities, or because the facilities have been decontaminated and decommissioned. Since the *1999 SWEIS*, the TA-54 Radioactive Materials, Research, Operations, and Demonstration Facility; the TA-48 Radiochemistry and Hot Cell Facility; the TA-21 Tritium Science Test Assembly; and the TA-3 Sigma Complex have been removed from the list. With these reductions in nuclear hazard categorizations, some facilities also have had their security hazard categorizations reduced. In addition, the new Decontamination and Volume Reduction System (TA-54) has been added to the list of nuclear facilities (June 2004) as a Hazard Category 2 nuclear facility. Several potential release sites, including MDAs, have also been added to the list of nuclear hazard facilities.

With the issuance of Nuclear Safety Management regulations (Title 10 *Code of Federal Regulations* [CFR] Part 830) on January 10, 2001, onsite transportation is also addressed relative to its nuclear hazard categorization. When the *1999 SWEIS* was published, onsite transportation was considered part of the affected environment. The onsite transportation of nuclear materials greater than or equal to Hazard Category 3 quantities is addressed in a NNSA-approved safety analysis (LANL 2003h).

Overview of Key Facility Capabilities and Changes

The following are brief descriptions of Key Facilities, their capabilities, and changes that have occurred since the publication of the *1999 SWEIS*. This discussion includes information on the location (TA) of each Key Facility, the building or buildings considered part of the Key Facility, and respective nuclear hazard categorizations. Emphasis is placed on the capabilities for which the facility maintains equipment and expertise and any changes that may have occurred since 1999. Subsequent chapters of this SWEIS will evaluate each alternative (No Action, Reduced, and Expanded) in terms of how it could impact the level of activity within each Key Facility capability, as well as major projects planned at any non-Key Facility.

---

[6] *Radiological facilities are defined as areas or activities that contain or use less than Hazard Category 3 inventories as listed in Table A.1 DOE-STD-1027-92, but where the amount of radioactive material present is sufficient to create a "radiological area" as defined by 10 CFR Part 835. Sealed radioactive sources, material in U.S. Department of Transportation Type B containers, and structures whose only source of radiation is machine produced x-rays may be excluded. The identification of radiological facilities is based upon the official list maintained by the Los Alamos Site Office as of November 2002 (LANL 2002h).*

Table 2–3 Los Alamos National Laboratory Key and Nuclear Facilities – *1999 SWEIS* and 2005 Listings

Key Facility and Location	*1999 SWEIS*		*2005 Listing*	
	Facility or Structure	***Nuclear Hazard Category***	***Facility or Structure***	***Nuclear Hazard Category***
Chemistry and Metallurgy Research Building (TA-3)	Chemistry and Metallurgy Research Building	2	Chemistry and Metallurgy Research Building	2
Machine Shops (TA-3)				
Materials Science Laboratory (TA-3)				
Sigma Complex (TA-3)	Sigma Building	3		
	Thorium Storage	3		
High Explosives Processing (TA-8 and TA-16)	Radiography Facility	2	Radiography Facility	Radiological
	Isotope Building	2		
	Experimental Science	2	Experimental Science	Radiological
	Intermediate Device Assembly	2	Intermediate Device Assembly	Radiological
High Explosive Testing (various TAs)				
Tritium Facilities (TA-16 and TA-21)	Weapons Engineering Tritium Facility	2	Weapons Engineering Tritium Facility	2
	Tritium System Test Assembly	2	Tritium Systems Test Assembly	Radiological
	Tritium Science and Fabrication Facility	2	Tritium Science and Fabrication Facility	Radiological
Pajarito Site (TA-18)	Critical Assembly and Storage Area 1	2	Los Alamos Critical Experiment Facility (whole facility)	2
	Hillside Vault	2		
	Critical Assembly and Storage Area 2	2		
	Critical Assembly and Storage Area 3	2		
Target Fabrication Facility (TA-35)				
Bioscience Facilities (various TAs)			Health Research Laboratory	Radiological
Radiochemistry Facility (TA-48)	Radiochemistry and Hot Cell Facility	3	Radiochemistry and Hot Cell Facility	Radiological
Radioactive Liquid Waste Treatment Facility (TA-50)	Main Treatment Plant	2	Main Treatment Plant, Pretreatment Plant	2
	Low-Level Waste Tank Farm		Low-level liquid influent tanks, treatment effluent tanks, low-level sludge tanks	2
	Acid and Caustic Tank Farm		Acid and caustic waste holding tanks	2
	Holding Tank		Holding Tank	2

Key Facility and Location	*1999 SWEIS*		*2005 Listing*	
	Facility or Structure	*Nuclear Hazard Category*	*Facility or Structure*	*Nuclear Hazard Category*
LANSCE (TA-53)	Experimental Science	3		
			1 L Target	3
			Lujan Center ER-1/2 Actinide	3
			Area A-East	3
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	Radioactive Materials, Research, Operations, and Demonstration	2 [a]	Actinide Research Technology Instruction Center	
	Waste Characterization, Reduction, and Repackaging Facility Building	2	Waste Characterization, Reduction, and Repackaging Facility	3
	Nondestructive Analysis Mobile Activities		Nondestructive analysis mobile activities outside TA-50-69	2
	Drum Storage		Drum Staging, Storage, and Equilibration Pad outside TA-50-69	2
	Low-Level Radioactive Waste Storage and Disposal Area G	2	Waste Storage and Disposal Facility (Area G) [b]	2
	Transuranic Waste Inspectable Storage Project	2 [a]		
	Transuranic Storage Dome (Building)	2	Waste Assay Facility	2
	Transuranic Drum Preparation	2		
	Radioassay and Nondestructive Testing Facility	2	Radioassay and Nondestructive Testing Facility	2
	Transuranic Storage Domes (3)	2	Transuranic Waste Management Domes (12)	(c)
	Sheds (4)	2	Sheds (4)	(c)
	Temporary Retrieval Dome	2		
	Tension Support Domes (5)	2		
	Decontamination and Volume Reduction Glovebox		Decontamination and Volume Reduction System	2
	Storage Pad/Transuranic Storage	2	Pad 10 (previously pads 2 and 4)	2
	Storage Pad	2		

Key Facility and Location	***1999 SWEIS***		***2005 Listing***	
	Facility or Structure	***Nuclear Hazard Category***	***Facility or Structure***	***Nuclear Hazard Category***
Plutonium Facilities Complex (TA-55)	Plutonium Facility	2	Plutonium Facility	2
	Nuclear Material Storage	2		
			Staging Facility	2
			Safe Secure Transport Facility	2
Non-Key Facilities (TA-3, TA-33, and TA-35)	Physics Building	3	Physics Building	Radiological
	Source storage	2		
	Calibration Building	3		
	Former Tritium Research	3	Former Tritium Research	Radiological
	Nuclear Safeguards Research Facility	3	Nuclear Safeguards Research Facility	Radiological
Site-wide			Site-wide transportation of nuclear materials	2
Potential Release Sites (TA-10, TA-21, TA-35, TA-49, TA-50, TA-53, and TA-54)			Former liquid disposal complex	3
			Material Disposal Area A	2
			Material Disposal Area B	3
			Material Disposal Area T	2
			Material Disposal Area W Sodium Storage Tanks	3
			Wastewater Treatment Plant	3
			Wastewater Treatment Plant (Pratt Canyon)	3
			Material Disposal Area AB	2
			Material Disposal Area C	2
			Underground tank with spent resin	2
			Material Disposal Area H	3

TA = Technical Area, LANSCE = Los Alamos Neutron Science Center.

[a] Data indicate that this building was a nuclear Hazard Category 2 in 1998 and in 2000 so it is included here.

[b] This includes low-level radioactive waste (including mixed waste) storage and disposal in domes, pits, shafts, and trenches; transuranic waste storage in domes and shafts; transuranic legacy waste in pits and shafts; disposal of asbestos in pits and shafts; and operations building for transuranic waste storage.

[c] These structures are included as part of the Waste Storage and Disposal Facility (Area G).

Sources: LANL 2003a, 2004a, 2006g, DOE and LANL 2005.

Capabilities and Other Activities

In the Key Facility framework, a capability refers to the combination of buildings, equipment, infrastructure, and expertise necessary to undertake types or groups of activities and to implement mission assignments. The *1999 SWEIS* defined specific capabilities for each of the 15 Key Facilities based on projections of work (including production, research, and development) anticipated at each Key Facility. In some cases, capabilities at more than one Key Facility may have similar or identical names, but slightly different descriptions and operations. This is because several Key Facilities often work together to support a single mission or program, and work taking place in one area may complement efforts in another location. Unless otherwise noted, the capabilities described in this new SWEIS are the same as those previously defined in the *1999 SWEIS*. With a few exceptions, the capabilities identified in the *1999 SWEIS* ROD for LANL have remained constant since 1999. The exceptions are:

- Movement of the Nonproliferation Training and Nuclear Measurement School, which was briefly located at TA-18 and returned to TA-3 (the Chemistry and Metallurgy Research Building) in 2004, where it will stay until the Chemistry and Metallurgy Research Building is no longer available or until a new Security Category I and II facility is built at TA-48 as part of the Radiological Sciences Institute, of which Phase I is the Institute for Nuclear Nonproliferation Science and Technology (see Appendix G, Section G.3 for details);
- Relocation of the Decontamination Operations Capability from the Radioactive Liquid Waste Treatment Facility to the Solid Radioactive and Chemical Waste Facilities in 2001;
- Loss of Cryogenic Separation Capability at the Tritium Key Facilities in 2001 (LANL 2004f); and
- Transfer of thin film loading of neutron tube targets from the Tritium Key Facilities to Sandia National Laboratories in 2006.

Facility Performance and Other Changes Since the 1999 SWEIS

To evaluate the environmental impacts, the *1999 SWEIS* estimated the level of operations for each capability. If all of these capabilities were conducted at the estimated levels, they would be expected to result in a certain amount of emissions, liquid discharges, and waste. These projected parameters (emissions, liquid, and waste) set the limits for the operations levels. The *1999 SWEIS*, however, was not intended to set stringent limits on the level of activity for a particular capability. In most facilities, the operations levels for all capabilities would not be reached at one time because of the ebb-and-flow nature of the work at LANL. Thus, it is possible to exceed the projected operations level for one capability and still be within the operations limits for the facility.

The facility performance and changes sections of the following Key Facility descriptions summarize the operational performance levels within the defined facility capabilities for the period since the *1999 SWEIS* was published (through the end of 2005). Emphasis is placed on whether any capabilities have been gained or lost and whether the levels of activity have remained within the established environmental impact envelope. Operations data for air emissions, liquid releases (number of NPDES outfalls and effluent quality where applicable), and waste volumes (including transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, and hazardous and chemical wastes) illustrate how the activity levels of each Key Facility have changed over the past 7 years. Quantified information about these changes is provided in **Table 2–5** at the end of this chapter.

2.4.1 Chemistry and Metallurgy Research Building (Technical Area 3)

The Chemistry and Metallurgy Research Building, (Building 3-29), located within TA-3, consists of seven wings that were constructed in 1952; a new wing (Wing 9) was added in 1960 for activities that must be performed in hot cells. The three-story building is a multiple-user facility in which specific wings are associated with different activities. It is the only LANL facility with full capabilities for performing special nuclear material analytical chemistry and materials science. This Key Facility is a Hazard Category 2 nuclear facility.

Chemistry and Metallurgy Research Building at TA-3

The principal capabilities and other activities at the Chemistry and Metallurgy Research Building include:

- Analytical chemistry capabilities involving the study, evaluation, and analysis of radioactive materials;
- Various operations considered essential for the stewardship of uranium products, including uranium processing and handling and storage of highly radioactive materials;
- Destructive and nondestructive analysis employing analytical chemistry, metallographic analysis, measurement of neutron or gamma radiation from an item, and other measurement techniques;
- Nonproliferation training utilizing measurement technologies and special nuclear material housed at the Chemistry and Metallurgy Research Building and other LANL facilities to train international inspection teams for the International Atomic Energy Agency;
- Actinide research and development that may include separation of medical isotopes from targets, processing of neutron sources, and research into the characteristics of materials, including the behavior or characteristics of materials in extreme environments; and
- Fabrication and processing of a variety of materials, including hazardous and nuclear materials, in support of highly enriched uranium processing and research and development on targets, weapons components, and other experimental tasks.

Chemistry and Metallurgy Research Building Performance and Changes Since the *1999 SWEIS*

As discussed in the *1999 SWEIS*, extensive upgrades originally planned for the Chemistry and Metallurgy Research Building would be much more expensive and time-consuming than originally anticipated and only marginally effective in providing the operational risk reduction and program capabilities required to support DOE mission assignments at LANL. As a result, DOE reduced the number of Chemistry and Metallurgy Research Building upgrade projects to those needed to ensure safe and reliable operations. Operations and capabilities are currently restricted due to safety and security constraints; the Chemistry and Metallurgy Research Building is not operational to the extent needed to meet the NNSA requirements established in the *1999 SWEIS* for the then-foreseeable future. In November 2003, NNSA issued an *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2003d), which evaluated the potential environmental impacts resulting from activities associated with consolidating and relocating the mission-critical Chemistry and Metallurgy Research Building capabilities at LANL and replacement of the Chemistry and Metallurgy Research Building. In its ROD issued in February 2004, NNSA decided to replace the Chemistry and Metallurgy Research Building with a new Chemistry and Metallurgy Research Replacement Facility at TA-55 and to completely vacate and demolish the Chemistry and Metallurgy Research Building (69 FR 6967). The ROD stated that the new facility would be established as a Hazard Category 2 nuclear facility. NNSA is currently re-evaluating the need for this facility as part of its evolution of Complex Transformation, as discussed in Chapter 1, Section 1.5, of this SWEIS.

The principal capabilities and activities described for this Key Facility either operated within the bounds of the *1999 SWEIS* over the past 7 years or were inactive. The capability to evaluate secondary assemblies used in nuclear weapons through destructive and nondestructive analyses has not been used since 1999. Mechanical and chemical processing of sealed sources is no longer allowed in the Chemistry and Metallurgy Research Building per the Facility Authorization Basis, so there were no actinide processing operation activities. The research and development project related to spent nuclear fuel and long-term storage was completed in 1997 when the final shipment from Omega West was sent to the Savannah River Site. In addition, there were no activities related to the spent nuclear fuel capability and long-term storage research. Regarding the fabrication and metallography capability, the project to produce molybdenum-99 was terminated in 1999, the Ulysses Project was never initiated, and the equipment was removed in preparation for the Bolas Grande Project.

Modifications to Wing 9 were started in 1999 to support the Bolas Grande Project. This project would provide disposition of large vessels previously used to contain experimental explosive shots involving plutonium. The National Environmental Policy Act (NEPA) coverage for this project was provided by a *Supplemental Analysis Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Bolas Grande Project* (DOE/EIS-0238-SA-03) (DOE 2003c). As of the end of 2007, implementation of this project was pending approval.

Less than half the projected number of samples was analyzed annually in support of actinide research and processing activities. The Chemistry and Metallurgy Research Building's capability for metallurgical microstructural and chemical analysis and compatibility testing of actinides was used to analyze and test an average of 100 samples per year, equal to the projected *1999 SWEIS* rate. Demonstration of the actinide decontamination technology was completed in 2001.

Radiological air emissions remain below *1999 SWEIS* projections, except for technetium-99 and germanium-68, which were each present in 1 year, and strontium-90, which was present in 2 years in dosimetrically insignificant amounts and were not identified in the *1999 SWEIS*. The Chemistry and Metallurgy Research Building operated with one NPDES-permitted outfall, as projected in the *1999 SWEIS*. Except for 2001, the outfall discharge rates have regularly exceeded *1999 SWEIS* projections (500,000 gallons per year) by as much as 4 million gallons per year. In 2004, a dechlorination system was added to prevent NPDES permit noncompliances for chlorine at this outfall. Chemical waste, low-level radioactive waste, and mixed low-level radioactive waste were below their projected amounts. In 2002, mixed transuranic waste quantities were slightly higher (21 cubic yards or 16 cubic meters per year) than the *1999 SWEIS* projections (17 cubic yards or 13 cubic meters per year). In 2001, transuranic waste quantities generated were 66 percent higher than projected due to remodeling activities at the Chemistry and Metallurgy Research Building (17 cubic yards or 13 cubic meters per year). Quantities generated in all other years were below projections.

2.4.2 Sigma Complex (Technical Area 3)

The Sigma Complex Key Facility, also located in TA-3, consists of four principal buildings: the main Sigma Building (3-66), the Beryllium Technology Facility (3-141), the Press Building (3-35), and the Thorium Storage Building (3-159). The Sigma Complex supports a large, multidisciplinary technology base in materials fabrication science. This facility is used mainly for materials synthesis and processing, characterization, fabrication, joining, and coating of metallic and ceramic items. The Sigma Complex Key Facility had two Hazard Category 3 nuclear facilities identified in the *1999 SWEIS*, 3-66 and 3-159. However, in April 2000, Building 3-159 was downgraded from a Hazard Category 3 nuclear facility to a radiological facility and removed from the nuclear facilities list. In March 2001, Building 3-66 also was downgraded from a Hazard Category 3 nuclear facility and removed from the nuclear facilities list. In September 2001, the Sigma Building, the Press Building, and the Thorium Building were placed on the radiological facility list. The Beryllium Technology Facility is a nonnuclear moderate hazard facility.


Sigma Building at TA-3

The primary capabilities and activities conducted within the Sigma Complex are:

- Research and development on materials fabrication, coating, joining, and processing, including materials synthesis and processing work related to research and development on fabricating items from materials that are difficult to work with;
- Characterization of materials, which includes understanding the properties of metals, metal alloys, ceramic-coated metals, and other similar combinations, as well as the effects on these materials and their properties caused by aging, chemical attack, mechanical stresses, and other agents; and
- Fabrication of metallic and ceramic items, including fabricating and working with metallic and ceramic materials and various combinations.

Sigma Facility Performance and Changes Since the *1999 SWEIS*

The *1999 SWEIS* projected substantial facility changes for the Sigma Building itself. Three of five planned upgrades are complete; one is essentially complete; and one remains incomplete. They include:

- Replacement of graphite collection systems (completed in 1998);
- Modification of the industrial drain system (completed in 1999);
- Replacement of electrical components (essentially completed in 2000; however, add-on assignments will continue);
- Roof replacement (most of the roof was replaced in 1998 and 1999; however, additional work needs to be performed); and
- Seismic upgrades (not started).

In addition to the five planned upgrades, three additional upgrades were completed in 2003:

- Replacement of liquid nitrogen Dewar container,
- Painting the exterior of the Sigma Building, and
- Reinstallation of the utilities to activate the Press Building.

Construction of the Beryllium Technology Facility, formerly known as the Rolling Mill Building, was completed in 1999. This state-of-the-art beryllium processing facility has 16,000 square feet (1,490 square meters) of floor space, of which 13,000 square feet (1,210 square meters) are used for beryllium operations. The remaining 3,000 square feet (280 square meters) are for general metallurgical activities. The mission of the new facility is to maintain and enhance the beryllium technology base that exists at LANL and to establish the capability for fabrication of beryllium powder components. Research also will be conducted at the Beryllium Technology Facility, including research concerning the energy- and weapons-related use of beryllium metal and beryllium oxide. The beryllium equipment for this new facility was moved in stages from the

Machine Shops Key Facility into the Beryllium Technology Facility in 2000. The authorization to begin operations in the Beryllium Technology Facility was granted by NNSA in January 2001.

The research and development activity and the fabrication of metallic and ceramic items activity have operated below the levels projected in the *1999 SWEIS*. Parts of the characterization of materials activity operated above the levels projected in the *1999 SWEIS*. Other activities, including analysis of tritium reservoirs and development of a library of aged non-special nuclear material, operated below the levels projected in the *1999 SWEIS*.

Radiological air emissions were below projected levels identified in the *1999 SWEIS*. Thorium-230 and uranium-235 were not identified in the *1999 SWEIS* as contributors to the Sigma Building's overall air emission makeup, but have been present in dosimetrically insignificant amounts (less than a microcurie). In early 2000, stack monitoring was discontinued because potential emissions from the monitored stacks were sufficiently low that such monitoring was no longer warranted for compliance. Since 1994, the facility has operated with two NPDES-permitted outfalls, but only one outfall was used. Annual outfall discharge rates were within *1999 SWEIS* projections for 1999 through 2005, except for 2003, when the facility's effluent exceeded NPDES permit levels by 4 percent. A dechlorination system was installed in October 2003 to prevent further noncompliance events (LANL 2004d). Chemical wastes exceeded projections in 2002 by 49,400 pounds (22,400 kilograms) due to structure rehabilitation and disposal of equipment and other material debris resulting from bringing the Press Building back on line. In 2004, chemical waste projections were again exceeded because the graphite machine shop at Sigma generated a lot of graphite waste that could not be disposed of in the Los Alamos County Landfill. Over a 4-year period, the LANL Pollution Prevention office has searched unsuccessfully for a company to take the graphite powder for recycle. During this time, 115 55-gallon drums (about 24,400 kilograms) of nonhazardous graphite waste accumulated. As a last resort, all the drums were disposed of in June 2004. Currently, drums are being disposed of as they are filled, about five at a time. Also included in the chemical waste volume disposed of in 2004 were two 20-foot transportainers containing 32,000 pounds (about 14,500 kilograms) of beryllium waste from the Beryllium Technology Facility.

2.4.3 Machine Shops (Technical Area 3)

The main Machine Shops Complex, located in TA-3, consists of two buildings, the Nonhazardous Materials Machine Shop (3-39) and the Radiological Hazardous Materials Machine Shop (3-102). Both buildings are located within the same exclusion area in the southwestern quadrant of TA-3. A 125-foot-long (38-meter-long) corridor connects the two buildings. In September 2001, Building 3-102 was placed on the radiological facility list. Historically, LANL has maintained a prototype capability in support of research and development for nearly all of the nuclear weapons components (parts) designed at LANL.

The primary capabilities and activities conducted at the Machine Shops Complex include:

- Fabrication of specialty components including unique, unusual, or one-of-a-kind parts, fixtures, tools, or other equipment for use (1) in various applications for destructive testing, (2) as replacement parts for the Stockpile Stewardship Program, and (3) in gloveboxes;
- Fabrication using unique or exotic materials such as depleted uranium and lithium and its compounds; and
- Dimensional inspection of finished fabricated components including measurements to ensure correct size and shape.

Machine Shops Performance and Changes Since the *1999 SWEIS*

Although not projected in the *1999 SWEIS*, building maintenance and upgrades were performed on Buildings 3-39 and 3-102. The heat-treating capability of Building 3-66 was duplicated in Building 3-102. Beryllium equipment was moved to the Beryllium Technology Facility from Building 3-39. Depleted uranium was added to the materials compatibility study, and controlled storage areas were added to Building 3-39 in support of the weapons program. In 2004, additional electrical upgrades of Building 3-39 were completed. Also in 2004, one facility modification provided space to house a vault for classified work at the Secret Restricted Data level in support of the Security and Safeguards Division's Joint Conflict and Tactical Simulation System. The Joint Conflict and Tactical Simulation System Laboratory consists of a vault for internal communications, an office area, and a stand-alone classified computing system, all of which were installed in room 27 of Building 3-39. The project involved adding walls inside the existing structure.

In 2005, modular units were constructed on the north side of Building 3-39 to conduct upgrades of test equipment, tooling, computer numerical controlled programming, and controls for TA-55 activities; these units are prototypes for the Plutonium Facilities Complex. All manufacturing science and technology activities conducted in Building 3-39 are nonhazardous. Other minor activities conducted in this space include robotics testing, tensile testing, and welding activities.

The principal activities listed above operated below the levels projected in the *1999 SWEIS*, including fabrication of specialty components and fabrication with unique materials. Dimensional inspection was provided for the fabrication activities.

Since 1999, radiological air emissions from the Machine Shops have been below those projected in the *1999 SWEIS*. The following nuclides were not identified in the *1999 SWEIS*, but have been present in dosimetrically insignificant amounts (microcuries): americium-241, plutonium-239, thorium-228, thorium-230, thorium-232, uranium-234, and uranium-235. The facility has no NPDES-permitted outfalls. In the past 6 years, transuranic, low-level radioactive, and chemical wastes either were not produced or their production was less than predicted in the *1999 SWEIS*. Until 2001, small quantities (less than 1 cubic yard or 1 cubic meter per year) of mixed low-level radioactive waste were produced, although none was projected in the *1999 SWEIS*.

2.4.4 Materials Science Laboratory (Technical Area 3)

The Materials Science Laboratory, located on the southeastern edge of TA-3, is composed of several buildings containing 27 laboratories, 60 offices, 21 materials research areas, and various support areas. The main building (3-1698) is a two-story structure with approximately 55,000 square feet (5,110 square meters) of floor space. The building is designed to accommodate scientists and researchers, including participants from academia and industry whose focus is on materials science research. This building first opened in 1993. In September 2001, the Materials Science Laboratory was placed on the radiological facility list, where it remains today.


Materials Science Laboratory at TA-3

The principal capabilities and activities conducted at the Materials Science Laboratory include:

- Materials processing to support formulation of a wide range of useful materials through the development of materials fabrication and chemical processing technologies;
- Mechanical testing in laboratories where materials are subjected to a broad range of mechanical loadings study their fundamental properties and characterize their performance;
- Development of advanced materials for high-strength and high-temperature applications; and
- Characterization of materials utilizing x-ray, optical metallography, spectroscopy, and surface science chemistry to understand the properties and processing of these materials and to apply that understanding to materials development.

Materials Science Laboratory Performance and Changes Since the *1999 SWEIS*

The *1999 SWEIS* projected completion of the top floor of the Materials Science Laboratory. This project remains unscheduled and unfunded. Construction of the Material Science and Technology Office Building in the southeast quadrant of TA-3 was initiated in 2003 and completed in 2004. This new building provides materials science and technology staff with permanent offices in place of a cluster of temporary trailers and transportable structures.

The principal capabilities listed above have been maintained at the levels projected in the *1999 SWEIS* or, in some cases, the processes have been improved. Radiological air emissions from this Key Facility have been sufficiently small, so measurements of radionuclides have not been necessary to meet facility or regulatory requirements. The facility has no NPDES-permitted outfalls. All generated wastes have been maintained below levels identified in the *1999 SWEIS*, except during 2000, when chemical wastes exceeded projections by approximately 620 pounds (280 kilograms) due to the generation of industrial solid waste by routine maintenance activities.

2.4.5 High Explosives Processing (Technical Areas 8, 9, 11, 16, 22, and 37)

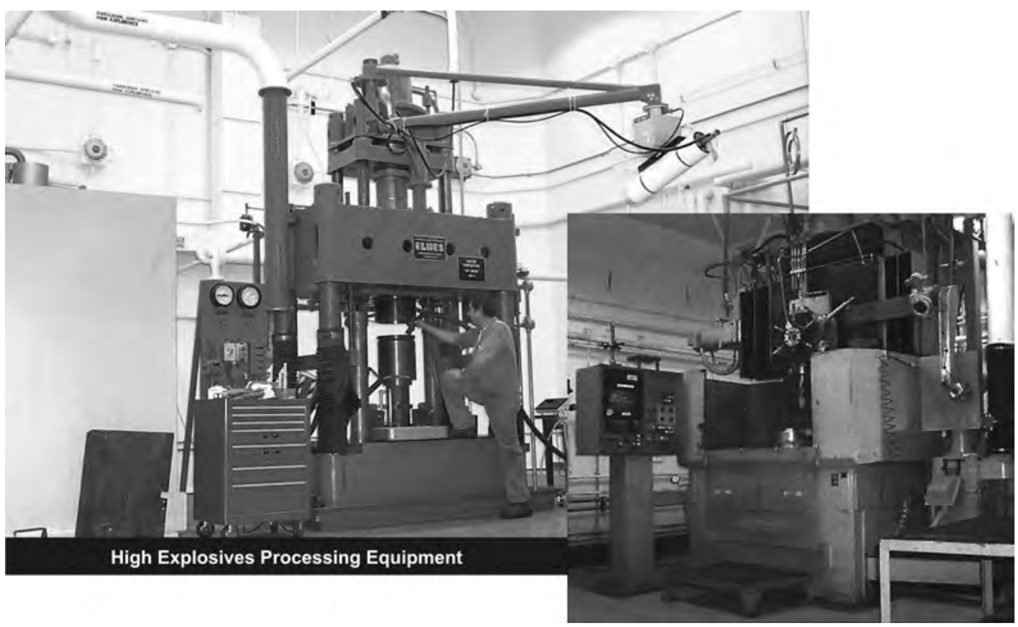
The High Explosives Research and Development and Processing Facilities are located in six TAs: TA-8, TA-9, TA-11, TA-16, TA-22, and TA-37. Most of these facilities were originally designed and built for production-scale operations during the early and mid-1950s and produced high explosives components for nuclear weapons in the U.S. stockpile reserve for several years. LANL has historically upgraded and modernized processing equipment in these facilities to provide prototype high explosives components to meet the needs of the Nevada Test Site Program, hydrodynamic tests at LANL, detonator design and production, and other high explosives activities.

Over the last few years, an average of 1,000 to 1,500 high explosives parts per year has been typically fabricated at LANL. Building types within this Key Facility consist of production and assembly facilities, analytical laboratories, explosives storage magazines, and a facility for treatment of explosive-contaminated wastewaters. At the time of the *1999 SWEIS*, this Key

Facility had one Hazard Category 2 nuclear building (the Radiography Facility) at TA-8. This building was downgraded to a radiological facility in 2005.

The primary capabilities and activities conducted at these facilities include:

- High explosives synthesis and production activities including explosive-manufacturing capabilities such as synthesizing new explosives and manufacturing pilot-plant quantities of raw explosives and plastic-bonded explosives;
- High explosives and plastics development and characterization for any explosives used in nuclear weapons technology;
- High explosives and plastics fabrication where high explosives powders are typically compacted into solid pieces and machined to final specified shapes;
- Assembly of test devices ranging from full-scale nuclear explosive-like assemblies (where fissile material has been replaced by inert material) to material characterization tests;
- Safety and mechanical testing of explosives samples, including tensile, compression, and creep properties; and
- Research, development, and fabrication of high-power detonators including detonator design; printed circuit manufacture; metal deposition and joining, plastic materials technology; explosives loading, initiation, and diagnostics; lasers; and safety of explosives systems design development and manufacturing activities.



High Explosives Processing Equipment

High Explosives Processing Facility Performance and Changes Since the *1999 SWEIS*

Although not projected in the *1999 SWEIS*, a real-time radiography capability was added to this Key Facility and became operational in 2001. Buildings 16-220, 16-222, 16-223, 16-224, 16-225, and 16-226 were vacated and demolished. Planning and modification work at TA-9 to consolidate high explosives formulation operations previously conducted at Building-16-340 continued. Explosives stored at TA-28 were moved to TA-37 for storage, and TA-28 is no longer used by the High Explosives Processing Key Facility. The Building-16-1409 incinerator associated with the burn operations of high explosives-contaminated combustible trash underwent Resource Conservation and Recovery Act (RCRA) clean-closure and was dismantled and scrapped. RCRA closure has also been obtained for TA-16-401 and TA-16-406, which are units at the TA-16 Burn Ground. Closure of MDA P, which began in 1997, was completed in 2002. An estimated total of about 20,800 cubic yards (15,900 cubic meters) of hazardous waste and 21,300 cubic yards (16,300 cubic meters) of other waste were excavated and shipped to a disposal facility. A total of 6,600 cubic yards (5,000 cubic meters) of material were shipped and used as clean fill at MDA J. The aboveground wastewater storage tank system was placed into service at TA-9 in 1998. The new High Explosives Wastewater Treatment Facility at TA-16 is a centralized treatment plant that became operational in 1997 and discharges approximately 35,000 gallons (132,000 liters) per year of treated effluent at an NPDES-permitted outfall. RCRA closure activities continued for the TA-16-387 flash pad and the TA-16-394 burn tray, resulting in removal of a total of about 860 cubic yards (660 cubic meters) of hazardous wastes. A burn unit was upgraded to improve capacity and efficiency and minimize environmental impacts. In 2000, the Cerro Grande Fire swept across TA-16, burning V-Site (an inoperable historic Manhattan Project era site), but all other buildings were placed into a safe closed condition, and fire personnel bulldozed a fire line around the Weapons Engineering Tritium Facility. No other High Explosives Processing facilities were destroyed, although some structures were damaged at TA-9, TA-11, and TA-37. All high explosives burning operations were consolidated at TA-16-388 and TA-16-399. Burning operations generally are limited to TA-16-388, although TA-16-399 is still available for burning of bulk high explosives.

In 2004, construction began on a new office building at the Hydrotest Design Facility, Building 22-120. Staff occupied the building in March 2005. In 2005, construction was completed on the new High-Power Detonator Production Facility, Building 22-115, and magazine 22-118. Use of the structures began in December 2005.

The principal activities at this Key Facility as described above were performed at levels equal to or less than those projected in the *1999 SWEIS*. No stacks have required monitoring for radiological air emissions. All non-point sources are measured using ambient monitoring. These facilities currently use 3 NPDES-permitted outfalls, compared to the 11 outfalls projected in the *1999 SWEIS*. Annual NPDES discharge rates since 1999 have remained below the levels projected in the *1999 SWEIS*. The quality of the NPDES effluent exceeded permit levels one time in March 2001 (LANL 2002d). Chemical wastes consistently exceeded *1999 SWEIS* projections for various reasons. Activities that caused these exceedances, some of which were covered by separate NEPA review, included: placement in storage of scrap metal for recycle due to the DOE radiological area release moratorium; cleanup of MDA R Legacy Material Action Project activities; and demolition and waste disposition of Buildings TA-16-220, -222, -223, -224, -225, and -226. Transuranic and mixed low-level radioactive waste generation has remained below the levels identified in the *1999 SWEIS*. Low-level radioactive waste quantities exceeded *1999 SWEIS* projections in 2003 by 12 cubic meters.

2.4.6 High Explosives Testing (Technical Areas 14, 15, 36, 39, and 40)

The High Explosives Testing Key Facility, located in five TAs (TA-14, TA-15, TA-36, TA-39, and TA-40), comprises more than one-half (22 of 40 square miles [14,080 of 25,600 acres (5,698 of 10,360 hectares)]) of the land area occupied by LANL and has 16 associated firing sites. The firing sites are in remote locations and canyons and specialize in experimental studies of the dynamic properties of materials under high-pressure and -temperature conditions. The facilities that make up the explosives testing operations are used primarily for research, development, test operations, and detonator development and testing related to the DOE Stockpile Stewardship Program. Major High Explosives Testing buildings are located at TA-15 and include the Dual Axis Radiographic Hydrodynamic Test Facility (TA-15-312) and the TA-15-306 firing site. Building types consist of preparation and assembly facilities, bunkers, analytical laboratories, high explosives storage magazines, and offices.


Typical Nonnuclear High Explosive Test

The major capabilities and categories of high explosives testing activities include:

- Hydrodynamic tests consisting of a dynamic integrated systems test of a mock-up nuclear package, during which the high explosives are detonated and the resulting motions and reactions of materials and components are observed and measured;
- Dynamic experiments to provide information regarding the basic physics of materials or to characterize the physical changes or motion of materials under the influence of high explosives detonations;
- Explosives research and testing activities conducted primarily to study the properties of the explosives themselves compared to explosive effects on other materials;
- Munitions experiment testing conducted to study the influence of external stimuli on explosives;
- High explosives pulsed-power experiment testing conducted to develop and study new concepts based on the use of explosively-driven electromagnetic power systems;

- Calibration, development, and maintenance testing conducted primarily to prepare for more elaborate tests, including tests to develop, evaluate, and calibrate diagnostic instrumentation or other systems; and
- Other explosives testing activities such as development of advanced high explosives and work to improve weapons evaluation techniques.

High Explosives Testing Facility Performance and Changes Since the *1999 SWEIS*

As projected in the *1999 SWEIS*, the Dual Axis Radiographic Hydrodynamic Test Facility was constructed. The first axis became operational in 2001 and the second axis was tested in late 2004. In 2005, failing accelerator cells at the Dual Axis Radiographic Hydrodynamic Test Facility Axis II were refurbished to bring them up to design specifications. Construction was also initiated on a concrete ramp and an access door into the Dual Axis Radiographic Hydrodynamic Test Facility Axis II; this access door will facilitate accelerator cell and equipment maintenance within the axis. As required by the *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement* (DOE 1995a), the Pulsed High Energy Radiation Machine Emitting X-Rays Facility (TA-15-184) was deactivated in March 2004. Although not projected, the Applied Research Optics Electronics Laboratory and adjacent parking lot were constructed. The outfall at TA-36 was eliminated from the NPDES permit.[7] Closeout of outfall 03A-028 located at the Pulsed High Energy Radiographic Machine Emitting X-rays Facility (Building 15-184) was initiated in 2005. Temporary closeout of aboveground storage tanks located at Buildings 15-306, 15-310, and 36-86 was initiated in 2005. These tanks (15-324, 15-325, 15-473, 15-474, 36-141, 36-142) previously contained dielectric mineral oil in support of radiographic experiments. Several structures within the High Explosives Testing Key Facilities were decommissioned and removed during 2005. These structures include TA-15-8, TA-15-46, TA-15-138, TA-15-141, TA-40-4, TA-40-19, and TA-40-43. Construction was also completed on the High Explosives Preparation Facility, the Camera Room at TA-36-12, the carpenter shop at TA-15, the X-Ray Calibration Facility at TA-15, and a warehouse at TA-15.

The 2000 Cerro Grande Fire destroyed or damaged equipment, materials, and storage structures within this Key Facility. Damaged buildings were subsequently decontaminated and demolished. As approximately 14 facilities were destroyed and approximately 28 additional facilities were damaged, the Cerro Grande Fire has had a long-term effect on the High Explosives Testing operations. Management has limited high explosives testing at TA-40 to tests that are contained because of adjacent steep canyon walls and excess forest fuels. All burned structures have been replaced.

As stated above, the principal activities have operated below the levels projected in the *1999 SWEIS*. During 2005, foam was used to reduce particulate emissions during dynamic experiments. Aqueous foam was used on explosive tests that included beryllium. Use of the foam continues for certain tests, but plans are to move these tests into containments.

[7] *This outfall was originally accounted for with the non-Key Facilities.*

No stacks require monitoring for radiological air emissions at this Key Facility; all non-point sources are measured using ambient monitoring. Chemical usage has been below that projected in the *1999 SWEIS*. This Key Facility has two functional NPDES-permitted outfalls, compared to 14 discussed in the *1999 SWEIS*. Total NPDES discharge volumes for these two outfalls were within *1999 SWEIS* projections for 2002 through 2005 and exceeded projected levels for 3 years (1999 through 2001). It should be noted that, prior to 2002, discharge rates were estimated and may have resulted in an overestimate of volume. A water meter was installed in 2002 to provide more accurate flow data. The quality of effluent from the Dual Axis Radiographic Hydrodynamic Test Facility exceeded NPDES permit levels one time during the period of interest in September 2001; changes were implemented and the effluent met requirements by the next sampling period (LANL 2002d). Chemical wastes produced were below *1999 SWEIS* projections, except in 2000, when chemical wastes exceeded projections due to cleanup performed following the Cerro Grande Fire. Construction and demolition debris accounted for an estimated 20,600 pounds (9,360 kilograms) of nonhazardous chemical waste that was disposed of in sanitary landfills. The remaining chemical waste was shipped offsite to approved hazardous waste facilities for treatment and disposal. Production of transuranic, low-level radioactive, and mixed low-level radioactive wastes was below the levels identified in the *1999 SWEIS* for years 1999 through 2005, with the exception of 2004, when mixed low-level radioactive wastes exceeded projections by approximately 18 cubic meters (640 cubic feet). The excess mixed low-level radioactive waste consisted mostly of lead bricks and plates used for shielding; the lead was contaminated with beryllium and depleted uranium. This was the result of an effort across the High Explosive Testing TAs to remove unwanted lead from the site.

2.4.7 Tritium Facilities (Technical Area 16 and Technical Area 21)

This Key Facility consists of tritium operations performed within TA-16 and TA-21. Tritium operations were conducted in three buildings over the past 7 years: the Weapons Engineering Tritium Facility (Building 16-205), the Tritium Science and Fabrication Facility (Building 21-209), and the Tritium Systems Test Assembly (Building 21-155N). These facilities support several tritium-related programs at LANL and play an important role in DOE energy research and nuclear weapons programs. The primary potential environmental impacts from tritium operations at LANL reside with these facilities.

The Weapons Engineering Tritium Facility at TA-16 is a Hazard Category 2 nuclear facility. It is a single-level structure with approximately 7,890 square feet (730 square meters) of floor area.

The Tritium Science and Fabrication Facility is a tritium research and development facility located in Building 21-209 at TA-21. This facility is located east of the Tritium Systems Test Assembly Facility at the DP East research area. During 2004, the tritium inventory at the Tritium Science and Fabrication Facility was reduced to less than 0.07 pounds (30 grams). This facility was then reclassified from a Hazard Category 2 to a Hazard Category 3 facility in August 2004. Programmatic activities at the Tritium Science and Fabrication Facility were reduced and moved to the Weapons Engineering Tritium Facility in 2005. The transition of the Tritium Science and Fabrication Facility to a radiological facility was completed in 2005. Neutron tube target loading activities at the Tritium Science and Fabrication Facility ended in March 2006 and the facility was placed in a surveillance and maintenance mode. NNSA prepared the *Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading*

Production (DOE 2005b); this project relocated the neutron tube target loading operations from the Tritium Science and Fabrication Facility to Sandia National Laboratories in Albuquerque, New Mexico.

The Tritium Systems Test Assembly Facility includes the main experimental tritium area (3,700 square feet [344 square meters]) and two small laboratories. The facility is located at the DP East research area. During 2003, the tritium inventory at the Tritium Systems Test Assembly was reduced; as a result, the facility was reclassified to a radiological facility. In August 2003, the Tritium Systems Test Assembly was formally designated for surveillance and maintenance and limited equipment removal, as part of its decontamination, decommissioning, and ultimate demolition process.

Weapons Engineering Tritium Facility at TA-16

The principal capabilities and activities conducted at the Weapons Engineering Tritium Facility, the Tritium Systems Test Assembly, and the Tritium Science and Fabrication Facility included:

- High-pressure gas fills and processing operations for research and development and nuclear weapon systems;
- Function testing for highly specialized gas boost systems used in nuclear weapons and experimental equipment;
- Separation and purification of tritium from gaseous mixtures using diffusion and membrane purification techniques;
- Tritium-handling capabilities to accommodate a wide variety of metallurgical and material research activities;

- Gas analysis using spectrometry and other techniques such as beta scintillation counting to measure the composition and quantities of gas samples;
- Calorimetry used for measuring the amount of tritium in a container; and
- Storage of tritium gas and tritium oxide.

Tritium Facilities Performance and Changes Since the *1999 SWEIS*

Modifications at the Tritium Key Facility since 1999 have included remodeling and upgrading facility structures, as well as constructing a new office building. During 2005, there were major construction activities and building modifications at the Weapons Engineering Tritium Facility at TA-16, including addition of a new diesel generator and an upgraded uninterruptible power supply unit. Inclusion of Building 16-450 in the Weapons Engineering Tritium Facility nuclear boundary was postponed because of the LANL operations standdown and it has yet to be included. In addition, NNSA halted implementation of neutron tube target loading activities at the Weapons Engineering Tritium Facility and transferred these activities and associated programmatic hardware to Sandia National Laboratories in Albuquerque in 2005.

Between 1999 and 2005,[8] no new capabilities were added to the Tritium Key Facility, and one capability, cryogenic separation, was lost due to discontinuation of its operation in the Tritium Systems Test Assembly Facility where it was located. Among the continuing capabilities, operation levels have consistently been below the levels projected in the *1999 SWEIS* and have remained within the established environmental envelope. For example, in 2005, 22 high-pressure gas fill operations were conducted, compared to 65 fills projected by the *1999 SWEIS* ROD, and approximately 11 gas boost system tests and gas processing operations were performed, compared to 35 projected (LANL 2005f).

The following summaries of operations data over the period 1999 through 2005 illustrate how activity levels are affecting the surrounding environment. All three buildings are served by ventilation systems that exhaust to stacks. Between 1999 and 2005, tritium air emissions were below the *1999 SWEIS* projections, with two exceptions: a one-time release of elemental tritium in January 2001 at the Weapons Engineering Tritium Facility and an exceedance of tritium in water vapor released from the Tritium Systems Test Assembly during 2002, 2003, 2004, and 2005 (due to deactivation activities). This Key Facility has two NPDES-permitted outfalls, as projected in the *1999 SWEIS*.[9] Annual NPDES discharge rates exceeded *1999 SWEIS* projections 5 out of 7 years. The quality of the TA-21 effluent exceeded NPDES permit levels twice in 1999 (LANL 2000e). Chemical waste volumes exceeded *1999 SWEIS* projections in 2001 and 2002 due to refrigerant replacement at Building 16-450. Low-level radioactive waste, mixed low-level radioactive waste, and transuranic waste volumes were all below the projected amounts.

[8] *The discussion of operations since 1999 includes operations at the TA-21 facilities, the Tritium Systems Test Assembly and Tritium Science and Fabrication Facility, as well as the TA-16 Weapons Engineering Tritium Facility operations.*
[9] *Although these outfalls were ascribed to the Tritium Key Facility in the 1999 SWEIS, the majority of the effluent comes from the TA-21 Steam Plant. For the sake of consistency, these outfalls continue to be accounted for with the Tritium Key Facility in this SWEIS.*

2.4.8 Pajarito Site (Technical Area 18)

The Pajarito Site is located entirely at TA-18. As described in the *1999 SWEIS*, this Key Facility includes the Los Alamos Critical Experiments Facility and other experimental facilities, and consists of a main building, three outlying remote-controlled critical assembly buildings known as the Critical Assembly and Storage Area, and several smaller support buildings including a vault facility called the Hillside Vault. These facilities are 3 miles (4.8 kilometers) from the nearest residential area, White Rock, and 0.25 miles (400 meters) from the closest TA. The Pajarito Site is located in a canyon at the confluence of Pajarito Canyon and Threemile Canyon. The surrounding canyon walls rise approximately 200 feet (61 meters) on three sides of the site. DOE lists this entire Key Facility as a Hazard Category 2 nuclear facility and identifies seven buildings with nuclear hazard categorizations.


The Pajarito Site (TA-18)

This Key Facility studies both the static and dynamic behavior of multiplying assemblies of nuclear materials. In addition, the Pajarito Site provides the capability to perform hands-on training and experiments with special nuclear material in various configurations below critical mass.

The principal capabilities of and activities conducted at the Pajarito Site since 1999 include:

- Use of critical assemblies to evaluate the performance of personnel radiation dosimeters;
- Development of nuclear materials detection and monitoring instruments;
- Characterization and evaluation of materials, primarily by measuring the nuclear properties of these materials;
- Subcritical measurements performed on arrays of fissile materials that are below critical mass for material in a given form;
- Experiments using bare and reflected metal critical assemblies that operate on a fast-neutron spectrum;

- Dynamic measurements conducted with two fast-pulsed assemblies that produce controlled, reproducible pulses of neutron and gamma radiation from tens of microseconds to several tens of milliseconds in duration;
- Use of critical assemblies to study "skyshine" (radiation transported point-to-point without a direct line of sight) and to produce radiation fields to mimic those found around nuclear weapons production and dismantlement facilities, in storage areas, and in experimental areas;
- Use of fast-pulsed assemblies that have the capability to vaporize fissile materials used to test materials, measure the properties of fissile materials, and test reactor fuel materials in simulated accident conditions;
- Use of critical assemblies that have varying spectral characteristics in both steady-state and pulsed modes to irradiate fissile materials and other materials with energetic responses for the purposes of testing and verifying computer code calculations; and
- Storage of Security Category III quantities of special nuclear material in the form of sealed sources recovered by the Off-Site Source Recovery Project.

Pajarito Site Performance and Changes Since the *1999 SWEIS*

Since the publication of the *1999 SWEIS*, two office trailers (TA-18-300 and -301) were installed at the Pajarito Site, security enhancements were made, and a cable tray was relocated within this site. The *1999 SWEIS* ROD projected replacement of the portable linear accelerator; this has not been performed. Construction projects in 2005 consisted of security and safety enhancements. In 2002, NNSA prepared the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE 2002i). In the associated ROD (67 FR 79906), NNSA decided to relocate Security Category I and II capabilities and materials to the Device Assembly Facility at the Nevada Test Site, in effect initiating the closure of TA-18. Security Category I and II special nuclear materials were moved from this area to the Plutonium Facility Complex at TA-55 pending transfer to the Nevada Test Site. (Currently only Security Category IV material remains at TA-18). Implementation of the ROD was initiated in 2004 (for further information see Appendix H, Section H.1). The *1999 SWEIS* identified nine capabilities for this Key Facility, all of which are still operating. The Nuclear Measurements School, which had moved to the Chemistry and Metallurgy Research Building from the Pajarito Site before the *1999 SWEIS*, moved back to the Pajarito Site in 2000. The International Atomic Energy Agency Classroom returned to the Chemistry and Metallurgy Research Building in 2004, but the rest of the school remains at TA-18.

The Cerro Grande Fire damaged no facilities at TA-18; however, the fire destroyed much of the vegetation in and around the Pajarito Site. As TA-18 is located in a canyon bottom, postfire flooding became a major concern. A flood contingency plan and flood control structures were designed to protect personnel, infrastructure, and nuclear materials. Some portable structures, such as metal sheds used to store radioactive sources, were moved to higher ground.

The principal capabilities of this facility, as listed above, have operated below the levels projected in the *1999 SWEIS*, in part due to a safety stand-down in late 1998 to 1999 and operational downtime from August 2000 to February 2003. There have been no measurable radiological air emissions from the Pajarito Site since 1999. The facility has no NPDES-permitted outfalls. All wastes produced were below levels identified in the *1999 SWEIS*, except during 2000, when approximately 280 cubic feet (8 cubic meters) of mixed low-level radioactive waste were generated as a result of maintenance activities.

2.4.9 Target Fabrication Facility (Technical Area 35)

The Target Fabrication Facility, located at TA-35, comprises three buildings (35-213, 35-455, and 35-458). The main building is a two-story structure encompassing approximately 61,000 square feet (5,670 square meters) of floor space housing activities related to weapons production and laser fusion research. The Target Fabrication Facility is located immediately to the east of TA-55 and directly north of TA-50. This Key Facility is categorized as a low hazard nonnuclear facility. Exhaust air from process equipment is filtered prior to exhaust to the atmosphere. Sanitary waste is piped to the sanitary waste disposal plant located in TA-46. Radioactive liquid waste and liquid chemical waste are transported to the TA-50 Radioactive Liquid Waste Treatment Facility using a direct pipeline.

Inspection of target component (TA-35)

The principal capabilities and activities conducted at the Target Fabrication Facility include:

- Precision machining and target fabrication operations to produce sophisticated devices consisting of highly accurate part shapes and often optical-quality surface finishes;
- Polymer synthesis to formulate new polymers, study their structure and properties, and fabricate them into various devices and components;

- Chemical vapor deposition and chemical vapor infiltration to produce metallic and ceramic bulk coatings, various forms of carbon (including pyrolytic graphite, amorphous carbon, and diamond), nanocrystalline films, powder coatings, thin films, and a variety of shapes up to 3.5 inches (9 centimeters) in diameter and 0.5 inches (1.25 centimeters) in thickness; and

- Characterization of materials.

Target Fabrication Facility Performance and Changes Since the *1999 SWEIS*

No major additions or modifications have occurred at the Target Fabrication Facility since issuance of the *1999 SWEIS* ROD. The principal activities, as listed above, operated at or below the levels projected in the *1999 SWEIS*, including the precision machining and target fabrication, the polymer synthesis, and the chemical and physical vapor deposition capabilities. Material characterization for tritium reservoirs operated for 2 years.

Programs at the Target Fabrication Facility (TA-35) suffered substantial downtime and loss of productivity during and after the Cerro Grande Fire. No direct fire damage occurred; however, some equipment was damaged because of fluctuating power and loss of liquid nitrogen cooling. Additionally, smoke damage to work areas and air-handling systems was sufficient to prevent use of the Target Assembly Area.

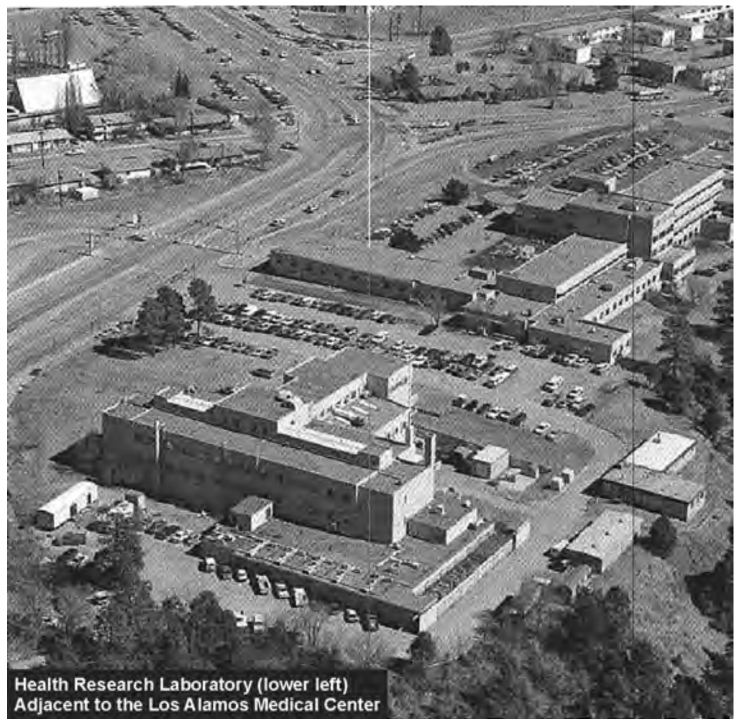
The Target Fabrication Facility has no NPDES-permitted outfalls. Radiological air emissions since 1999 were below the levels projected in the *1999 SWEIS* or were sufficiently small that measurement systems were not deemed necessary to meet regulatory or facility requirements. Waste volumes were within the amounts projected in the *1999 SWEIS*, except chemical wastes, which exceeded projections in 2005 due to disposal of beryllium-contaminated waste from disposal of excess equipment from Rocky Flats, decommissioning of beryllium operations in Room A7, and removal and replacement of a beryllium-contaminated machine from the machine shop.

2.4.10 Bioscience Facilities (Technical Areas 43, 3, 16, 35, 46) (formerly called the Health Research Laboratory [Technical Area 43])

Since publication of the *1999 SWEIS*, the definition of this Key Facility has expanded to include a broader picture of bioscience research taking place across LANL. Some of the capabilities that were attributed to the Health Research Laboratory in the *1999 SWEIS* have become more visible as research and development in particular areas have increased, and some have become less visible as research and development in other areas have declined. These changes, which reflect the dynamic nature of a research laboratory, required an expanded definition of this Key Facility.

The Bioscience Facilities currently include the main Health Research Laboratory (TA-43), as well as additional offices and laboratories located at TA-3, TA-16, TA-35, and TA-46. The impacts of Bioscience Facilities activities at TA-3-1698, the Materials Science Laboratory, are accounted together with the potential impacts of that Key Facility and are not double-counted here. Operations at TA-35, TA-43, and TA-46 have chemical, laser, and limited radiological activities that maintain hazardous materials inventories and generate hazardous chemical wastes and very small amounts of low-level radioactive waste.

There are four biosafety levels consisting of protocols for laboratory practices, techniques, safety equipment, and laboratory facilities. Biosafety Level 1 and Biosafety Level 2 activities and laboratories are currently in operation at LANL and are covered by this SWEIS (these levels are defined in Appendix C, Section C.3). Work conducted in these areas is governed by safety and security requirements for biological agents as outlined in the document entitled, "Biosafety in Microbiological and Biomedical Laboratories," published by the Center for Disease Control, including biohazardous materials listed for each respective biosafety level (HHS 2007).


Health Research Laboratory (lower left)
Adjacent to the Los Alamos Medical Center

Operations at this Key Facility have evolved a great deal since 1999. At that time, the principal capabilities and activities were:

- Research to characterize the extent of diversity in environmental microbes and to understand their functions and occurrences in the environment;
- Research using molecular and biochemical techniques to determine and analyze the sequence of genomes;
- Research using imaging and spectroscopy systems to analyze the structures and functions of subcellular systems and components;
- Research investigating the effects of natural and catastrophic cellular events like response to aging, harmful chemical and physical agents, and cancer;
- Capability to generate biometric organic materials and construct synthetic biomolecules;
- Research isolating and characterizing the properties and three-dimensional shapes of deoxyribonucleic acid (DNA) and protein molecules;
- Performance of whole-body scans as a service to the LANL Personnel Monitoring Program; and
- General biological work performed at Biosafety Levels 1 and 2, which were performed under safety and security requirements for biological materials, including biohazardous material that can be worked at these levels.

Bioscience Facilities Performance and Changes Since the *1999 SWEIS*

As discussed, major additions have been made to the definition of this Key Facility since the *1999 SWEIS*. Today, the principal capabilities and activities conducted at the Bioscience Facilities include:

- Biologically inspired materials research, including studies of how some materials mimic the functions of living systems based upon the relationships found between structure, function, and formation;
- Cell biology projects focused on understanding cellular responses to stress over a range of resolutions from molecular biochemistry to whole-cell studies and proceeding to multicellular and cell-environment interactions;
- Computational biology research focused on developing tools for managing, analyzing, and interpreting biological data and on modeling simple and complex biological systems;
- Environmental microbiology research focused on microbial systems and their environment, including the collection of environmental samples containing microbes, biochemical and genetic analysis of their distribution and functions in ecological systems, and growth and analysis of environmental isolates;
- Genomic studies using molecular and biochemical techniques to analyze the genes of humans, animals, plants, and fungi, as well as genetic material of microbes and viruses including the development of strategies to evaluate the specific sequence of individual genes and gene mapping;
- Bioscience research emphasizing the development and implementation of high-throughput tools and technologies for understanding biology at the systems level;
- Measurement science and diagnostics capabilities including a variety of spectroscopies for analysis of biomolecules and biomolecular complexes, flow cytometry-based analysis of materials, and mass spectrometry for proteomics, metabolomics, and structural biology;
- Molecular synthesis work focused on creating new, isotopically labeled molecules for observation of specific chemical groups and for use as standards in the detection of chemical agents and biological toxins;
- Structural biology using experimental techniques such as x-ray scattering and neutron diffraction, nuclear magnetic resonance, time-resolved vibrational spectroscopies, and state-of-the-art neutron protein crystallography;
- Biothreat reduction and bioforensics analyses, including DNA sequencing, single nucleotide polymorphism, and other molecular approaches to identify pathogen strain signatures for biodefense and national security purposes;
- Pathogenesis research involving genome-scale and computationally enhanced experimental studies to gain a quantitative understanding of various aspects of pathogen life cycles, with a focus on understanding infections in humans, animals, and plants and the epidemiology and life cycle of pathogens in the environment; and

- General biological work performed at Biosafety Levels 1 and 2, including select agent work at Biosafety Level 2 under the Center for Disease Control's "Biosafety in Microbiological and Biomedical Laboratories" guidelines.

The changes in the descriptions of the capabilities ascribed to the Bioscience Facilities have had negligible impacts on wastes and emissions. Most of the principal activities described above remained below *1999 SWEIS* projections and within the established environmental envelope.

Activity levels within the environmental microbiology and genomics capabilities exceeded *1999 SWEIS* projections 1 year out of 7. Research involving DNA exceeded *1999 SWEIS* projections 5 out of 7 years, and research involving protein molecules exceeded projections all 7 years. A number of projects involving work with viruses not specifically anticipated in the *1999 SWEIS* have been approved.

Two changes of note are that bioscience work with radioactive materials is continually decreasing and the animal colony was eliminated in 1999. Although the colony was eliminated, live animals including small animals, amphibians, and insects, are still kept for short periods of time at various locations at LANL, and wild animal handling is performed during environmental surveillance activities in the field and in field trailers.

A Biosafety Level 3 facility was constructed in 2004, but operational occupancy and operation has not occurred (as already stated). NNSA is preparing an EIS to analyze the potential impacts of its operation.

The effects of the Cerro Grande Fire on the Bioscience Facilities and operations included the loss of portable offices containing computers, intellectual property, and data at TA-46. Smoke damage occurred in several buildings at TA-43 and TA-46, requiring cleaning or replacement of an air-handling system and many replacement air filters, as well as replacement of laser optics (TA-46 and TA-3-1698).

Radiological air emissions are not measured for this Key Facility. The Bioscience Facilities currently have no NPDES-permitted outfalls. One outfall was projected in the *1999 SWEIS*, but was removed from service in 1999; no flow was discharged from the outfall during that year. Chemical and radioactive wastes generated were below the volumes projected in the *1999 SWEIS*.

2.4.11 Radiochemistry Facility (Technical Area 48)

The Radiochemistry Key Facility includes all of TA-48 (116 acres [50 hectares]). The facility has three roles: research, production of medical radioisotopes, and support services to other LANL organizations, primarily through radiological and chemical analyses of samples. TA-48 contains five major research buildings: the Radiochemistry Laboratory (48-1), the Assembly Checkout Building (48-17), the Diagnostic Instrumentation and Development Building (48-28), the Clean Chemistry/Mass Spectrometry Building (48-45), and the Weapons Analytical Chemistry Facility (48-107). There is also a Machine and Fabrication Shop (48-8). The Radiochemistry Laboratory (48-1) was downgraded to a radiological facility in 2003.

The principal capabilities and activities conducted at TA-48 include:


Radiochemistry Hot Cell (TA-48)

- Radionuclide transport studies including numerous chemical and geochemical investigations that address concerns about hydrologic flow and transport of radionuclides;
- Environmental remediation capabilities including characterization and remediation of soils contaminated with radionuclides and toxic metals, data analysis, and integrated site-wide assessment;
- Ultra-low-level measurements using isotopic tracers and high-sensitivity measurement technologies to support the nuclear weapons program;
- Development of radiation detectors, conduct of radiochemical separations, and performance of nuclear and radiochemistry for non-weapons-related work;
- Isotope production involving the chemical separation and distribution of isotopes to the medical and industrial communities;
- Actinide and transuranic chemistry using the special safe handling environment provided by the alpha wing of the Radiochemistry Laboratory;
- Reexamination of archive data and measurement of nuclear process parameters of interest;
- Inorganic chemistry work including synthesis, catalysis, and actinide chemistry, as well as the development of environmental technology;
- Synthesis, structural analysis, and x-ray diffraction analysis of actinide complexes in both single-crystal and powder form; and
- Sample counting involving measurement of the quantity of radioactivity present in each sample.

Radiochemistry Facility Performance and Changes Since the *1999 SWEIS*

No facility changes were projected for the Radiochemistry Facility in the *1999 SWEIS*. During 2005, the fire notification system was upgraded under the institutional program. The Building 48-1 roof was replaced in 2007, and heating, ventilation, and air conditioning upgrades are underway. Five structures at TA-48 suffered only minor direct effects from the Cerro Grande Fire; activities in these buildings were not affected. Building 48-45, the Clean Chemistry/Mass Spectrometry Building, however, suffered severe ash, dirt, and soot contamination and its interior was subsequently gutted and replaced.

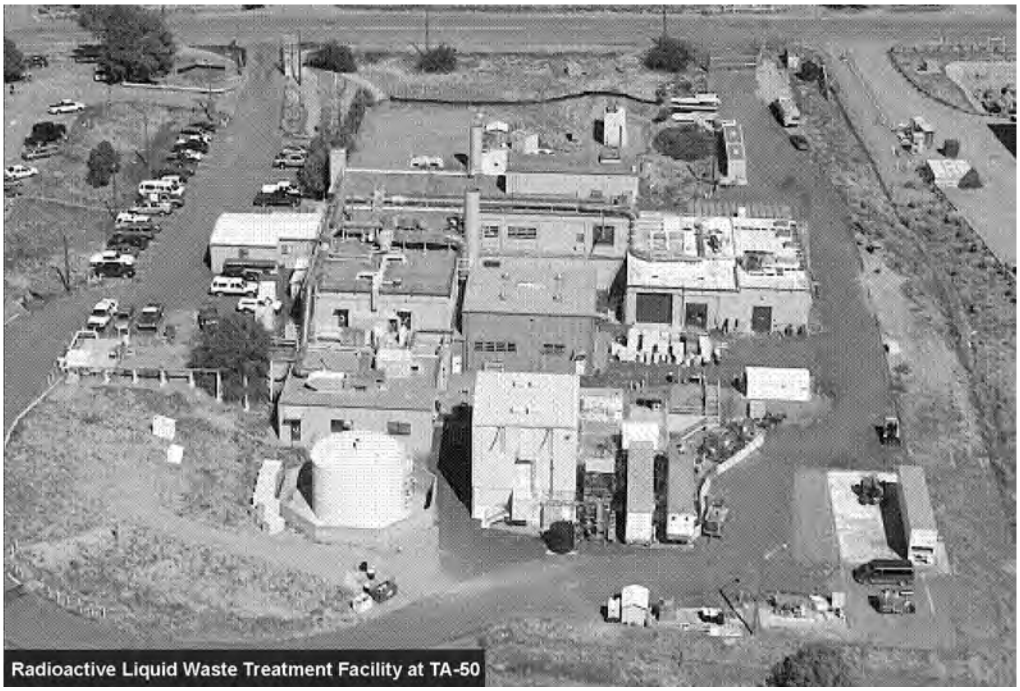
Many of the activities listed above operated at or below the levels projected in the *1999 SWEIS*. In 2005, the environmental remediation capability operations were approximately half the projected level, and the structural analysis capability level of operations was one-third of its projected level. The high-sensitivity measurement technologies level of operations was approximately the same as the level projected in the *1999 SWEIS*. Radiochemical operations levels were slightly lower than projected levels from 1999 to 2002 and substantially decreased in 2003, 2004, and 2005. Both the data analysis and actinide chemistry capabilities operated below the levels of activity projected in the *1999 SWEIS*.

Several other capabilities exceeded the *1999 SWEIS* projections. There was a slight increase in the level of operations for isotope production and sample counting from 1999 through 2005. In addition, radionuclide transport studies increased operations levels to approximately twice the levels projected in the *1999 SWEIS*. Radiochemical operations increased to twice the levels projected in the *1999 SWEIS* until 2002, when there was a substantial decrease in the operations levels.

Radiological air emissions were below *1999 SWEIS* projections for arsenic-72, beryllium-7, bromine-77, plutonium-239, and uranium-235 only. Release of several radionuclides exceeded projections at least 1 year out of 7 (1999 through 2005) including arsenic-73, arsenic-74, gallium-68, germanium-68, rubidium-86, and selenium-75. The nuclides plutonium-238, silicon-32, thorium-230, thorium-232, and uranium-238 were not identified in the *1999 SWEIS*, but were present at least once in the years 1999 through 2005 in microcurie quantities. The Radiochemistry Facility currently has no NPDES-permitted outfalls, although 2 outfalls were projected in the *1999 SWEIS* ROD. No discharges occurred after 1999 from these outfalls prior to their elimination. Chemical wastes from the Radiochemistry Facility exceeded *1999 SWEIS* projections in 2001 through 2004. Excess chemical waste volumes resulted in part from cleanup following the Cerro Grande Fire. Contaminated soil caused by a leaky pipe was subsequently removed from a fire recovery construction project after it was uncovered during excavation of trenches for new utilities. Several chemical clean-outs to dispose of unwanted chemicals were performed at this Key Facility as well. In 2003, transuranic and mixed low-level radioactive waste quantities were small, but exceeded *1999 SWEIS* projections. These wastes were generated by activities supporting the Building-48-1 reclassification from a nuclear facility to a radiological facility.

2.4.12 Radioactive Liquid Waste Treatment Facility (Technical Area 50)

The Radioactive Liquid Waste Treatment Facility is located in TA-50, near the center of LANL. It treats radioactive liquid wastes generated at other LANL facilities and houses analytical laboratories supporting waste treatment operations. This Key Facility consists of four primary structures: the Radioactive Liquid Waste Treatment Facility (50-01), the tank farm and pumping station (50-02), the acid and caustic solution tank farm (50-66), and a 100,000-gallon (380,000-liter) influent holding tank (50-90), as well as a number of ancillary structures. Presently, these four structures are considered one Hazard Category 2 nuclear facility.



Radioactive Liquid Waste Treatment Facility at TA-50

The principal capabilities and activities conducted at the Radioactive Liquid Waste Treatment Facility include:

- Waste characterization and packaging including identification and quantification of constituents of concern in waste streams and packaging and labeling waste according to U.S. Department of Transportation regulations;
- Waste transportation including inspection and cross-checking for acceptance;
- Liquid and solid chemical materials and radioactive waste storage;
- Waste pretreatment;
- Radiological liquid waste treatment using a number of treatment processes, including ultrafiltration and reverse osmosis; and
- Secondary waste treatment.

Radioactive Liquid Waste Treatment Facility Performance and Changes Since the *1999 SWEIS*

The decontamination capability was transferred to the Solid Radioactive and Chemical Waste Key Facility in 2000. Between 1999 and 2005, all liquid waste discharge volumes processed through this Key Facility were less than projected in the *1999 SWEIS* due to ongoing source reduction efforts and internal recycling by waste generators. Most of the process changes at the Radioactive Liquid Waste Treatment Facility have been aimed at further improving the quality of the effluent discharged by the facility. Nitrate reduction equipment was installed at the Radioactive Liquid Waste Treatment Facility in 1998 to improve effluent quality to meet new groundwater standards. In 2001, this equipment was taken out of service; currently, low-volume, high-nitrate liquid wastes are separated "upstream" by the waste generators and shipped to offsite commercial hazardous waste treatment facilities for treatment and disposal. An electrodialysis reversal unit and an evaporator were installed at the Radioactive Liquid Waste Treatment Facility in 1999 and 2000, respectively, to process the waste stream from the reverse osmosis unit. In 2002, a perchlorate removal system (using ion exchange resin columns) was added to the Radioactive Liquid Waste Treatment Facility to further improve the quality of effluent discharged.

The Radioactive Liquid Waste Treatment Facility was one of the very few facilities that operated during the Cerro Grande Fire. Operations were mandatory because radioactive liquid wastes continued to be generated. These flows would be expected from cooling systems and experiments that required cooling during the wildfire. Subsequent to the wildfire, radioactive liquid waste generation continued below typical rates because other LANL facilities required time to resume normal levels of operations.

Other changes that have taken place since issuance of the *1999 SWEIS* ROD largely have been the result of lowered incoming waste volumes, which have enabled changes in certain process steps and rendered others unnecessary. In 2000, the lead decontamination trailer was decommissioned because the quantity of lead needing decontamination had become so small that this operation was no longer cost-effective. In 2001, the transfer line that had carried liquid wastes from the TA-21 tritium facilities to the Radioactive Liquid Waste Treatment Facility was eliminated from service. Because of reduced waste volumes at the TA-21 facility, these materials are now transported by truck. During 2002, the Radioactive Liquid Waste Treatment Facility shop (Building 50-83) was relocated to TA-54 to make room for construction of a new 300,000-gallon (1,140,000-liter) influent storage facility funded by the Cerro Grande Rehabilitation Project. Construction of the new facility began in 2004.

The following radionuclides were not identified in the *1999 SWEIS* as potential radiological air pollutants, but were present in dosimetrically insignificant amounts (microcuries): americium-241, plutonium-238, plutonium-239, strontium-90, thorium-228, thorium-230, thorium-232, uranium-232, uranium-234, uranium-235, and uranium-238. The Radioactive Liquid Waste Treatment Facility has one NPDES-permitted outfall, as projected in the *1999 SWEIS*. Discharge flow rates have been consistently lower than projected in the *1999 SWEIS* and have steadily decreased. In 1999, the Radioactive Liquid Waste Treatment Facility effluent did not meet water quality discharge standards (the effluent exceeded NPDES permit quality standards nine times) and NMED issued a letter of noncompliance to LANL

(LANL 2002d). Since then, Radioactive Liquid Waste Treatment Facility has installed new or upgraded treatment processes to improve effluent quality. With these improvements, 2005 marked the sixth consecutive year that Radioactive Liquid Waste Treatment Facility effluent had zero violations of the NPDES permit limits and zero exceedances of the DOE Derived Concentration Guide for radioactive liquid wastes. Annual average nitrate discharges were reduced from 360 milligrams per liter in 1993 to less than 10 milligrams per liter in 2000 and have remained at that level through 2005. Another important improvement since the *1999 SWEIS* is that tritium-contaminated wastewater that was previously treated at TA-50 is now being treated at the TA-53 Radioactive Liquid Waste Treatment Plant, which has no environmental discharge of effluents. Transuranic waste generation levels have been below *1999 SWEIS* projections. Every year except 2001, the amount of chemical wastes generated at the Radioactive Liquid Waste Treatment Facility has been below projections. In 2001, however, chemical waste exceeded generation projections due to the replacement of storage tanks and some associated plumbing. Secondary wastes generated during the treatment of radioactive liquid waste and wastes resulting from decontamination operations at LANL, caused several waste streams to exceed projections. Solid low-level radioactive waste volumes exceeded generation projections in 1999, 2001, 2002, 2003, 2004, and 2005. In 2005, exceedance of the low-level radioactive waste volume projected in the *1999 SWEIS* resulted from about 75 cubic yards (58 cubic meters) of construction debris and soil generated from the Cerro Grande Rehabilitation Project to install additional influent storage tanks. Also included in the annual solid low-level radioactive waste volumes are the aqueous evaporator bottoms shipped offsite for treatment (about 96 cubic yards [73 cubic meters] in 2005). Solid mixed low-level radioactive waste generation at the Radioactive Liquid Waste Treatment Facility was not projected in the *1999 SWEIS*, but small quantities have been generated every year but one since 1999. More than 95 percent of these mixed wastes resulted from relocation of the lead contamination activities and attendant cleanup of the area; the balance were wastes from the analytical chemistry laboratory. Transuranic waste and mixed transuranic waste volumes have been below projections.

2.4.13 Los Alamos Neutron Science Center (Technical Area 53)

LANSCE lies entirely within TA-53 and comprises more than 400 structures. The majority of LANSCE operations are associated with the 800-million-electron-volt linear accelerator, a proton storage ring, and three major experimental areas: the Manuel Lujan Neutron Scattering Center (the Lujan Center), the Weapons Neutron Research Facility, and Experimental Area C. Experimental Area A, formerly used for materials irradiation experiments and isotope production, is currently inactive. Experimental Area C is the location of proton radiography experiments for the Stockpile Stewardship Program.

This Key Facility has three Hazard Category 3 and no Hazard Category 2 nuclear facilities. In September 2001, the radioactive liquid waste treatment facility and basins in TA-53 (53-945 and 53-954) were added to the LANL radiological facility list (LANL 2002h).

The principal capabilities and activities conducted at LANSCE include:

- Accelerator beam delivery, maintenance, and development of diagnostic instruments;

- Experimental area support including facility and plant operating and engineering services; environment, safety, and health services and oversight; site and building physical security; visitor control; and facility specific training;
- Neutron science and nuclear physics research;
- Accelerator transmutation of wastes experimentation;
- Subatomic physics research including proton radiography experiments;
- Production of medical radioisotopes; and
- High-power microwaves research and advanced accelerator development.

The Los Alamos Neutron Science Center at TA-53

LANSCE Performance and Changes Since the *1999 SWEIS*

The *1999 SWEIS* ROD projected that substantial facility changes and expansion would occur at LANSCE by December 2005. Three projects have been completed, and one has been started:

- The Low-Energy-Demonstration Accelerator became operational. The Low-Energy-Demonstration Accelerator started high-power conditioning of the radio frequency quadruple power supply in November 1998. The first proton beam was produced in March 1999, and maximum power was achieved in September 1999. It was designed for a maximum energy of 12 million electron volts, not the 40 million electron volts projected by the *1999 SWEIS* ROD. The Low-Energy-Demonstration Accelerator was shut down in December 2001 and will remain inactive. The current plan is to remove all support equipment and leave the building and the accelerator itself in place.

- Enhancements were made to the Short-Pulse Spallation Source. The Short-Pulse Spallation Source Project was completed in 2004. This project consisted of two components: Accelerator Enhancement and Spectrometer Enhancement. The Accelerator Enhancement portion completed in June 2003 provided a brighter H^- ion source and upgraded the Proton Storage Ring to handle the higher beam current. The Spectrometer Enhancement Subproject completed in January 2004 provided three new neutron-scattering spectrometers to the Lujan Center and upgraded the capability of one instrument.

- A new 100-megaelectronvolts Isotope Production Facility was constructed. Construction started in 2000 and the facility was completed in 2002. The Isotope Production Facility generated its first beam on December 23, 2003. Full production began in 2005.

- Closure of two sanitary lagoons was initiated. Characterization started in 1999 and continued into 2000. Cleanup at the south lagoon began in 2000 with removal of the sludge and liner. Data analysis and sampling continued through 2001 for both lagoons, and an Interim Action Plan was written for remediation of the north lagoon. Cleanup of the north lagoon was performed in 2002. The lagoons (Solid Waste Management Unit [SWMU] 53-002[a]-99) have been remediated, including complete removal of all contaminated sludge and liners; definition of the nature and extent of residual contamination; and determination that the residual contamination does not pose a potentially unacceptable risk to humans or the environment. Currently, the site is located within an industrial area under LANL (institutional) control and is expected to remain so for the reasonably foreseeable future. For these reasons, neither additional corrective action nor further characterization is warranted at the site. The closure report for the lagoons was reviewed and approved by NMED on July 25, 2006.

Projects that were anticipated to be completed by 2005 in the *1999 SWEIS*, but have not yet been started include the One-megawatt Target/Blanket; the Long-Pulse Spallation Source, including decontamination and renovation of Area A; the Los Alamos International Facility for Transmutation; the Exotic Isotope Production Facility; decontamination and renovation of Area A-East; and the Dynamic Experiment Laboratory. The Stockpile Stewardship Program is currently using Experimental Area C, Building 53-3P, for proton radiography and the Blue Room in Building 53-07 for neutron resonance spectroscopy.

In addition to these projected construction activities, several projects not anticipated in the *1999 SWEIS* have been implemented. A new warehouse was constructed in 1998 to store equipment and other materials formerly stored outside. A new waste treatment facility for radioactive liquids generated at LANSCE and two associated evaporation basins were constructed during 1999. Construction of a new cooling tower was completed in 2000. Construction of this and another cooling tower (structures 53-963 and 53-952) replace cooling towers 53-60, 53-62, and 53-64, which have been taken out of service. The new towers discharge through Outfall 03A-048, as did their predecessors. Construction of two new instruments on Flight Paths 12 and 13 at the Lujan Center started in 2002. The cold neutron Flight Path 12 was commissioned in February 2004, as was most of the NPD-Gamma experiment (NPD is a nuclear reaction in which a neutron impinges on a proton and emits a deuteron plus a gamma ray). The liquid hydrogen target was installed during fall 2005. Basic construction of

Flight Path 13 was completed in 2006. A new experimental facility for production of ultracold neutrons is nearing completion in Experimental Area B.

LANSCE was nearly untouched by the Cerro Grande Fire; a small portion of the roof of one building was damaged. The only impact to operations was evaluating and restoring the status of accelerator systems because site power was lost during the fire. Systems and equipment were returned to power sequentially instead of simultaneously, which required about a month to complete.

The *1999 SWEIS* identified seven capabilities for the LANSCE Key Facility. No new capabilities have been added, and none has been deleted. During 2001, LANSCE operated both accelerators and three of the five experimental areas. Area A has been idle for more than 2 years; Area B has been idle for several years, but as indicated above, a new Ultracold Neutron Facility is under construction (DOE 2002i).

All of the capabilities described above operated at activity levels below those projected in the *1999 SWEIS* or did not operate at all. Support of activities in the experimental areas was conducted as projected in the *1999 SWEIS*, including an increase in power for the LANSCE linear accelerator. Less than 10 percent of the projected number of neutron research experiments was conducted at the Lujan Center. Weapons-related experiments were conducted as well as experiments involving contained high explosives. Research and development was conducted on high-power microwaves and advanced accelerators.

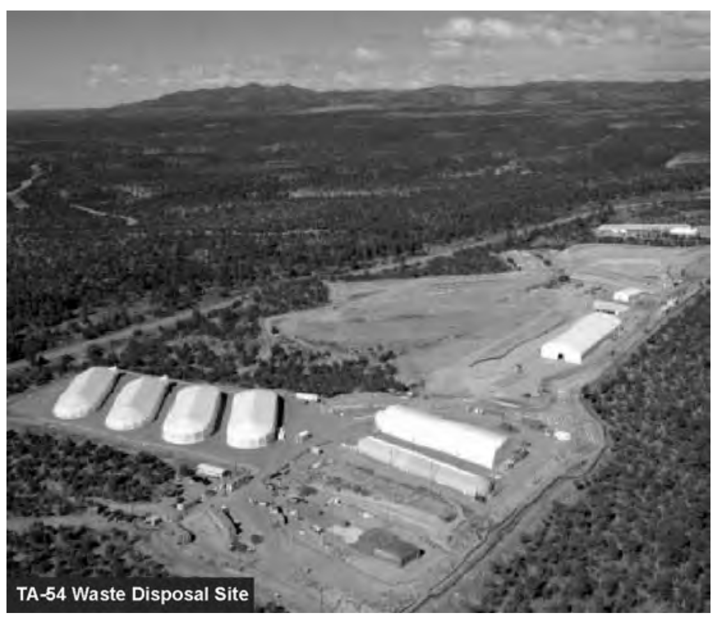
Because of the number of facilities that were not funded and therefore not completed, no accelerator waste transmutation tests were performed; no lead target tests were conducted; and no exotic, neutron-rich, and neutron-deficient isotopes were produced since issuance of the *1999 SWEIS* ROD. Ultra-cold neutron experiments ran only 3 of the 7 years.

The primary indicator of activity for LANSCE is production of the 800-million-electron-volt LANSCE proton beam. Between 1999 and 2005, production figures for the beam were all less than the 6,400 hours at 1,250 microamps projected by the *1999 SWEIS*. In fact, the delivery of an accelerator beam was successful one-third of the time projected in the *1999 SWEIS*. No medical isotopes were produced, except in 2005 when 64 targets for medical isotope production were irradiated, compared to 50 projected by the *1999 SWEIS*.

LANSCE accounts for more than 90 percent of all radioactive air emissions from LANL. These emissions come predominantly (greater than 95 percent) from stack ES–2, which ventilates Building 53-3, the linear accelerator, and adjacent experimental stations. Additional emissions come from stack ES–3, which exhausts the proton storage ring and experimental stations at the Manuel Lujan Center and the Weapons Neutron Research Facility buildings. Both ES–2 and ES–3 are equipped with continuous monitoring equipment. Emissions of activation products from LANSCE were higher in 2005 than in recent years due to the total hours of operation and the failure of one component of the emissions control system. The total point-source emissions were approximately 18,400 curies. As in recent years, the Area A beam stop did not operate during 2005; however, operations in Line D resulted in the majority of emissions reported for 2005. A corrective action implemented in late November 2005 returned emissions rates to their expected levels, and these reduced emissions rates are expected to continue in the future. The following nuclides were not projected as radiological air emissions in the *1999 SWEIS*, but have since been present in measured air emissions or occurred at levels above those projected (see Appendix B for additional information on air emissions): arsenic-72, arsenic-73, beryllium-7, bromine-76, bromine-77, bromine-82, carbon-11, cobalt-60, mercury-193, mercury-193m, mercury-195, mercury-195m, mercury-197, mercury-197m, mercury-203, nitrogen-16, osmium-191, oxygen-14, oxygen-15, selenium-75, sodium-24, sulfur-37, and tritium as water vapor. LANSCE currently has four NPDES-permitted outfalls, compared to five outfalls projected in the *1999 SWEIS*. These outfalls discharge cooling tower blowdown, and discharge rates were consistently below *1999 SWEIS* projections. While operational, the Low-Energy-Demonstration Accelerator (TA-53-952) cooling tower effluent exceeded NPDES permit levels twice in 1999, resulting in a shutdown of operations and an update of procedures (LANL 2000e). LANSCE generates both low-level radioactive liquid wastes and radioactive solid wastes such as beam line components and scrap metals, papers, and plastics. All chemical waste, low-level radioactive waste, mixed low-level radioactive waste, and transuranic waste generation amounts were below the *1999 SWEIS* projections, except for mixed low-level radioactive waste in 2000, which was above the 1999 waste generation projection.

2.4.14 Solid Radioactive and Chemical Waste Facilities (Technical Area 54 and Technical Area 50)

The majority of the structures associated with the Solid Radioactive and Chemical Waste Facilities are located at TA-54. There are over 200 structures within this TA, over 100 of which are dedicated to waste management. This waste management operation captures and tracks data for waste streams regardless of their points of origin and ultimate disposition. A variety of wastes are managed by the Solid Radioactive and Chemical Waste Facilities, including transuranic, low-level radioactive, industrial, toxic, hazardous, and mixtures of these waste types. Transuranic wastes are processed at the Waste Characterization Reduction and Repackaging Facility in TA-50 and transported to TA-54 for storage pending disposal. Most waste handled in TA-54 is of a solid physical state, although there are also small quantities of gaseous or liquid hazardous, toxic, and mixed wastes.


TA-54 Waste Disposal Site

The Hazard Category 2 nuclear facilities at this Key Facility include outdoor operations at the Waste Characterization, Reduction, and Repackaging Facility (50-69); waste storage and disposal facilities in Area G (including low-level waste disposal pits, shafts, and trenches, transuranic waste storage domes, sheds, and storage pads); the Waste Assay Facility (54-2); the Radioassay and Nondestructive Testing Facility (54-38); and the Decontamination and Volume Reduction System (54-412). The

Waste Characterization, Reduction, and Repackaging Facility (50-69) is a Hazard Category 3 nuclear facility.

The principal capabilities and activities conducted at the Solid Radioactive and Chemical Waste Key Facilities include:

- Waste characterization to ensure compliance with waste acceptance criteria for WIPP;
- Solid waste compaction to provide improved package integrity, minimize subsidence at the disposal pit, and conserve disposal space;
- Size reduction to reduce volume and repackage waste;
- Waste transport reception and acceptance, including visual inspection of vehicles and containers, cross-checking of container labels and shipping manifests, and radiation surveys of vehicle and containers;
- Waste storage, including storage of sealed sources for the Off-Site Source Recovery Project;
- Retrieval of transuranic wastes, including repackaging, characterization, and placement in aboveground storage domes;
- Solid low-level radioactive waste disposal in cells and shafts;
- Decontamination of items including personal respirators, air-proportional probes, vehicles, and portable instruments for reuse, as well as precious metals, scrap metals, and lead for resale; and
- Other waste processing such as storage of transuranic sludge (solidified and packaged by the Radioactive Liquid Waste Treatment Facility), stabilization of pyrophoric uranium chips and subsequent storage of the resulting gels, and electrochemical treatment of mixed low-level radioactive waste.

Solid Radioactive and Chemical Waste Facilities Performance and Changes Since the *1999 SWEIS*

Two construction projects were planned for the Solid Radioactive and Chemical Waste Facilities in the *1999 SWEIS*. Additional fabric domes for the storage of transuranic waste were completed in 1998. Execution of the other project, expansion of Area G, has not been completed. Design is underway; construction is scheduled to begin in 2009 with operation expected in 2010. The Radioactive Materials Research Operations and Demonstration Facility was transferred to the Plutonium Key Facility in 2003. A substantial fraction of TA-54's heavy earthmoving equipment was used for the Cerro Grande Fire and was not available for some time. The wildfire also impacted Solid Radioactive and Chemical Waste operations later in the year because fire-related debris was shipped to Area G for storage and disposal.

In 2003, volumes of transuranic waste and mixed transuranic waste processed by the Solid Chemical and Radioactive Waste Facility exceeded *1999 SWEIS* projections. In 2005, volumes of chemical waste, low-level radioactive waste, and mixed transuranic waste exceeded *1999 SWEIS* projections. These waste volumes exceeded projected amounts due to repackaging of legacy transuranic waste for shipment to WIPP. About 95 percent (1,300 drums) of the low-level radioactive wastes were empty drums wrapped in plastic resulting from repackaging of transuranic waste at the Waste Characterization, Reduction, and Repackaging Facility. These drums are typically sent to TA-54, Area G, for compaction and disposal. There are no NPDES-permitted outfalls. No stacks require monitoring for radiological air emissions; all non-point sources are measured using ambient monitoring. Thorium isotopes were identified in 2005 in dosimetrically insignificant quantities.

2.4.15 Plutonium Facility Complex (Technical Area 55)

The Plutonium Facility Complex consists of six primary buildings and a number of support, storage, security, and training structures located throughout the main complex at TA-55. The Plutonium Facility, Building 55-4, is categorized as a Hazard Category 2 nuclear facility, but was built to comply with the seismic standards for Hazard Category 1 buildings. In May 2005, a staging facility, PF-185 (55-185), was upgraded to Hazard Category 2. A third Category 2 nuclear facility, the Safe Secure Transport Facility (55-355), was constructed and became operational in November 2005. In addition, TA-55 includes two low hazard chemical facilities (Buildings 55-3 and 55-5) and one low hazard energy source facility (55-7). The *1999 SWEIS* also identified one potential Hazard Category 2 nuclear facility (the Nuclear Material Storage Facility, Building 55-41), which was slated for potential modification to bring it into operational status. The modifications were not performed, however, and a decision was made in 2006 to demolish the building.


Plutonium Complex at TA-55

The principal capabilities and activities conducted at the Plutonium Facility Complex include:

- Plutonium stabilization, including recovering, processing, and storing the existing inventory;
- Manufacturing plutonium components or other items for research and development or for the nuclear weapons stockpile;

- Surveillance and disassembly of weapons components using both nondestructive and destructive evaluation on pits removed from the stockpile and storage;
- Actinide materials research and development, which involves metallurgical and other characterization of materials and measurements of physical materials properties;
- Development of ceramic-based nuclear reactor fuel fabrication technologies;
- Research on providing a long-term reliable heat source for power systems to support space and terrestrial uses, as well as performing recovery, recycling, and blending of plutonium-238; and
- Storage, shipping, and receiving for the majority of the LANL special nuclear material inventory.

Plutonium Facility Complex Performance and Changes Since the *1999 SWEIS*

Several construction projects and upgrades were planned for the Plutonium Facility Complex and analyzed in the *1999 SWEIS*. A new administrative office building (called the Facility Infrastructure Technical Support Building) and upgrades to certain Plutonium Facility support systems have been completed. Construction of the Fire Safe Storage building (55-314) was completed in October 2004. Another office building, the Manufacturing Technical Support Facility (55-312), was completed in August 2003. As already stated, modifications to the Nuclear Material Storage Facility were halted and a decision was made to demolish the building. Security Category I and II and some Security Category III and IV materials, which are part of the TA-18 Relocation Project, have been relocated to secure facilities at the Plutonium Facility Complex at TA-55 while awaiting transfer to offsite facilities. Procurement and installation of a new uranium decontamination system was initiated in 2004 and was ongoing in 2005. Interim radiography capability also was ongoing in 2005. None of the buildings at TA-55 suffered serious damage from the 2000 Cerro Grande Fire, although the fire encroached on the fenced perimeter intrusion detection and assessment systems area.

The principal activities listed above operated well within the bounds of projections in the *1999 SWEIS*. One change, however, occurred in the plutonium stabilization operation and only the highest priority items have been stabilized. Recovery, processing, and storage of the remaining inventory are now scheduled to be completed by 2013.

All other processes at the Plutonium Facility Complex remained below *1999 SWEIS* projected operating levels. Manufacturing of plutonium components produced no quality-certified pits until 2003; production of fewer than 20 quality-certified pits each year has occurred since 2004. In addition, the surveillance and disassembly of weapons components operated below the projected number of pits. Plutonium-238 research has processed, evaluated, and tested below the 55 pounds (25 kilograms) of material per year projected in the *1999 SWEIS*. Because the Nuclear Material Storage Facility has not been available as a storage vault, NNSA has continued to store working inventory in the TA-55-4 vault. The number of items in the vault has remained relatively constant at levels identified in the *1999 SWEIS*.

Since 1999, the actinide research and development capability processed less than the 881 pounds (400 kilograms) per year projected in the *1999 SWEIS*, and the number of pits that were disassembled or converted also was below the projected amount. Research supporting actinide cleanup activities continued at low levels, and no plutonium residues originating from Rocky Flats were processed. Minimal study of nuclear fuels used in terrestrial and radioisotope power systems has occurred since 1999. In 2002, the Plutonium Facility Complex again began purifying and encapsulating plutonium fuels for this capability.

Radiological air emissions from this Key Facility were below *1999 SWEIS* projections in the years up to and including 2005, except for releases of elemental tritium that exceeded projections in 2002 and 2003 and the presence of actinides (isotopes of thorium and uranium) that were not projected in the *1999 SWEIS* in 2005. The facility has one NPDES-permitted outfall, which is consistent with the *1999 SWEIS* projections, and the NPDES discharge rate has been consistently below projected amounts. The quality of effluent exceeded NPDES permit levels only once in 2003 before being corrected (LANL 2004d). Transuranic, low-level radioactive, and mixed low-level radioactive wastes were all below the *1999 SWEIS* projections. Chemical wastes, however, exceeded projections in 2001 (generated by replacement of the hydraulic cylinders at the facility); in 2002 (generated by cleanup of soil contaminated with spilled transformer oil); and in 2003 (generated by cleanup of soil contaminated with diesel fuel).

2.4.16 Non-Key Facilities

The balance and majority of LANL buildings are referred to in the *1999 SWEIS* as non-Key Facilities. Non-Key Facilities house operations that are unlikely to cause significant environmental impacts. These buildings and structures are located in 30 of the 48 TAs over approximately 14,200 acres (5,750 hectares) of LANL's 25,600 acres (10,360 hectares) of land.

Some of the LANL non-Key Facilities are designated as radiological or moderate hazard facilities, but do not meet the criteria for Key Facilities. Some are currently operating, but several are designated as nonoperable surplus and are awaiting DD&D following removal of special nuclear material and other hazardous materials. At the present time, other than MDAs, there are no Hazard Category 2 or 3 nuclear facilities among the non-Key Facilities at LANL.

The following list provides information about physical changes to non-Key Facilities that have occurred since the issuance of the *1999 SWEIS*, including hazard category designation changes where appropriate:

- Various Chlorination Stations (Buildings 0-1109, 0-1110, 0-1113, 0-1114, 16-560, 54-1008, 72-3, 73-9) were designated moderate chemical hazard facilities in the *1999 SWEIS*. The quantity of chlorine stored at these facilities has been reduced or the stations no longer use gaseous chlorine for water treatment and are therefore no longer categorized as hazardous facilities. Ownership of certain of the chlorination stations was conveyed to Los Alamos County as part of the 1998 conveyance of the Los Alamos water distribution system and rights to surface water and water rights for subsurface water.

- The Omega West Building (2-1) and reactor were completely decontaminated and demolished in September 2003.
- The Ion Beam Building (3-16) houses an accelerator that is currently in safe-shutdown mode. All radioactive sources have been removed from that building.
- All cryogenics equipment has been removed from the Condensed Matter and Thermal Physics Laboratory (3-34) since 1999, and the Ion Beam M Laboratory now occupies the basement.
- The Health Physics Instrument Calibration facilities, located within the Physics Building (3-40), were designated in the *1999 SWEIS* as a Hazard Category 3 nuclear facility. Prior to 2002, the Health Physics Instrument Calibration facilities were relocated to Buildings 36-1 and 36-214, both of which are on the radiological facilities list. Building 3-40 also remains on the radiological facilities list.
- The Source Storage Building (3-65) was given a Nuclear Hazard Category 2 classification in the *1999 SWEIS*, but was downgraded and removed from the radiological facilities list. It is currently used for storage of materials and test kits.
- The Calibration Building (3-130) was designated in the *1999 SWEIS* as a Hazard Category 3 nuclear facility due to the radioactive source inventories stored in the building. The building is being converted into office space with some light-laboratory areas. All radioactive sources and special nuclear material have been removed, and the building is no longer on the radiological facilities list.
- The Liquid and Compressed Gas Facility (3-170) was reclassified to a low chemical hazard status. All toxic materials have been removed from this facility since 1999.
- Building 21-5, a laboratory, has been reclassified as a radiological facility since 1999.
- Building 21-150, Molecular Chemistry, has been removed from the radiological facilities list and is now identified as a surplus structure.
- The High Pressure Tritium Facility (33-86), a former high-pressure tritium-handling facility, was decommissioned in 2002 prior to its subsequent demolition.
- The Nuclear Safeguards Research Facilities (35-2 and 35-27) were classified as Hazard Category 3 nuclear facilities in the *1999 SWEIS* and were subsequently downgraded to radiological facilities in 2000 (DOE and LANL 2005).
- Central High Pressure Calibration Facility construction (36-214) was completed in October 2001. The facility has been categorized as a radiological facility. In addition, Building 36-1, a laboratory and office building, has been categorized as a radiological facility since 1999.

- The Laboratory Building (41-4) was categorized as a radiological facility in the *1999 SWEIS*. Building 41-30 was demolished along with a major portion of Building 41-4. Building 41-1, an underground storage vault known as the Ice House, is categorized as a radiological facility, although no special nuclear material is now stored there.

- The Sewage Treatment Plants (Building 46-340) were designated as moderate chemical hazard facilities prior to 1999. As these plants no longer use any chlorine gas for effluent disinfection, the hazard designation has recently been changed.

The *1999 SWEIS* identified just one major construction project (the Atlas Facility) for inclusion as a new future non-Key Facility. Construction of Atlas within existing buildings and a readiness review were completed in 2001. The Atlas conducted a series of 16 program experiments through October 2002 for the science-based Stockpile Stewardship Program before it was then disassembled and moved to the Nevada Test Site in 2003. After being reassembled, certified, and prepared for operation at the Nevada Test Site, Atlas was placed in standby, ready to support stockpile stewardship as a tri-laboratory (Lawrence Livermore National Laboratory, Sandia National Laboratories, and LANL) resource and a state-of-the-art research facility.

In addition to Atlas, DOE undertook several new construction projects since issuance of the *1999 SWEIS* that were not proposed at that time. These include the Nonproliferation and International Security Center, Center for Integrated Nanotechnologies, Emergency Operations Center, office buildings, LANL Medical Facility, and Live Fire Shoot House. Non-Key Facilities received substantial fire damage from the 2000 Cerro Grande Fire, which impacted 86 structures or buildings, damaged 31 and destroyed 10, including several temporary office facilities. A number of construction projects were undertaken in response to post-Cerro Grande Fire needs.

The following information describes additional non-Key Facility construction projects undertaken since 1999 and their current status:

- The Center for Integrated Nanotechnologies is based in Albuquerque, with facilities at LANL and Sandia National Laboratories. The Center provides open access to tools and the expertise needed to explore the scientific integration of nanostructures into the micro- and macro world. Operated by the DOE Office of Science's Nanoscale Science Research Center, the Center for Integrated Nanotechnologies is a national user facility devoted to establishing the scientific principles that govern the design, performance, and integration of nanoscale materials. In May 2004, groundbreaking took place for a new building that provides laboratory and office space for the LANL branch of the Center. Located northeast of the Materials Science Laboratory in TA-3, this two-story, 36,500-square-foot (3,390-square-meter) building will house approximately 50 workers, including LANL staff and collaborators from universities, other laboratories, and private industry. This building was completed in December 2005 and dedicated in August 2006.

- The Cerro Grande Fire showed that the existing Emergency Operations Center had outlived its useful life. Further research showed that upgrading it would be neither economical nor practical, and the decision was made to design and build a new Emergency

Operations Center. Construction began in early 2002, and the new Emergency Operations Center located at TA-69 became fully operational in December 2003.

- Five two-story office buildings were constructed after the Cerro Grande Fire to replace occupied space lost during the fire and afterwards as a result of postfire recovery efforts. These buildings house about 100 personnel each, consolidating functions and employees within physical proximity, and were occupied in 2003 and 2004.

- The Occupational Medicine Program occupies a new building (the LANL Medical Facility) at TA-3 that houses 60 medical personnel and supports approximately 2,500 LANL patients per month. Through the project, existing nonpermanent facilities were replaced because they had exceeded their life expectancy and were rapidly deteriorating to the point that their condition was impacting the delivery of medical programs. The readiness occupational assessment for the new Medical Facility was completed in December 2003 and the facility became functional in 2004.

- The newly constructed Live Fire Shoot House provides an environment for the safe and realistic conduct of advanced tactical security force training for the Protection Technology Los Alamos staff. Exterior and interior walls were designed to contain bullets and fragmentation from multiple impacts, and bullets traps were also constructed. The facility became operational in March 2003.

- Design of the Information Management Office Building was initiated. The building would consolidate various personnel into a centralized, more efficient office building within TA-3; however, issues have arisen over the size of the building and the planned location. Construction of this building is on hold.

- The National Security Sciences Building constructed in TA-3 provides approximately 275,000 square feet (25,550 square meters) of space for theoretical and applied physics, a Computation Science Program, and senior management office functions. This building is eight stories high and will house about 700 personnel and their functions. Current operations of these capabilities would move from the Administration Building (Building 3-43), which is scheduled to be demolished. The new building also includes a one-story, 600-seat lecture hall and a separate multilevel parking structure that provides 400 spaces near the site. The parking structure was constructed and opened in 2005; the main building was completed in 2006.

- Two new parking structures were constructed in the TA-3 area to ease the critical shortage of parking spaces. One is a precast concrete structure that is four stories tall and provides parking for 337 vehicles. Construction on this first structure began in July 2003 and was completed in April 2004. The second structure (see above) is near the National Security Sciences Building.

- Two staffed access control stations were constructed on Pajarito Road in 2003. The stations cover about 200 square feet (19 square meters) in floor space and an adjacent support building is equipped with various video systems, electric control devices, and fencing to preclude drive-around. They have been operational since April 2004. A temporary truck inspection station was also constructed at the intersection of NM 4 and East Jemez Road.

These non-Key Facilities occupy more than half of LANL and now provide space for about 70 percent of the workforce. In previous years, activities in these facilities have typically contributed less than 20 percent of most operational effects. In 2004, however, new construction and operational effects in the non-Key Facilities increased. For example, approximately 2 million pounds (930,000 kilograms) of chemical waste generated at the non-Key Facilities constituted about 84 percent of total LANL chemical waste volume in 2004 and exceeded the *1999 SWEIS* ROD projection by about 50 percent. Also in 2004, the non-Key Facilities generated about 87 percent of the total LANL low-level radioactive waste volume; about 30 percent of the mixed low-level radioactive waste volume; and about 54 percent of the transuranic waste volume. The combined flows of the Sanitary Wastewater Systems Plant and the TA-3 Steam Plant account for about 88 percent of the total discharge from non-Key Facilities and about 67 percent of all water discharged by LANL.

Measurement of radiological air emissions from stacks at two non-Key Facilities (Buildings 33-86 and 41-4) ceased in 2003. There were no plutonium or uranium emissions from non-Key Facilities between 1999 and 2004. Tritium emissions slightly exceeded *1999 SWEIS* projections in years 1999 to 2001 because of cleanup activities. These radioactive air emissions of approximately 1,000 curies per year represent off-gassing from inactive facilities and their cleanup activities and less than 5 percent of the total 21,700 curies of emissions from all of LANL that were projected by the *1999 SWEIS* ROD.

Non-Key Facilities currently operate five NPDES-permitted outfalls, compared to 22 outfalls identified in the *1999 SWEIS* for non-Key Facilities. Eighteen outfalls were removed from service since 1999 as a result of efforts to reroute and consolidate flows to eliminate outfalls. In 2001, one of those rerouted outfalls was reinstated in the NPDES permit to direct cooling tower effluent back to Sandia Canyon. The total amount of the effluent discharged by non-Key Facilities exceeded *1999 SWEIS* projections during 3 of the 5 years. Only three of these five NPDES-permitted outfalls have discharged effluent since 1999, because the Sanitary Wastewater Systems Plant effluent is pumped to TA-3 and combined with the Power Plant effluent, and the rerouted outfall just resumed discharging into Sandia Canyon in 2005. Since issuance of the *1999 SWEIS* ROD, non-Key Facilities have continued to discharge about 75 percent of the total NPDES effluent from LANL. Effluent discharged from non-Key Facilities had a 99.9 percent compliance rate during this period; only three events occurred where NPDES permit requirements were exceeded: effluent from the TA-3 Co-Generation Complex (TA-3 Power Plant) cooling towers exceeded permit limits once in 2001 and again in 2002, and effluent from the Metropolis Center cooling towers exceeded permit limits once in May of 2003.

Waste volumes generated by non-Key Facilities have exceeded *1999 SWEIS* projections in several categories. Projected chemical waste volumes were exceeded in 2001 due to the Cerro Grande Fire cleanup, and low-level radioactive waste generation projections were exceeded for the years 2000 through 2004 due to decontamination and decommissioning activities, heightened operational activities, and new construction.

2.5 Overview of Actual Impacts Compared to Site-Wide Environmental Impact Statement Projections

From 1999 through 2005, radioactive airborne emissions from point sources (stacks) have varied from a low of 1,900 curies during 1999 to a high of approximately 19,000 curies during 2005 (just under 90 percent of the 10-year average annual curies of 21,700 projected in the *1999 SWEIS*). The final maximally exposed individual dose over this same multiple-year period varied from a low of 0.32 millirem in 1999 to a high of 6.46 millirem during 2005 (compared to a 5.44 millirem projected dose for this period of time). This dose rate is below the EPA emissions limit of a 10 millirem per year dose rate for DOE facilities.

Calculated NPDES effluent discharges ranged from a low of 124 million gallons (469 million liters) per year in 2001 to a high of 317 million gallons (1.2 billion liters) per year in 1999, compared to a projected discharge volume of 278 million gallons (1.05 billion liters) per year. The apparent decrease in flows, however, is primarily due to the methodology by which the flows were measured and reported in the past. Historically, instantaneous flows were measured during field visits as required in the NPDES permit. These measurements were then extrapolated over a 24-hour day, 7 days per week. With implementation of the new NPDES permit on February 1, 2001, data began to be collected and reported using actual flows recorded by flow meters installed at most outfalls. At those outfalls that do not have meters, the flows are calculated as before (based on instantaneous flow).

Quantities of solid radioactive and chemical wastes generated have ranged from approximately 3.2 percent of the mixed low-level radioactive waste projections in the *1999 SWEIS* during both 1999 and 2002 to 852 percent and 849 percent of the chemical waste projections during 2000 and 2001, respectively. The extremely large quantities of chemical waste (61 million pounds [27.7 million kilograms] during 2000 and 60.8 million pounds [27.6 million kilograms] during 2001) are a result of environmental restoration activities. For example, the remediation of MDA P resulted in 47.4 million pounds (21.5 million kilograms), or 88 percent of the 53.8 million pounds (24.4 million kilograms) of chemical waste generated during 2001. Most chemical wastes are shipped offsite for disposal at commercial facilities (LANL 2003h, 2004f). In 2003, the quantity of mixed transuranic waste generated was 137 percent of the mixed transuranic waste projection. The larger-than-projected quantity of mixed transuranic waste was the result of the Decontamination and Volume Reduction System repackaging of legacy transuranic waste for shipment to WIPP (LANL 2005f). **Table 2–4** summarizes LANL emissions, doses, discharges, and radioactive waste generation and compares them to the *1999 SWEIS* projections.

The LANL workforce has been maintained above *1999 SWEIS* projections since 1999. The 13,504 employees recorded at the end of 2005 represent 1,953 more employees than projected. Since 1999, the peak electricity consumption by LANL operations was 421,413 megawatt-hours during 2005, and the peak demand was 70.9 megawatts during 2001 and 2003, compared to *1999 SWEIS* projections of 782,000 megawatt-hours with a peak demand of 113 megawatts. The peak water usage was 453 million gallons (1.71 billion liters) during 1999 (compared to 759 million gallons [2.87 billion liters] projected), and the peak natural gas consumption was 1.49 million decatherms (42.2 million cubic meters) during 2001 (compared to 1.84 million decatherms [52.1 million cubic meters] projected in the *1999 SWEIS*). Between 1999 and 2005, the highest collective total effective dose equivalent for the LANL workforce was 241 person-rem during 2003, which is considerably lower than the workforce dose of 704 person-rem projected by the *1999 SWEIS* (LANL 2004f).

Table 2–4 Los Alamos National Laboratory Emissions, Doses, Discharges, and Radioactive Waste Generation Since 1999 [a]

	SWEIS ROD	***1999***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***
Radioactive Airborne Emissions from Point Sources								
- Total annual release in curies	21,700	1,900	3,100	15,400	6,150	2,060	5,230	19,100
Percent of 21,700 curies	–	*9*	*15*	*70*	*30*	*9*	*25*	*88*
- MEI dose in millirem per year	5.44	0.32	0.65	1.84	1.69	0.65	1.68	6.46
Percent of 5.44 millirem	–	*6*	*12*	*34*	*31*	*12*	*30*	*119*
NPDES discharges in million gallons per year	278	317	265	124	178	210	162	198
Percent of 278 million gallons per year	–	*114*	*95*	*45*	*64*	*76*	*58*	*71*
Low-level radioactive waste in cubic yards per year	16,000	2,190	5,530	3,400	9,560	7,640	19,400	7,080
Percent of 16,000 cubic yards per year	–	*13.7*	*34.6*	*21.3*	*59.8*	*47.8*	*121*	*44.3*
Mixed low-level radioactive waste in cubic yards per year	830	30	780	80	30	50	50	90
Percent of 830 cubic yards per year	–	*3.6*	*94.0*	*9.6*	*3.6*	*6.0*	*6.0*	*10.8*
Transuranic waste in cubic yards per year	440	190	160	150	160	530	50	100
Percent of 440 cubic yards per year	–	*43.2*	*36.4*	*34.1*	*36.4*	*120*	*11.4*	*22.7*
Mixed transuranic waste in cubic yards per year	150	110	120	60	110	210	30	130
Percent of 150 cubic yards per year	–	*73.3*	*80.0*	*40.0*	*73.3*	*140*	*13.3*	*86.7*
Chemical waste in 1,000 pounds per year	7,160	34,000	61,000	60,800	3,820	1,520	2,460	4,340
Percent of 71,000 pounds per year	–	*475*	*852*	*849*	*53*	*21*	*34*	*61*

[a] Values are rounded.
ROD = Record of Decision, MEI = maximally exposed individual, NPDES = National Pollutant Discharge Elimination System.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.378533; pounds to kilograms, multiply by 0.4536.
Sources: LANL 2003h, 2004f, 2005f, 2006g.

Measured parameters for ecological resources and groundwater were similar to *1999 SWEIS* projections, and measured parameters for cultural resources and land resources were below projections. For land use, the *1999 SWEIS* projected the disturbance of 41 acres (17 hectares) of new land at TA-54 because of the need for additional disposal cells for low-level radioactive waste. This expansion is currently underway. In addition, construction of the Los Alamos Research Park was completed on 44 acres (18 hectares) of land along West Jemez Road.

Cultural resources remained protected, and no excavation of sites at TA-54 has occurred. (The *1999 SWEIS* projected that 15 prehistoric sites would be affected by the expansion of Area G into Zones 4 and 6 at TA-54.) Excavations did occur, however, at the Airport-1 East and White Rock-1 tracts from June 2002 through March 2003. These two land tracts were conveyed to the County of Los Alamos for future development (see Table 4-2). Eleven cultural sites also were excavated in Rendija Canyon in 2004 (LANL 2005f).

As projected in the *1999 SWEIS*, water levels in wells penetrating into the regional aquifer continue to decline in response to pumping, typically by several feet each year. In areas where pumping has been reduced, water levels show some recovery. No unexplained changes in patterns have occurred from 1999 through 2005 period, and water levels in the regional aquifer have continued a gradual decline that started in about 1977. Five additional characterization wells were completed in 2004 and, pursuant to the 2005 Consent Order, 21 additional characterization wells were installed in 2005. In addition, ecological resources are being sustained as a result of protection afforded by DOE ownership of LANL. These resources include biological resources such as protected sensitive species, ecological processes, and biodiversity. The recovery and response to the Cerro Grande Fire of May 2000 included a Wildfire Fuels Reduction Program, burned area rehabilitation and monitoring efforts, and enhanced vegetation and wildlife monitoring (LANL 2004f, 2005f).

For the most part, operations at LANL remained within the projections made in the *1999 SWEIS*. Operations that exceeded projections, such as the number of employees or the amount of chemical waste generated from cleanup activities, produced a neutral or beneficial impact on northern New Mexico. A larger number of employees increased the tax base and resulted in a higher level of economic activity. Although the amount of chemical waste generation was higher, thereby increasing the amount of offsite transportation, it was managed without adverse impact to the LANL waste management infrastructure and treatment and disposal of the waste was accomplished in accordance with applicable regulations. Overall, data on operations during the period from 1999 through 2005 indicate that LANL was still approaching the operation levels of the Expanded Operations Alternative in the *1999 SWEIS*, as modified for a lower level of pit production.

Table 2–5 summarizes the actual impacts and performance changes by resource or impact area from 1999 through 2005 compared to the projected impacts for the modified Expanded Operations Alternative in the *1999 SWEIS*. The first column lists the resource or environmental impact areas. For each resource or impact area, the next column provides a summary description of the projected impact for the Expanded Operations Alternative as presented in the *1999 SWEIS*. The third column summarizes the actual impacts for the years 1999 through 2005 as reported in the *LANL SWEIS Yearbooks*. The final column presents an assessment of performance at the site compared to the projected performance in the *1999 SWEIS*. This comparison shows that, in general, LANL operated within the bounds projected in the *1999 SWEIS*.

Table 2–5 Summary Comparison of *1999 SWEIS*[10] Projected Impacts and Actual Changes and Performance (1999 to 2005)

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Land Resources	LANL covered 43 square miles (111 square kilometers), with about 5 percent of the site developed. It was divided into 6 land use categories and contained 944 permanent buildings, 512 temporary structures, and 806 miscellaneous buildings. Changes to land use included TA-67, where 60 acres (24 hectares) of forested land would be cleared for a road and the land use category changed from "Explosives" to "Explosives and Waste Disposal." Area G expansion was estimated to disturb 41 acres (16.6 hectares) of approximately 72 acres designated for waste disposal. The *1999 SWEIS* predicted limited land disturbance (about 100 acres [40 hectares] of previously undisturbed land) from new construction.	LANL now covers 40 square miles (104 square kilometers). Land use categories have increased from 6 to 10. The number of structures, which change often, now includes 952 permanent buildings, 373 temporary structures, and 897 miscellaneous buildings. Major projects have occupied more land than predicted. Forty-four acres (18 hectares) were leased to Los Alamos County for a research park. Environmental restoration activities have not substantially added to available land. About 4,078 acres (1,650 hectares) have been designated for conveyance to Los Alamos County and the New Mexico Department of Transportation, and transfer to the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso), of which 2,259 acres (914 hectares) have been turned over (as of the end of 2006), including all lands to be transferred to the Department of the Interior (in trust for the Pueblo of San Ildefonso). In 2000, the Cerro Grande Fire burned 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) at LANL. Direct impacts on land use included damage to or loss of 332 structures. Fire mitigation work, such as flood retention structures, affected about 50 acres (20 hectares) of undeveloped land.	Land use changes were slightly greater than those projected in the *1999 SWEIS*. Actions undertaken at LANL that were either not addressed or predicted in the *1999 SWEIS* include the conveyance of land to Los Alamos County and the New Mexico Department of Transportation, and the transfer of land to the Pueblo of San Ildefonso; and several projects that could disturb up to 245 more acres (99 hectares) of greenfield sites than predicted in the *1999 SWEIS*. These actions, however, were addressed in separate NEPA review documents. Land use changes related to the number of buildings at LANL were within the range of impacts evaluated within the *1999 SWEIS*.
Visual Resources	LANL is primarily distinguishable in the daytime by views of its water storage towers, emission stacks, and occasional glimpses of older buildings. At elevations above LANL, the view is primarily of scattered austere buildings and groupings of several-storied buildings. LANL has relatively few nighttime security light sources compared to the nearby communities; the distinction between LANL and the nearby communities is lost to the casual observer.	In many cases, new construction has reduced visually incompatible building styles and allowed for the removal of some of the more austere buildings. One new building has been built at the Los Alamos Research Park. Radio towers have been erected, but have been painted to blend with the background. The water tower at the new Emergency Operations Center has also been painted to blend with the background. Two domes have been added at TA-54, which contrast with the natural landscape and can be seen from the Pueblo of San Ildefonso sacred area, the Nambe-Española area, and areas in western and southern Santa Fe County.	Visual impacts resulting from continuing operations at LANL slightly exceeded those projected in the *1999 SWEIS*. Actions undertaken at LANL that either were not fully addressed or occurred since the *1999 SWEIS* was published include the construction of domes at TA-54, construction of new facilities (especially those that extend above the tree line), and forest thinning. Activities associated with each of these areas were addressed in separate NEPA actions.

[10] *Based on the Expanded Operations Alternative as defined in the 1999 SWEIS and ROD (64 FR 50797).*

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
	Projected temporary and minor impacts included changes resulting from construction and environmental restoration activities.	The Cerro Grande Fire altered views and made site facilities more visible. Since 2000, wildfire prevention activities, such as forest thinning, have reduced tree density on 7,700 acres (3,110 hectares) resulting in a more open, park-like forest, increasing the visibility of some facilities. Bark beetles have killed thousands of evergreen trees, opening the forest and making LANL facilities more visible.	The Cerro Grande Fire and bark beetle infestation altered the viewscape beyond that analyzed in the *1999 SWEIS* or other subsequent NEPA review documents.
Geology and Soils			
- Geology	The *1999 SWEIS* identified major seismic features at LANL. Some sections of faults at LANL constitute active and capable faults under the Nuclear Regulatory Commission nuclear facility criteria. Surface rupture from faulting in TA-3 was identified and concern regarding seismic risk to the Chemistry and Metallurgy Research Building was identified.	LANL operations have not affected seismicity concerns. Most construction was conducted at a distance from mapped faults and injection wells were not operated. Based on the seismic risk at TA-3 identified in the *1999 SWEIS*, LANL decided to move the Chemistry and Metallurgy Research Building operations to TA-55, an area of no observed seismic faulting (DOE 2003c).	Impacts at LANL were within those projected in the *1999 SWEIS*.
- Soils	The *1999 SWEIS* identified canyon walls as areas of potential slope instability and indicated that disturbed or unvegetated soils have a greater potential for erosion. Small quantities of contaminants from facility operations would impact LANL soils, and that contaminated soil would be excavated from LANL.	LANL operations have not substantially affected slope instability or soil erosion. Construction activities were set back from canyon walls, and although localized erosion due to disturbed soils occurred at construction sites, it was mitigated by standard construction best management practices such as silt fences and flow barriers. The Cerro Grande Fire increased soil erosion at LANL. Releases from facility operations causing soil contamination have been below *1999 SWEIS* projections due to improvements in facility operating procedures.	Impacts were fewer than those projected in the *1999 SWEIS*, in part due to the removal of contaminated soils through environmental restoration activities and continued use of engineering controls at construction sites. While the Cerro Grande Fire increased soil erosion, the overall effects were mitigated through various actions such that *1999 SWEIS* projections were not exceeded.
Surface Water			
- NPDES Outfall Volumes	Total of 55 NPDES-permitted outfalls. Total projected discharge volumes through permitted outfalls: • 278 million gallons per year (1,052 million liters per year). • 136 million gallons per year (515 million liters) from Key Facilities. • 142 million gallons (538 million liters) per year from non-Key Facilities.	NPDES-permitted outfalls decreased to 21 – including 20 industrial outfalls and 1 sanitary outfall. The total flow from all NPDES outfalls was below *1999 SWEIS* projections for 6 of 7 years; in 1999, the flow exceeded *1999 SWEIS* projections by 14 percent. Key facilities: Combined volumes have been less than *1999 SWEIS* projections; however, discharges from four Key Facilities exceeded their individual 1999 projections. • Tritium Facilities: discharges exceeded annual projections each year, ranging from 0.4 to 33 million gallons per year (1.5 to 125 million liters per year), compared to *1999 SWEIS* projection of 0.3 million gallons (1.1 million liters) per year.	The number of NPDES outfalls was within the *1999 SWEIS* projections. The number of permitted NPDES outfalls and the total flow were consistent with or below *1999 SWEIS* projections. The distribution of flow from individual Key and non-Key Facilities, however, has changed from that projected in the *1999 SWEIS*. Although there appears to be a decrease in total flow from NPDES outfalls, it is largely due to a change in how flow is measured and reported. The current method adopted in 2001 uses actual flow meters in many (but not all)

Resource or Impact Area	***1999 SWEIS Projected Impacts***	***Actual Impacts and Performance Changes (1999 to 2005)***	***Assessment***
		• Chemistry and Metallurgy Research Building discharges exceeded projections 6 of 7 years, ranging from 0.02 to 4.5 million gallons (0.08 to 17 million liters) per year, compared to *1999 SWEIS* projection of 0.5 million gallons (1.9 million liters) per year. • High Explosives Testing Facility discharges exceeded projections 3 years, ranging from 9 to 16.1 million gallons (34 to 61 million liters) per year in 1999 through 2001, compared to *1999 SWEIS* projection of 3.6 million gallons (14 million liters) per year. • Sigma Complex discharges exceeded projections in 2003, with 7.6 million gallons (29 million liters) compared to the *1999 SWEIS* projection of 7.3 million gallons (28 million liters) per year. Non-Key Facilities: Total flow exceeded *1999 SWEIS* projections 3 out of 7 years, in part due to extrapolation from instantaneous flow measurements.	outfalls and measuring stations, providing more accurate information.
- NPDES Outfall Quality	The implied measure of performance is compliance with NPDES permit levels, the New Mexico Water Quality Control Commission stream standards, and DOE Derived Concentration Guides for radionuclides. As described in the *1999 SWEIS*, RLWTF would be modified and the High Explosives Waste Treatment Facility would be constructed to improve effluent quality.	NPDES effluent quality met permitted levels for 99.75 percent of samples since 2000; number of events where permit levels were exceeded ranged from 0 to 14 (of about 1,100 samples) per year. Exceedances resulted in preparation and implementation of corrective action plans. RLWTF has improved the quality of effluent, reducing annual levels of nitrates and radionuclides. Since 1999, radionuclides activities have been well below the Derived Concentration Guides levels, and nitrates and fluorides concentrations were well below the standards. Volumes of effluent discharged from the High Explosives Wastewater Treatment Facility outfall have been below *1999 SWEIS* projections since 1999.	Surface water quality impacts are consistent with or less than those projected in the *1999 SWEIS*. Overall quality and volume of effluents were within the levels projected in the *1999 SWEIS*.
- Water Quality Impacts from Stormwater and Construction Sources	Water quality was projected to be similar or better than recent experience. The following LANL operations were identified in the *1999 SWEIS* as impacting surface water quality: • Stormwater discharges from industrial activities, with 76 industrial facilities identified on LANL site. • Construction activities disturbing greater than 5 acres (2 hectares). • Excavation or dredge and fill activities, which are permitted by the Corps of Engineers and the New Mexico	LANL still requires Stormwater Pollution Prevention Plans and best management practices to protect surface waters from pollutants from industrial stormwater sources and construction projects. The number of industrial activities requiring individual Stormwater Pollution Prevention Plans has ranged from 15 to 22. Stormwater Pollution Prevention Plans and best management practices are now required for all projects disturbing greater than 1 acre (0.4 hectares) of land. An increase in construction projects and dredge and fill projects was seen following the Cerro Grande Fire; however, each project was required to implement Stormwater Pollution Prevention Plans and meet 404 and 401 permit conditions to protect surface waters.	Impacts from storm flows and construction or excavation projects were within *1999 SWEIS* projections.

Resource or Impact Area	1999 SWEIS Projected Impacts	Actual Impacts and Performance Changes (1999 to 2005)	Assessment
	Environment Department (Section 404 and 401 permits).		
- Contaminant Transport	Small increases in outfall flows to watersheds were not expected to result in substantial contaminant transport offsite. Outfall discharge volumes per watershed were projected. Storm flow and sediment transport were identified as primary mechanisms for potential contaminant transport beyond LANL boundaries. The *1999 SWEIS* discussed watershed monitoring activities to track the extent of offsite contaminant movement in sediments and surface waters, including monitoring for radionuclides, metals, organics, polychlorinated biphenyls, and high explosives residue.	Several actions and best management practices were implemented to manage, control, and minimize stormwater and sediment transport. On average, outflows to individual watersheds have been within projections, and trends show that outfall flows per watershed have been declining, thereby reducing the potential for contaminant transport. The number of watersheds receiving outfall flow has been reduced from 8 to 5. The annual flow discharged to the individual watersheds exceeded *1999 SWEIS* projections 5 times from 1999 to 2000 and 1 time since 2000. While radionuclides at or above background levels have been detected in sediments on- and offsite, the overall pattern of radioactivity in sediments has not greatly changed since the *1999 SWEIS*. Concentrations of metals, radionuclides, polychlorinated biphenyls, and high explosives residue above water quality standards have been detected during storm flows; however, these events are infrequent and short-lived. As a direct result of the Cerro Grande Fire, stormwater runoff increased (2 to 4 times for average flow, and 10 to 1,000 times for peak flows), increasing the potential for contaminant transport. Storm events in 2001 and 2002 were found to accelerate the transport of legacy contamination (radionuclides) from Pueblo Canyon into lower watersheds and canyons.	Contaminant transport impacts were consistent with the *1999 SWEIS*, due to LANL programs and best management practices that manage and control storm flow and sediment transport. Increased or accelerated transport of contaminants that occurred from postfire storm flows are considered to be short-lived events that are being controlled and will diminish within the next few years.
Groundwater			
- Water Use	The projected effect of water use over the next 10 years (extracted from the main aquifer) is an average drop in DOE well fields of up to 15 feet (4.6 meters).	The drop in the Los Alamos County (previously DOE) well fields has continued to be 1 to 2 feet (0.3 to 0.6 meters) per year, per the Water Supply at Los Alamos 1998 to 2001 report (LANL 2003b).	Impacts of LANL water use on the regional aquifer continue to be bounded by the impacts analyzed in the *1999 SWEIS*.
- Quantity	No substantial changes to groundwater quantities were expected based on recent experience with LANL discharges that had little effect on groundwater quantities.	LANL discharges have had little effect on groundwater quantities in the last 6 years.	Impacts of LANL discharges on groundwater quantities continue to be bounded by the impacts analyzed in the *1999 SWEIS*.
- Quality	Because mechanisms for recharge to groundwater are highly uncertain, it is possible that discharges under any of the alternatives in the *1999 SWEIS* could result in contaminant transport in groundwater and off the site.	Regional groundwater samples taken in 2005 and 2006 show the presence of hexavalent chromium. Other contaminants detected included perchlorate in all groundwater zones in Mortandad Canyon, in the regional aquifer in Pueblo Canyon, and in alluvial groundwater in Cañon de Valle; and 1,4-dioxane in perched groundwater in Mortandad Canyon.	Hexavalent chromium has not been detected in offsite regional groundwater or in water supply wells. Production well Otowi-1 in Pueblo Canyon was taken permanently off-line because it had one tenth of the risk level of 24.5 micrograms per liter of perchlorate. There is no Federal or State standard for 1,4-dioxane.

Resource or Impact Area	***1999 SWEIS Projected Impacts***	***Actual Impacts and Performance Changes (1999 to 2005)***	***Assessment***
Air Quality			
- Nonradiological Criteria Pollutants	Ambient standards would be met. Annual emissions of criteria pollutants (tons per year): CO = 58 NO_x = 201 PM = 11 SO_2 = 0.98	Ambient standards have been met. Annual emissions for highest year, excluding years of the Cerro Grande Fire and fire mitigation activities (tons per year): CO = 35 NO_x = 93.8 PM = 5.5 SO_2 = 1.9	Annual emissions of criteria pollutants from LANL operations reported in the *Annual Emissions Inventories Through 2005* were within *1999 SWEIS* projections. As of 2004, revised reporting methods for the Title V Operating Permit Emissions Report include small exempt boilers and stand-by emergency generators in the emissions calculations; their inclusion results in SO_2 emissions higher than projected in the *1999 SWEIS*. Cerro Grande Fire and fire mitigation activities caused a temporary increase in CO, PM_{10} and SO_2 emissions above the levels analyzed in the *1999 SWEIS*.
- Other Nonradiological Pollutants	A screening analysis of toxic and hazardous pollutants indicated that levels of potential consequence to the public would not be exceeded for most air pollutants. Further detailed analysis demonstrated that concentrations of other pollutants would be below guideline values. For carcinogens, the combined lifetime incremental cancer risk due to all carcinogenic pollutants from all TAs was estimated. Major contributors to the combined cancer risk values included chloroform, formaldehyde, and trichloroethylene from TA-43 (Bioscience Facilities). The cancer risk to the public of less than 7.4×10^{-7} was dominated by the contribution from chloroform. Although annual emissions of chemical pollutants were not reported in detail for all facilities, the details presented for TA-3, for example, indicate emissions of 153 toxic pollutants. The *1999 SWEIS* did not address toxic and hazardous emissions from combustion sources.	Reported toxic and hazardous pollutant emissions generally have been less than guideline values. Carcinogenic emissions generally have been less than the *1999 SWEIS* projections. Chloroform emissions were less than 30 percent of the *1999 SWEIS* projections. TA-3 peak emissions data show that 21 additional pollutants were emitted and emissions of 39 pollutants exceeded *1999 SWEIS* projections. Seventy-five pollutants were not emitted that were projected.	The amounts of chemicals used and the amounts emitted to the air continue to show considerable variation. Although the actual quantities and chemicals vary from those analyzed in the *1999 SWEIS*, the concentrations to which the public is exposed continue to be below levels of potential consequence.

Resource or Impact Area	*1999 SWEIS Projected Impacts*		*Actual Impacts and Performance Changes (1999 to 2005)*		*Assessment*
- Nonradiological Construction Activities	Air quality impacts of construction activities were not quantified in the *1999 SWEIS*. The *1999 SWEIS*, however, indicated that construction activities were planned in various areas and would include land disturbance. These activities would result in emissions from disturbed areas and from equipment.		Construction of new facilities, demolition, and remediation activities have resulted in short-term increases in air pollutant concentrations. These activities were mitigated as appropriate to prevent exceedance of the ambient standards.		Construction at LANL is an ongoing activity with temporary and localized air quality impacts.
- Radiological		*Annual Average (curies per year)*	*Annual Average (curies per year)*	*Peak Year (curies)*	Annual average air emissions continue to be below levels projected in the *1999 SWEIS*. The exceptions for peak years were due to deactivation activities at TA-21 and a single event at the Weapons Engineering and Tritium Facility for tritium, as well as a failed valve and hours of operation at LANSCE for activation products.
	Actinides	0.000798	0.0000113	0.0000302	
	Fission Products	0.00014	Not reported	Not reported	
	Activation Products	16,000	5,070	18,900	
	Tritium (water vapor)	1,260	815	1,200	
	Tritium (gas)	1,920	1,770	8,740	
	Argon-41	870	22.7	49.8	
	Other Noble Gases	1,640	Not detected	Not detected	
	Uranium	0.152	0.00836	0.02	
Noise	There would be little change in noise impacts to the public from traffic or site activities, although sudden loud noises associated with explosives testing may occasionally startle members of the public and workers. There would be some increase in the frequency of impulsive noise, but these noises would be occasional and not prolonged or unusual to the community.		Construction activities at LANL are common and generally have not altered noise conditions to levels that annoy the public. The increase in workforce has not resulted in any noticeable increase in traffic noise.		Noise impacts from construction and operation were similar to those discussed in the *1999 SWEIS*.
Ecological Resources	Only 5 percent of LANL was determined to be unavailable to wildlife. There were 900 species of vascular plants and 294 species of animals in the area. There were 50 acres (20 hectares) of wetlands, 13 acres (5 hectares) of which were created or enhanced by wastewater from 38 outfalls. The site is home to 3 federally listed endangered species, 2 federally listed threatened species, 18 species of concern, and numerous state-listed species. Areas of Environmental Interest were established at LANL to protect threatened and endangered species.		In total, major projects used slightly less acreage of undeveloped land than predicted in the *1999 SWEIS*. About 5 acres (2 hectares) of the Los Alamos Research Park have been cleared, resulting in the loss of habitat. The reduction in permitted outfalls to 21 by 2003 has reduced the amount of wetlands supported by such flows. Approximately 34 acres (14 hectares) of wetlands occur at LANL. Impacts to ecological resources from land conveyance and transfer have resulted in a reduction in potential onsite habitat and the loss of DOE protection for threatened and endangered species, including areas of core and buffer zones within the Areas of Environmental Interests.		Impacts to biological resources were somewhat greater than those predicted in the *1999 SWEIS*. The *1999 SWEIS* did not account for certain events that occurred after 1999, including the land conveyance and transfer. Activities associated with each of these areas were addressed in separate NEPA documents. The Cerro Grande Fire and bark beetle infestation have altered the ecology of the site. The bark beetle infestation could impact runoff, herbaceous growth, and wildlife populations, as well as increase the potential fire hazard.

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
	As discussed in the *1999 SWEIS*, about 100 acres (40 hectares) of undeveloped land at LANL were predicted to be disturbed by construction projects, resulting in some habitat loss. The closure of 27 outfalls was predicted to reduce wetland acreage by 8.6 acres (3.5 hectares). About 25 acres (10 hectares) of the core zone of the Areas of Environmental Interest and 38 acres (15 hectares) of buffer zone could be affected by new projects (some of which would be completed in the future).	The Cerro Grande Fire burned 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) of LANL. Direct impacts to ecological resources included a reduction in habitat and the loss of wildlife. Fire mitigation work, such as flood retention structures, affected about 50 acres (20 hectares) of undeveloped land. Additionally, between 1997 and 2004, 8,233 acres (3,332 hectares) of forest were thinned to reduce potential wildfire. Thinning has both positive and negative effects on wildlife. An infestation of bark beetles resulted in a 12 to 100 percent mortality of pine and fir trees across LANL.	Forest thinning creates a forest that appears more park-like and increases the diversity of shrubs, herbs, and grasses in the understory.
Offsite Radiological Impacts			
- Offsite Population	Affected population within 50 miles (80 kilometers) of LANL.	Population within 50 miles (80 kilometers) of LANL grew by 14 percent between 1995 and 2000.	Lower emissions than those projected in the *1999 SWEIS* resulted in lower population dose and risk.
Dose (per year)	33.09 person-rem	2.5 person-rem in peak year (2005)	
Risk (per year)	0.0165 latent cancer fatalities	0.0015 latent cancer fatalities in peak year (2005)	
- MEI	LANL site MEI located north-northeast of LANSCE.	No change in location for the LANL site MEI.	Average dose to MEI continues to be bounded by projections in the *1999 SWEIS*. Higher emissions in 2005, resulting in a higher MEI dose, were due to a failed valve at LANSCE. The peak year dose is below the 10 millirem annual public exposure limit.
Dose (per year)	5.44 millirem	6.5 millirem in peak year (2005)	
Risk (per year)	2.72×10^{-6} latent cancer fatalities	3.9×10^{-6} latent cancer fatalities in peak year (2005)	
Worker Health			
- Average Measurable Dose			Average dose to workers continues to be bounded by projections in the *1999 SWEIS*.
Dose (per year)	198 millirem	149 millirem in peak year (2000)	
Risk (per year)	7.92×10^{-5} latent cancer fatalities	8.9×10^{-5} latent cancer fatalities in peak year (2000)	
- Collective Dose			Collective dose to the worker population continues to be bounded by projections in the *1999 SWEIS*.
Dose (per year)	704 person-rem	241 person-rem in peak year (2003)	
Risk (per year)	0.281 latent cancer fatalities	0.145 latent cancer fatalities in peak year (2003)	
	Factor used to estimate risk of latent cancer fatalities per rem was 0.0004 in 1999.	Dose-to-risk factor for workers increased from 0.0004 to 0.0006 latent cancer fatalities per rem.	

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Environmental Justice	There would be no disproportionately high and adverse impacts to minority or low-income populations from LANL activities. Consultations would continue to provide opportunities for avoiding or minimizing adverse impacts to traditional cultural properties at LANL. Human health impacts associated with special pathways would not present disproportionately high and adverse impacts to minority and low-income populations.	There were no disproportionately high and adverse impacts to minority or low-income populations from LANL activities during this period. Potential impacts to sacred lands adjacent to LANL from activities at TA-54 have been of concern to the San Ildefonso Pueblo. The amount of radiological material released to the environment (curies per year) has been well within the amount projected in the *1999 SWEIS*.	Impacts have not exceeded any health, safety, and environmental regulation, standard, or guideline; nor have they been high or adverse to minority and low-income populations. Ongoing consultations with representatives of the San Ildefonso Pueblo address concerns that activities at LANL and at TA-54 could affect sacred lands. Human health impacts associated with special pathways remained below the levels projected in the *1999 SWEIS*.
Cultural Resources	Cultural resources at LANL were categorized as prehistoric, historic, and traditional cultural properties. As discussed in the *1999 SWEIS*, about 75 percent of LANL was surveyed for cultural resources. Surveys identified 1,295 prehistoric sites, 2,319 historic sites, and 54 traditional cultural properties on or near LANL. As predicted in the *1999 SWEIS*, 15 prehistoric sites associated with the expansion of Area G could be impacted. No impacts to historic sites were expected. Impacts to traditional cultural properties were not fully predictable due to the lack of information on their specific locations and nature; however, impacts could result from changes in hydrology, explosives, hazardous materials, and security measures. It was noted that consultation with affected Pueblos would accompany any potential expansion in Area G or enhancement of pit manufacturing.	The percentage of LANL surveyed for cultural resources increased to 90 percent in 2005, and the number of known cultural resource sites increased as well. Conveyance and transfer of land resulted in the removal of cultural resources from the responsibility and protection of DOE, including resources eligible for listing on the National Register of Historic Places and American Indian sacred sites, remains, and traditional religious sites. A data recovery plan has been written to resolve adverse effects on tracts conveyed to the County of Los Alamos; transferred land would be held in trust by the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) and so would remain under Federal protection. Following the Cerro Grande Fire, an assessment determined that about 400 archaeological sites and historic buildings and structures were impacted by the fire. Impacts included direct loss, soot staining, spalling and cracking of stone masonry walls, and the exposure of artifacts from erosion. Additionally, the fire and the tree-thinning measures taken to reduce wildfire hazard resulted in the discovery of 447 new archaeological sites.	Impacts to cultural resources at LANL exceeded the level predicted in the *1999 SWEIS*, which did not account for events such as land conveyance and transfer. Certain activities associated with the development of new sites and land conveyance and transfer were addressed in separate NEPA documents. The Cerro Grande Fire caused extensive damage to cultural resources at LANL.
Socioeconomics	The *1999 SWEIS* projected the need for 11,351 full-time equivalent LANL-affiliated employees. Changes in employment at LANL would change regional population, employment, personal income, and other socioeconomic measures.	By 2005, there were 13,504 LANL-affiliated employees.	Socioeconomic impacts from continued operations at LANL between 1998 and 2005 have exceeded the socioeconomic impacts projected in the *1999 SWEIS* due to the larger number of employees.

Resource or Impact Area	***1999 SWEIS Projected Impacts***	***Actual Impacts and Performance Changes (1999 to 2005)***	***Assessment***
Infrastructure			
- Electricity	LANL was projected to require 782,000 megawatt-hours of electricity per year, with a peak load demand of 113 megawatts.	Average annual usage: 391,096 megawatt-hours per year, with peak usage of 421,413 megawatt-hours in 2005. Average peak load demand: 68.8 megawatts, with a peak of 70.9 megawatts in 2001 and 2003.	Annual electricity usage at LANL remained below the levels projected in the *1999 SWEIS*. Electrical usage has not exceeded the annual 963,600 megawatt-hour system capacity, or the physical transmission capability (thermal rating) of 110 megawatts.
- Fuel	LANL was projected to require 1.84 million decatherms (52.1 million cubic meters) of natural gas per year. Note: A decatherm is equivalent to 1,000 cubic feet.	Average annual usage: 1.32 million decatherms (37.4 million cubic meters) per year. Peak year usage: 1.49 billion cubic feet (42.2 million cubic meters) (2001).	Annual natural gas usage at LANL remained below the level projected in the *1999 SWEIS*. Demand for natural gas has not exceeded the contractually limited capacity of 8.07 million decatherms (229 million cubic meters) per year.
- Water	LANL was projected to require 759 million gallons (2.87 million liters) of water per year.	Average annual usage: 385 million gallons (1.46 billion liters) per year. Peak year usage: 453 million gallons (1.71 billion liters) (1999).	Annual water usage at LANL remained below the level projected in the *1999 SWEIS*. Demand for water has not exceeded the ceiling quantity of approximately 542 million gallons (2 billion liters) per year.
Environmental Restoration	The *1999 SWEIS* evaluated Environmental Restoration Program impacts in the ecological and human health risk assessments and in analyses related to the transport, treatment, storage, and disposal of waste. Other environmental restoration–related impacts addressed qualitatively in the *1999 SWEIS* included fugitive dust, surface runoff, soil and sediment erosion, and worker health and safety risks.	The environmental restoration project originally identified 2,124 potential release sites, including 1,099 regulated by the New Mexico Environment Department under RCRA and 1,025 regulated by DOE. At the end of 2005, 829 potential release sites remained to be investigated or remediated. Cleanup activities have been completed at many sites. No further action determinations have been made for 774 units, and 146 units have been removed from LANL's RCRA Permit. Major unplanned environmental restoration activities were undertaken in response to the Cerro Grande Fire that reduced long-term exposures to legacy contaminants. The large quantities of waste generated by cleanup were sent to offsite facilities.	The overall impacts of environmental restoration activities and waste generated by activities at LANL remained within the qualitative projections presented in the *1999 SWEIS*.

Resource or Impact Area	*1999 SWEIS Projected Impacts*	*Actual Impacts and Performance Changes (1999 to 2005)*	*Assessment*
Waste Management and Pollution Prevention	Waste management impacts were projected in the *1999 SWEIS* for five categories of waste (low-level radioactive waste, mixed low-level radioactive waste, transuranic waste, mixed transuranic waste, and chemical waste). Liquid radioactive wastes were evaluated separately and subcategory (sludge) quantities were projected. For low-level radioactive waste disposal at TA-54, the *1999 SWEIS* and ROD selected the preferred option of expansion into Zones 4 and 6, providing an additional 72 acres (29 hectares) of low-level radioactive waste disposal area, of which 41 acres (16.6 hectares) would actually be disturbed by waste disposal.	In general, quantities of radioactive waste were below *1999 SWEIS* projections for all categories. Overall low-level radioactive waste generation was well below the projected level up until 2004, when the projection was exceeded due to heightened activities and new construction at non-Key Facilities. Mixed low-level radioactive waste remained within the *1999 SWEIS* projection. For transuranic waste, the quantities were within the *1999 SWEIS* projection for 6 of the 7 years; in 2003, the transuranic waste projection was exceeded due to repackaging of legacy waste for shipment to WIPP and the receipt and storage of sealed sources by the Off-Site Source Recovery Program. Generation of mixed transuranic waste by the waste repackaging effort in 2003 exceeded the *1999 SWEIS* projection, the only exceedance for this category. The chemical waste projection was exceeded for the years 1999 through 2001 due to environmental restoration cleanups. Numerous facility-specific variances to the *1999 SWEIS* chemical waste projections occurred over the timeframe, mostly due to one-time events such as chemical cleanouts or maintenance activities. For liquid radioactive wastes, quantities treated were within *1999 SWEIS* projections; some sludge exceeded *1999 SWEIS* projections, but was within the low-level radioactive waste management capacity. Low-level radioactive waste operations at TA-54 were conducted within the existing footprint.	The amount of waste managed at LANL was within *1999 SWEIS* projections for all waste categories with a few exceptions. Although sporadic exceedances took place, the quantities generated were within the capacity of the existing LANL waste management infrastructure. Liquid radioactive waste treatment quantities remained within *1999 SWEIS* projections.
Emergency Preparedness and Security	LANL's Comprehensive Emergency Management and Response Program, which includes specialized response teams, specialized training, and response agreements in cooperation with local government response agencies was described in the *1999 SWEIS*. In addition, DOE was studying a variety of options for the renovation of the emergency preparedness and security infrastructure at LANL that included replacing a number of aging structures individually or as part of a multi-building effort.	Until 2003, the LANL Emergency Operations Center was located within TA-59. A new Emergency Operations Center located at TA-69 was completed and began operations in 2003.	Impacts were consistent with those described in the *1999 SWEIS*, except for measures taken in response to enhanced national security concerns after the attacks of September 11, 2001.

TA = technical area, NEPA = National Environmental Policy Act, NPDES = National Pollutant Discharge Elimination System, CO = carbon monoxide, NO_x = nitrogen oxide, PM = particulate matter, SO_2 = sulfur dioxide, rem = roentgen equivalent man, MEI = maximally exposed individual, RLWTF = Radioactive Liquid Waste Treatment Facility, LANSCE = Los Alamos Neutron Science Center, RCRA = Resource Conservation and Recovery Act, ROD = Record of Decision, WIPP = Waste Isolation Pilot Plant.

[a] Based on the Expanded Operations Alternative as defined in the *1999 SWEIS* and ROD (64 FR 50797).

CHAPTER 3

ALTERNATIVES FOR CONTINUED OPERATION OF LOS ALAMOS NATIONAL LABORATORY

3.0 ALTERNATIVES FOR CONTINUED OPERATION OF LOS ALAMOS NATIONAL LABORATORY

This chapter describes proposed alternatives for the continued operation of Los Alamos National Laboratory (LANL). These alternatives provide the basis for analysis of potential impacts in this environmental impact statement. Site-wide activities, activities that would occur in specific technical areas, and activities proposed to occur at each Key Facility are described for each alternative. Some activities are common to all alternatives; others vary among the alternatives.

This *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (LANL SWEIS) evaluates potential environmental impacts associated with continued operation of LANL. The three alternatives described in this chapter, the No Action Alternative, a Reduced Operations Alternative, and an Expanded Operations Alternative, provide the basis for this evaluation. As the names of the alternatives imply, each considers operating LANL at different activity levels. Under the No Action Alternative, LANL would continue to be operated at currently approved levels (see Section 3.1 of this chapter), implementing those projects, including new construction, for which National Environmental Policy Act (NEPA) analyses have been completed. Under the Reduced Operations Alternative, many capabilities would remain unchanged, others would be eliminated or reduced in activity level, and most projects that have been approved based on completed NEPA analyses would go forward. The Expanded Operations Alternative, which NNSA has selected as its Preferred Alternative, proposes an increase in activity levels for some capabilities, as well as several new projects. These proposed activities and projects are evaluated in Appendices G, H, I, and J. Many capabilities would remain unchanged, even under the Expanded Operations Alternative.

Alternatives for Continued Operation of Los Alamos National Laboratory

No Action Alternative—Operations would continue at current levels consistent with previous decisions such as the *1999 LANL Site-Wide Environmental Impact Statement* Record of Decision (ROD), other RODs, and Findings of No Significant Impact.

Reduced Operations Alternative—Construction of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility would be cancelled, thereby limiting pit production. Operations would be reduced at high explosives processing and testing facilities and eliminated at the Los Alamos Neutron Science Center and Pajarito Site.

Expanded Operations Alternative (Preferred Alternative)—Selected operations would increase, including plutonium pit production. Other projects proposed and analyzed in this SWEIS would be implemented.

The Expanded Operations Alternative in the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (*1999 SWEIS)* (DOE 1999a) is the basis for the No Action Alternative in this new Site-Wide Environmental Impact Statement (SWEIS). Under the *1999 SWEIS* Expanded Operations Alternative, the U.S. Department of Energy (DOE) anticipated expanding operations at LANL as the need arose to the highest reasonably foreseeable levels, including full implementation of pit manufacturing up to 50 pits per year under single-shift operations (80 pits per year using multiple shifts). As a result of constraints at the time the Record of Decision (ROD) was issued, however, including project delays and operational limitations for the Chemistry and Metallurgy Research Building (instituted to ensure that the operational risks [including seismic and human health risks] were maintained at an acceptable level), DOE determined that additional study of methods for implementing the 50 pits per year (or 80 pits per year) production capacity was warranted. In effect, DOE postponed a decision to expand pit manufacturing beyond a level of 20 pits per year. The impacts analysis in the *1999 SWEIS* Expanded Operations Alternative, however, is based on full implementation of pit production of 80 pits per year. That impacts analysis is also the basis for all of the alternatives analyzed in this SWEIS, although impacts in certain resource areas are distinguishable.

This chapter is organized by alternative; projects at the site-wide, technical area (TA), or Key Facility level are described within each alternative as appropriate. Key Facilities are described by their capabilities and the activity level at which each capability would be implemented. To the largest extent possible, projects and activities are evaluated at the Key Facility level because this is the most basic and descriptive level. A number of proposed projects described in the No Action and Expanded Operations Alternatives, however, are not tied to a Key Facility; instead, they are either site-wide or TA-related. Site-wide projects are described in Sections 3.1.1 and 3.3.1. Projects that would occur in a specific TA are described in Sections 3.1.2 and 3.3.2. Capabilities, activity levels, and proposed changes to Key Facilities are described in Sections 3.1.3, 3.2, and 3.3.3.

> **Technical Area (TA)**
>
> Geographically distinct administrative unit established for the control of LANL operations. There are currently 49 active TAs; 47 in the 40 square miles of the LANL site, one at Fenton Hill, west of the main site, and one comprising leased properties in town.

The No Action Alternative discussion in Section 3.1 contains complete descriptions of the capabilities of each Key Facility, as well as tables presenting the activity levels for each capability under each of the three alternatives. Discussions of the Reduced and Expanded Operations Alternatives in Sections 3.2 and 3.3, respectively, only discuss the changes from the No Action Alternative.

Evaluations and descriptions of each alternative implicitly include continued and evolving scientific, engineering, technology research and development (R&D), and support services throughout LANL, including those at the Key Facilities. Given the nature of R&D, specific activities are expected to vary and evolve over time; however, these changes can be sufficiently characterized to permit analysis of their consequences within the context of the alternatives. In addition, activity levels identified for each capability should be considered the maximum operating levels for which impacts are analyzed. Proposed new activities or increases in activity levels above those analyzed would require further NEPA compliance analysis.

In addition to operations associated with the capabilities described for each alternative, routine maintenance, construction, and support activities are required to maintain the availability and viability of LANL operations on an ongoing basis. DOE NEPA Implementing Procedures (Title 10 *Code of Federal Regulations* [CFR] Part 1021, Subpart D) list classes of actions called categorical exclusions that DOE has determined do not individually or collectively have a significant effect on the human environment and therefore do not require environmental assessments (EAs) or environmental impact statements (EISs). These actions include activities related to facility operations, safety and health, site characterization and environmental monitoring, and environmental remediation and waste management. Representative activities that can be categorically excluded, provided they meet certain criteria, include routine maintenance; facility repairs; plant rearrangements; building modifications; seismic upgrades; roof replacement and repairs; replacement or upgrading of pumps, piping, and electrical components; and exterior work on the facility and grounds. In addition, certain operations found to be associated with insignificant environmental impacts based on DOE experience may be categorically excluded. After documenting that a proposed activity or project meets the categorical exclusion criteria, any of these routine activities may be implemented without additional NEPA analysis. Categorically excluded activities would proceed regardless of decisions made about the level of LANL operations and are not detailed across the alternatives discussions. Appendix L includes summaries of activities routinely performed at LANL that typically receive categorical exclusions.

An updated probabilistic seismic hazard analysis providing an improved understanding of the seismic characteristics of LANL was completed in 2007 (LANL 2007a): this is discussed in more detail in Chapter 5, Section 5.12.3. LANL's *Engineering Standards Manual ISD 341-2* (LANL 2007c) was revised to incorporate natural phenomena hazard mitigation requirements for new structural designs and for renovation, replacement, modification, maintenance and rehabilitation projects. These requirements are applicable to construction projects under all alternatives.

3.1 No Action Alternative

The No Action Alternative reflects implementation of decisions made by DOE and the National Nuclear Security Administration (NNSA) based on the *1999 SWEIS* (DOE 1999a) and other analyses performed in accordance with DOE's NEPA process. In the *1999 SWEIS* ROD, DOE announced its decision to implement the Expanded Operations Alternative described in the *1999 SWEIS*, with a level of plutonium pit manufacturing of 20 pits per year. Therefore, the current No Action Alternative continues implementation of the *1999 SWEIS* Expanded Operations Alternative as modified in the ROD. The No Action Alternative also includes implementation of decisions made on actions evaluated in other EISs and EAs completed since 1999; these other NEPA implementing documents are summarized in Chapter 1, Section 1.5. For the purposes of this SWEIS, the construction and operation of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility is included within the No Action Alternative in keeping with the bounding approach for impact analysis. However, NNSA is engaged in a programmatic review process that includes a reconsideration of its 2004 decision regarding that portion of the Chemistry and Metallurgy Research Replacement Facility through preparation of the *Complex Transformation Supplemental Programmatic Environmental Impact Statement* (*Complex Transformation SPEIS*) (see earlier discussion of this document in Chapter 1). In addition to other actions for which DOE has completed NEPA reviews, many actions have been implemented at LANL based on reviews and determinations that they met conditions in DOE NEPA Implementing Procedures for being categorically excluded from further NEPA compliance evaluation.

3.1.1 Site-Wide Projects

Proposed projects not associated with a specific TA or Key Facility are identified in **Table 3–1** and described in this section. Table 3–1 also shows site-wide actions associated with the Expanded Operations Alternatives that are discussed in Section 3.3.1. There are no new site-wide activities proposed under the Reduced Operation Alternative.

Table 3–1 Site-Wide Projects and Activities

Project	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Security Needs	Security-Perimeter Project: - Build new access control stations at the intersection of Jemez Road and Diamond Drive and near the intersection of Camp May Road and West Jemez Road (mostly completed by the end of 2006). - Construct a road connecting West and Camp May Roads. Implement Nuclear Materials Safeguards and Security Upgrades Project Phase II to upgrade security systems at TA-55.	Same as No Action Alternative	Same as No Action Alternative, plus: - *Implement Security-Driven Transportation Modifications* (see Appendix J): – Construct traffic control stations and modify roadway to control access to Pajarito Road between TA-48 and TA-63. – Construct a vehicle and pedestrian bridge across Ten Site Canyon and a roadway from TA-63 to TA-35. – Construct commuter bus parking lots at TA-48 and TA-63. - Auxiliary Actions include: – Construct a vehicle bridge across Mortandad Canyon from TA-35 to TA-60; connect to paved road along the length of Sigma Mesa. – Construct a vehicle bridge across Sandia Canyon from TA-60 to TA-61; create intersection with East Jemez Road.
Remediation and Closure Activities	Continue remediation of potential release sites. Remediate and close MDA H.[a]	Same as No Action Alternative	Same as No Action Alternative, plus: - Implement *MDA Remediation, Canyon Cleanups and Other Consent Order Actions* [b, c] (see Appendix I). - Perform activities such as groundwater monitoring as necessary to support closure of the Los Alamos County Landfill.
Land Conveyance and Transfer	Convey or transfer previously identified parcels of LANL land to Los Alamos County, the New Mexico Department of Transportation, and the Department of the Interior in trust for the Pueblo of San Ildefonso.	Same as No Action Alternative	Same as No Action Alternative
Electrical Power System Upgrades	Construct new power line between Norton and new Southern TA Substations and from the Southern TA Substation to the new Western TA Substation. Construct new 115-kilovolt electrical substation along the Pajarito Corridor West. Upgrade Eastern TA Substation. Uncross Reeves and Norton-Los Alamos power lines.	Same as No Action Alternative	Same as No Action Alternative

Project	***No Action Alternative***	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Wildfire Hazard Reduction	Implement ecosystem-based management program for approximately 10,000 acres (4,000 hectares) of LANL land. Includes prescribed fire, mechanical and manual forest thinning, access road construction, and fuel breaks.	Same as No Action Alternative	Same as No Action Alternative
Disposition of Flood and Sediment Retention Structures	Remove aboveground portion of Pajarito Canyon flood retention structure and stabilize sides. Grade streambed and reseed banks. Remove aboveground portions of steel diversion wall at TA-18.	Same as No Action Alternative	Same as No Action Alternative
Trails Management Program	Repair, maintain, improve, and close, as necessary, publicly used trails on the LANL site.	Same as No Action Alternative	Same as No Action Alternative
Off-Site Source Recovery Project	Continue to receive and store certain excess and unwanted sealed sources containing plutonium-239 and other actinides.	Same as No Action Alternative	Same as No Action Alternative, plus: - Implement *Increase in Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project*: – Increase scope of project to accept additional types and quantities of sealed sources, including nonactinide beta-gamma emitters (see Appendix J).
Management of Construction Fill	Transport and store up to 150,000 cubic yards per year of soil excavated from Chemistry and Metallurgy Research Replacement Facility, and other construction projects, at TA-16 or TA-61 borrow areas.	Same as No Action Alternative	Same as No Action Alternative

TA = technical area; MDA = material disposal area; Consent Order = Compliance Order on Consent entered into by DOE, the University of California as the management and operating contractor, and the State of New Mexico.

[a] Remediation of MDA H is discussed in Section 3.1.2.4 as a TA project.

[b] Activities required to comply with the Consent Order are evaluated under the Expanded Operations Alternative because they do not meet the No Action Alternative definition found in Section 3.1 of this SWEIS. As explained in Chapter 1, Section 1.4 of this SWEIS, the decisionmaker does not need to select an entire alternative, but can select among the proposed alternatives for each project or activity.

[c] NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.

Notes: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS. To convert cubic yards to cubic meters, multiply by 0.76456.

3.1.1.1 Security Needs

Under the No Action Alternative, security operations and projects, including those initiated as a result of heightened security concerns related to the attacks of September 11, 2001, and the 2004 operational standdown at LANL, would continue. Projects approved and partially implemented include the Security Perimeter Project and Nuclear Materials Safeguards and Security Upgrades.

The Security Perimeter Project was first evaluated in the *Environmental Assessment for Proposed Access Control and Traffic Improvements at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2002k). Proposed changes to project implementation have been reviewed in subsequent NEPA documents: the *Supplement Analysis, Security Perimeter Project* (DOE 2003a), *the NEPA Compliance Review for Proposed Modifications to the Security Perimeter Project at Los Alamos National Laboratory* (NNSA 2004a), and most recently, the *NEPA Compliance Review Addendum for Proposed Modifications to the Security Perimeter Project at Los Alamos National Laboratory* (NNSA 2005a). This project initially proposed changes to traffic patterns around LANL, including the construction of bypass roads and the addition of access control stations to screen and limit access to LANL. Project modifications include not constructing the bypass roads and changing locations and designs for the access control stations. To date, four staffed access control stations have been completed, two along Pajarito Road, one at the intersection of Jemez Road and Diamond Drive (that intersection was redesigned to prevent vehicles from entering TA-3 without passing through the station), and another at the intersection of Camp May Road and West Jemez Road. West Jemez Road was redesigned at that point to facilitate vehicle screening and related activities. Together, these four access control stations will allow security personnel to restrict access to the site during times of heightened security; under normal security conditions, roads around the perimeter of LANL would remain open to the public. In addition, a road connecting West and Camp May roads will be constructed, largely following the route of an existing unpaved service road across TA-62.

The overall objective of the Nuclear Materials Safeguards and Security Upgrades Project is to upgrade and replace the existing physical security system to address new protection strategy requirements and the deteriorating physical security infrastructure. This project involves activities categorically excluded from further NEPA evaluation and is being implemented in two phases. In Phase I, which is already completed, the data and communications backbone for the central and secondary alarm stations security system was installed. In Phase II, the security system at TA-55 will be upgraded to provide an effective, responsive security system to address design-basis threats and other requirements. Phase II includes upgrades or replacements of existing exterior physical security systems and installation of interior intrusion detection, assessment, delay, access control, and security communications equipment to support the new protection strategy for TA-55. These systems will be integrated with the security control system installed in Phase I.

3.1.1.2 Remediation and Closure Activities

Remediation and cleanup efforts at LANL are regulated by and coordinated between NMED and DOE. Until recently, investigations and corrective measures in compliance with the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act were carried out in accordance with LANL's Hazardous Waste Facility Permit. But on March 1, 2005, the corrective action program specified in the permit was replaced by a Compliance Order on Consent (Consent Order). For the No Action Alternative, environmental investigations and restoration efforts would be implemented as they were prior to the Consent Order. Although not included in the No Action Alternative, NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in this SWEIS.

3.1.1.3 Land Conveyance and Transfer

As discussed in Chapter 2 of this SWEIS, LANL began conveying land to Los Alamos County and transferring land to the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) in 2002, as directed by Public Law 105-119. DOE anticipates conveying or transferring additional land before the end of 2012, the deadline prescribed in the Defense Authorization Act, which extended the deadline from 2007 as originally established in Public Law 105-119. Tracts identified for future conveyance and transfer are (LANL 2006a):

- A-4, to be conveyed to Los Alamos County, is part of the airport along NM 501 located east of the Los Alamos townsite, close to the East Gate Business Park.
- A-8, A-10, and A-11 are tracts to be conveyed to Los Alamos County and are part of the DP Road tract, located between the western boundary of TA-21 and the major Los Alamos townsite commercial districts.
- A-13, to be conveyed to Los Alamos County, is currently the DOE Los Alamos Site Office location. This tract is located within the Los Alamos townsite between Los Alamos Canyon and Trinity Drive.
- A-14, the Rendija Canyon tract, to be conveyed to Los Alamos County, is located north of the Los Alamos townsite's Barranca Mesa residential subdivision.
- A-18, to be conveyed to Los Alamos County, and B-3, to be transferred to the U.S. Department of the Interior in trust for the San Ildefonso Pueblo, are located east of the Los Alamos townsite and include much of Pueblo Canyon.
- C-1, C-2, C-3, and C-4 are tracts to be conveyed to the State of New Mexico Department of Transportation and are part of the White Rock tract, a complex area that incorporates the alignments and intersections of NM 4 and NM 502 and the easternmost part of Jemez Road.

3.1.1.4 Electrical Power System Upgrades

The power systems at LANL are being upgraded to increase site infrastructure reliability to meet current and future needs. The *Environmental Assessment for Electrical Power System Upgrades at Los Alamos National Laboratory* (DOE 2000a) assesses proposed electrical power system upgrades, including construction and operation of a new 115-kilovolt power transmission line that would originate at the Norton Substation and terminate at a new DOE-administered Western TA Substation. The transmission line from the Norton Substation to the point where it reaches the new Southern TA Substation near NM 4 will be operated at 115 kilovolts, but will be built to 345-kilovolt specifications to provide redundant service to LANL and the Los Alamos townsite.

Construction of the new Southern TA switchyard and the portion of the new power line from the new Southern TA Substation to the Western TA Substation has been completed. Refurbishment of the Eastern TA Substation is complete. The project to uncross the two existing transmission lines is expected to be complete by 2010. Construction of the portion of the new power line from the Norton Substation to the Southern TA Substation is in the design phase. A new substation will also be installed along Pajarito Corridor West at TA-50. See Chapter 4, Section 4.8.2.1, for more detail about these upgrades.

3.1.1.5 Wildfire Hazard Reduction Project Plan

Five major wildfires have ignited in the local area outside the LANL boundaries over the past 50 years. Such wildfires pose a serious threat to LANL buildings, structures, and utilities. A Wildfire Hazard Reduction and Forest Health Improvement Program was proposed in late 2001 to protect LANL from wildfires. The proposed activities were evaluated in the *Environmental Assessment for the Wildfire Hazard Reduction and Forest Health Improvement Program at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2000e). Initial fuel-reduction treatments were implemented through the Cerro Grande Rehabilitation Project using *Wildfire Hazard Reduction Project Plan* (LANL 2001b) guidance. About 10,000 acres (4,000 hectares), roughly 35 percent of LANL, were treated under this program from 2001 through 2005. Plans for future wildfire risk reduction activities such as monitoring for regrowth of fuel sources, tree thinning, and prescribed fire are described in the *Management Review Draft, LANL Wildland Fire Management Plan* (LANL 2005g).

3.1.1.6 Disposition of Flood and Sediment Retention Structures

The *Environmental Assessment for the Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2002j) evaluates removal of certain flood and sediment retention structures that were constructed as part of NNSA's emergency response actions for the Cerro Grande Fire of 2000. These structures were built to address changes in local watershed conditions that resulted from the fire. Watershed conditions are expected to return to a prefire status or approximate the prefire condition 3 to 8 years after the fire. After the watershed recovers, these structures would no longer be necessary to protect LANL facilities and the businesses and homes located downstream. This project will remove part of the aboveground portion of the Pajarito Canyon flood retention structure, including gabions installed along the downstream channel. The streambed will be graded, the remaining sides of the flood retention structure will be stabilized, and the banks will be reseeded. The area will be monitored and maintained to prevent slope erosion and damage to the floodplain and downstream wetlands. This project will also include removal of the aboveground portions of the steel diversion wall at TA-18. A Clean Water Act Section 404 Dredge and Fill Permit from the U.S. Army Corps of Engineers and a Section 401 Water Quality Certification from the New Mexico Environment Department will be required for removal of these structures. Any sediment removed will be characterized and either reused onsite, or if contaminated, disposed of in accordance with regulatory requirements. Best management practices involving stormwater controls will be implemented during removal activities as required by LANL's Construction Stormwater Permit Program.

3.1.1.7 Trails Management Program

NNSA and LANL staff recently began work on a Trails Management Program to address resource issues through improved and active stewardship. This program was evaluated in the *Environmental Assessment for the Proposed Los Alamos National Laboratory Trails Management Program, Los Alamos, New Mexico* (DOE 2003b). The program goal is to balance recreational trail use with environmental, cultural, safety, security, and social concerns. The program first established the Trails Assessment Working Group, which began meeting in December 2003 to formulate a plan for repair, construction, and implementation of environmental and cultural resources protection, safety, and security measures throughout the trail network. An inventory of all trails was started in 2005; further assessments would include end-state conditions and post-repair or post-construction assessments. The Working Group is also considering how community volunteers could contribute to the program.

3.1.1.8 Off-Site Source Recovery Project

The Off-Site Source Recovery Project has the responsibility to identify and as needed, to recover and store excess and unwanted sealed radiological sources on behalf of NNSA in cooperation with the U.S. Nuclear Regulatory Commission (NRC). From 1979 through 1999, DOE recovered excess and unwanted radioactive sealed sources containing plutonium-239 and beryllium on a case-by-case basis as requested by NRC. Since 1999, the Off-Site Source Recovery Project has assisted NNSA in managing actinide-bearing sealed sources and, in one case, strontium-90-bearing items that were recovered after being identified as potential threats to national security.

The LANL component of the current program disposes of recovered sources or places them in secure storage until a disposal path is available. Under the No Action Alternative, the Off-Site Source Recovery Project would continue to manage the same types and quantities of sealed sources as it has in the past. Sources containing actinide isotopes would be brought to LANL and safely stored if there were no other reasonable option to safely disposition the sources such as reuse or disposal. The Off-Site Source Recovery Project currently operates at the Chemistry and Metallurgy Research Building Key Facility, Pajarito Site Key Facility, Solid Radioactive and Chemical Waste Key Facilities, and Plutonium Facility Complex Key Facility. Activities related to this project are described as part of the specific capabilities of those Key Facilities.

3.1.1.9 Management of Construction Fill

Excavation during construction projects can result in large amounts of soil that cannot be immediately used for that project or in the immediate area. Uncontaminated construction fill is currently stored in two borrow areas at LANL, TA-61 and TA-16. This material can be used as backfill in other construction or remediation projects.

Excavation in TA-55 for the Chemistry and Metallurgy Research Replacement Facility (see Section 3.1.3.1) is expected to result in up to approximately 150,000 cubic yards of uncontaminated fill. The size of this excavation would bound excavation for other construction projects in this SWEIS. There is no capacity for storage of this amount of material at TA-55, and the fill would need to be transported by truck to the existing borrow areas or a similar to-be-determined location. At 10 cubic yards per truck load, there would be a total of 15,000 round trips between the TA-55 construction site and the destination borrow area over a period of 1 year.

Security concerns will determine the routing and timing of truck trips. One route would be west on Pajarito Road to Diamond Drive, and then either west on West Jemez Road to TA-16 or east on East Jemez Road to TA-61. An alternate route is east on Pajarito Road to NM 4, north to East Jemez Road, west on East Jemez either to TA-61 or to Diamond Drive and west on West Jemez Road to TA-16. The latter route would be the longest distance; from TA-55 to TA-16 would be approximately 20 miles.

3.1.2 Technical Area Projects

Under the No Action Alternative, changes will take place in a number of TAs. New facility construction; modification of existing structures; and facility or area upgrades would be undertaken to address security issues, building conditions, and increases or decreases in activities and personnel. These changes could result from programmatic initiatives, specific technical projects, implementation of corrective actions, or responses to environmental or other external concerns such as the Cerro Grande Fire.

Major changes anticipated for the TAs are identified in **Table 3–2** and described in this section.

3.1.2.1 Technical Area 3

TA-3 is the most populated area at LANL, with numerous buildings that support a variety of Key Facilities. As the center of technical, administrative, and physical support activities for LANL, TA-3 is the location of a number of new buildings and in-progress construction and office consolidation projects. The National Security Sciences Building, an eight-story building with approximately 275,000 square feet (25,500 square meters) of office, meeting, and light laboratory space, and its associated structures are under construction; the main building and parking structure have been completed and are in use. The existing building that was replaced by the National Security Sciences Building is planned to be demolished (NNSA 2001). Under the No Action Alternative, the Information Management Office Building, which would add approximately 15,000 to 18,000 square feet (1,400 to 1,700 square meters) of office space on two stories, was planned for the northeast corner of the intersection of Diamond Drive and Pajarito Road. Funding and location issues, however, have put this project on hold. Three additional two-story office buildings, each about 70 by 100 feet (21 by 30 meters) would provide about 15,000 to 17,000 gross square feet (1,400 to 1,600 square meters) of office space. Two of the buildings would be built due west of the existing Wellness Center; the third would be constructed near the northeast corner of the intersection of Mercury and Bikini Atoll Roads.

One general infrastructure project that would be completed at TA-3 under the No Action Alternative is the installation of two new combustion turbine generators, as evaluated in the *Environmental Assessment for the Installation and Operation of Combustion Turbine Generators at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2002l). This EA analyzed installation and operation of two new simple-cycle, gas-fired combustion turbine generators, each with an approximate output of 20 megawatts of electricity (rated at an elevation of 7,400 feet [2,220 meters]), as standalone structures within the Co-Generation Complex (Power Plant) at

TA-3. The installation site is immediately adjacent to existing structures and vehicle parking areas. No undeveloped areas would be involved. The first unit became operational in September 2007. There is presently no timetable for installing the second unit. See Chapter 4, Section 4.8.2.1 for more information about this project.

Table 3–2 Technical Area Projects and Activities

Activities	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
TA-3			
Installation of Combustion Turbine Generators	Install two 20-megawatt combustion turbine generators.	Same as No Action Alternative	Same as No Action Alternative
National Security Sciences Building	Demolish old building	Same as No Action Alternative	Same as No Action Alternative
Physical Science Research Complex Project	No activity	No activity	Construct the Physical Science Research Complex (see Appendix G).
Information Management Office Building Project	Construct Information Management Office Building	Same as No Action Alternative	Same as No Action Alternative
Replacement Office Buildings Project	Construct three office buildings.	Same as No Action Alternative	Construct up to 9 additional office buildings (see Appendix G).
TA-18			
TA-18 Closure Project, Including Remaining Operations Relocation and Structure DD&D	Continue certain Pajarito Site activities and store only Security Category III and IV materials. No DD&D activities would occur.	Remove all nuclear materials from the Pajarito Site. Shut the site down and place in surveillance and maintenance mode.	Remove all nuclear materials from the Pajarito Site. DD&D all buildings except a historic cabin and other historic properties from the Manhattan Project and Cold War eras that have been designated for long-term retention (see Appendix H).
TA-21			
TA-21 Structure DD&D Project	Deactivate tritium facilities and place in surveillance and maintenance mode.	Same as No Action Alternative	DD&D of structures located within the boundaries of TA-21 (see Appendix H).
TA-54			
MDA H Closure	Remediate and close MDA H in accordance with the Consent Order.	Same as No Action Alternative	Same as No Action Alternative
TA-62			
Science Complex Project	No activity	No activity	Construct and operate Science Complex (see Appendix G).
TA-72			
Remote Warehouse and Truck Inspection Station Project	No activity	No activity	Construct and operate Remote Warehouse and Truck Inspection Station (see Appendix G).

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MDA = material disposal area; Consent Order = Compliance Order on Consent entered into by DOE, the University of California as the management and operating contractor, and the State of New Mexico.
Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

3.1.2.2 Technical Area 18

Activities occurring in TA-18 are being discontinued in accordance with the ROD (67 *Federal Register* [FR] 79906) for the *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory (TA-18 EIS)* (DOE 2002i). TA-18 and the Pajarito Site Key Facility are used synonymously in this SWEIS because activities occurring in TA-18 are those assigned to the Pajarito Site Key Facility as defined in this SWEIS and because they are geographically identical. Closure of the Pajarito Site Key Facility is identified in this section because the Key Facility is within TA-18, but activities to implement closure are described in the Pajarito Site Key Facility sections of this Chapter (see Sections 3.1.3.9, 3.2.3, and 3.3.3.5).

3.1.2.3 Deactivation and Decontamination of Technical Area 21 Buildings

Historically, there have been two primary research areas in TA-21 – DP West and DP East. Buildings in DP West are primarily abandoned and deteriorating, with little process equipment present. DP West has been in LANL's decontamination and decommissioning program since 1992, and about half the facilities have been demolished. DP East still houses offices and some tritium facilities, but the remaining tritium work is moving to either the Weapons Engineering Tritium Facility in TA-16 or to Sandia National Laboratories in Albuquerque, New Mexico (*Final Environmental Assessment for the Proposed Consolidation of Neutron Generation Tritium Target Loading Production* [DOE 2005b]). The facilities will be deactivated as funding becomes available. Some buildings in DP East still contain equipment from current and recent operations that may contain accountable quantities of radioactive material. Most of this material would be removed during deactivation. Following deactivation, the tritium buildings will be placed in surveillance and maintenance mode along with the DP West buildings.

> **Decontamination, Decommissioning, and Demolition (DD&D)**
>
> Actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the structure.

3.1.2.4 Technical Area 54 Material Disposal Area H Closure

Material disposal area (MDA) H, located within TA-54, is a fenced site about 0.3 acres (0.12 hectares) in size that consists of nine inactive vertical inground shafts. Between 1960 and 1986, the site was used for burial of classified containerized and noncontainerized solid wastes, some of which were contaminated with radioactive, hazardous, and high explosives constituents. MDA H subsurface shafts contain primarily radioactive metal, most of which is either known or presumed to be depleted uranium. Investigations and studies for remediation of MDA H have been completed, and now NNSA needs to implement a corrective measure to comply with the legal requirements of the Atomic Energy Act of 1954, as amended, and the Compliance Order on Consent (Consent Order) entered into by DOE, the University of California as the management and operating contractor, and the State of New Mexico. As discussed in the following paragraphs, NNSA has completed its evaluations and is awaiting a decision from the New Mexico Environment Department.

The *Environmental Assessment for the Proposed Corrective Measures at Material Disposal Area H within Technical Area 54 at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2004e) evaluated five corrective measure options—three containment options and two excavation and removal options. For options involving in-place containment of wastes, physical controls (engineered barriers such as caps and containment barriers) and institutional controls (such as access restrictions) would be required for generations to come. As a result, long-term environmental stewardship requirements would be incorporated into any containment option.

The corrective measure option preferred by NNSA and recommended to the State of New Mexico for implementation in the *Corrective Measures Study Report for Material Disposal Area H, Solid Waste Management Unit 54-004, at Technical Area 54* (LANL 2003d) was replacement of the existing surface with an engineered evapotranspiration cover. Final selection of a corrective measure option was made by the New Mexico Environment Department in November 2007.

3.1.3 Key Facilities

3.1.3.1 Chemistry and Metallurgy Research Building

The Chemistry and Metallurgy Research Building, located within TA-3, is an actinide chemistry and metallurgy research facility. The only building currently in this Key Facility is the Chemistry and Metallurgy Research Building, a three-story, multiple-user facility in which specific wings are associated with different activities. It is the only LANL facility with full capabilities for performing special nuclear material analytical chemistry, materials characterization, and actinide R&D.

Although most capabilities and operating levels projected in the *1999 SWEIS* ROD (see Appendix A) for the Chemistry and Metallurgy Research Building are being retained as capabilities in this SWEIS, two important issues affect the capabilities and activity levels for this Key Facility. First, because of seismic concerns, DOE has administratively restricted operations and reduced the amount of nuclear material that can be used and stored in the building to levels lower than those projected in the *1999 SWEIS* ROD. Therefore, several capabilities are either operating at reduced levels or are not active. Second, as discussed later in this section, the Chemistry and Metallurgy Research Building has been identified for replacement and demolition. The impact analyses in this SWEIS are based on capabilities, activities, and operating levels presented in this section, regardless of whether they are administratively reduced or restricted and whether those activities would occur in the Chemistry and Metallurgy Research Building, its replacement facility, or both during a transition period.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–3** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–3 Chemistry and Metallurgy Research Building Capabilities and Activity Levels [a]

Capability	*No Action Alternative* [b]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [c]
Analytical Chemistry	Support actinide research and processing activities by processing approximately 7,000 samples per year.	Same as No Action Alternative	Support actinide research and processing activities by processing approximately 11,000 samples per year.[a]
Uranium Processing	Recover, process, and store LANL's highly enriched uranium inventory.	Same as No Action Alternative	Same as No Action Alternative
Destructive and Nondestructive Analysis	Evaluate up to 10 secondary assemblies per year through destructive and nondestructive analysis and disassembly.	Same as No Action Alternative	Same as No Action Alternative
Nonproliferation Training	Conduct nonproliferation training using special nuclear material.	Same as No Action Alternative	Same as No Action Alternative
Actinide Research and Development (Actinide Research and Processing in the *1999 SWEIS*)	Characterize approximately 100 samples per year using microstructural and chemical metallurgical analysis. Perform compatibility testing of actinides and other metals to study long-term aging and other material effects. Analyze transuranic waste disposal related to validation of WIPP performance assessment models. Perform transuranic waste characterization. Analyze gas generation such as could occur in transuranic waste during transportation to WIPP. Demonstrate actinide decontamination technology for soils and materials. Develop actinide precipitation method to reduce mixed wastes in LANL effluents. Process up to 900 pounds (400 kilograms) of actinides per year between TA-55 and the CMR Building.	Same as No Action Alternative	Same as No Action Alternative, plus: - Receive, disassemble, and analyze assemblies and components used to measure radiological effects on different materials. - Conduct Performance Demonstration Program to test nondestructive analysis and nondestructive examination equipment. - Develop small-scale (less than 2 pounds [1 kilogram] per year) actinide processing capability. - Perform gas-solid interfacial studies using surface-science instrumentation and associated techniques. - Investigate physical and mechanical properties of plutonium metal alloys.
Fabrication and Processing (Fabrication and Metallography in the *1999 SWEIS*)	Process up to 5,000 curies of neutron sources per year (both plutonium-238 and beryllium and americium-241 and beryllium sources). Process neutron sources other than sealed sources. Stage a total of up to 1,000 plutonium-238 and beryllium and americium-241 and beryllium neutron sources in Wing 9 floor holes. Produce 1,320 targets per year for isotope production. Separate fission products from irradiated targets. Support fabrication of metal shapes using highly enriched uranium (as well as related uranium processing activities), with an annual throughput of approximately 2,200 pounds (1,000 kilograms).	Same as No Action Alternative	Same as No Action Alternative, plus: - As a part of the Isotope Production Program, produce up to 100 curies per year of industrial or medical radioisotopes. - Produce up to 9 pounds (4 kilograms) per year of americium oxide. - Fabricate metal alloys. - Study and perform fabrication methods and effects of actinide materials thermomechanical processing. - *Increase types and quantities of sealed sources stored for the Off-Site Source Recovery Project* (see Appendix J).

Capability	No Action Alternative [b]	Reduced Operations Alternative	Expanded Operations Alternative [c]
Large Vessel Handling	Process up to two large vessels from the Dynamic Experiments Program annually.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades/DD&D			
Replacement of CMR Building	Construct and operate a CMRR Facility in TA-55 and conduct DD&D of the CMR Building. Wing 9 hot cell operations and certain other capabilities would be eliminated. The CMRR Facility would replace the CMR Building as the Key Facility.	Construct and operate only the radiological laboratory, administrative and support facility portion of the CMRR Facility; continue to down scope and consolidate operations within the existing CMR Building in performance of minimal mission support work.	Same as No Action Alternative, plus: - Reconstruct Wing 9 hot cell capabilities in proposed new *Radiological Sciences Institute* in TA-48 (see Section 3.3.3.7 and Appendix G).

WIPP = Waste Isolation Pilot Plant; TA = technical area; DD&D = decontamination, decommissioning, and demolition; CMR = Chemistry and Metallurgy Research, CMRR = Chemistry and Metallurgy Research Replacement Facility.

[a] Activity levels shown cannot be met while work is performed in the Chemistry and Metallurgy Research Building due to seismic concerns that restrict the level of operations and limit the allowable amount of nuclear materials. Full operations would be achievable upon movement of all activities into the new Chemistry and Metallurgy Research Replacement Facility.

[b] DOE 1999a.

[c] LANL 2004c, 2006a.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Analytical Chemistry. Analytical chemistry capabilities involve the study, evaluation, and analysis of radioactive materials. These activities support R&D associated with various nuclear materials programs, many of which are performed at other LANL locations on behalf of, or in support of, other sites across the DOE complex (such as the Hanford Site, Savannah River Site, and Sandia National Laboratories). Sample characterization activities include assay and determination of isotopic ratios of plutonium, uranium, and other radioactive elements; major and trace elements in materials; the content of gases; constituents at the surface of various materials; and methods to characterize waste constituents in hazardous and radioactive materials.

Uranium Processing. Uranium processing capabilities encompass many types of operations that are essential for uranium product stewardship, including uranium processing (casting, machining, and reprocessing operations, including R&D of process improvements and uranium and uranium compounds characteristics) and highly enriched uranium handling and storage. The Chemistry and Metallurgy Research Building also provides limited backup to support nuclear materials management needs for TA-55 activities, as well as pilot-scale unit operations to back up uranium technology activities at the Sigma Complex (described in Section 3.1.3.2), other LANL facilities, and other DOE sites.

Destructive and Nondestructive Analysis. Destructive and nondestructive analysis involves analytical chemistry, metallographic analysis, neutron- or gamma-radiation-based measurement, and other measurement techniques. These activities support weapons quality component surveillance, nuclear materials control and accountability, special nuclear material standards development, R&D, environmental restoration, and waste treatment and disposal.

Nonproliferation Training. Measurement technologies are used at the Chemistry and Metallurgy Research Building and other LANL facilities to train international inspection teams for the International Atomic Energy Agency. Such training might use special nuclear material.

Actinide Research and Development. Actinide research and processing at the Chemistry and Metallurgy Research Building typically involves solids or small quantities of solution. Research involving highly radioactive materials or remote handling, however, may use the hot cells in Wing 9 of the Chemistry and Metallurgy Research Building to minimize personnel exposure to radiation or other hazardous materials. Actinide research and processing can include separation of medical isotopes from targets, neutron source processing, and material characteristics research, including the behavior or characteristics of materials in extreme environments such as high temperatures or pressures.

The primary mission to study long-term aging and other material effects is achieved through microstructural and chemical metallurgical analysis and compatibility testing of actinides and other metals. This R&D is conducted in hot cells on pits exposed to high temperatures.

Fabrication and Processing. The Chemistry and Metallurgy Research Building has facilities to fabricate and analyze a variety of parts, including targets and weapons components used for various research and experimental tasks. Fabrication and processing at this building involve a variety of materials, including hazardous and nuclear materials. Much of the work is performed to support highly enriched uranium processing, R&D, pilot operations, and casting. Some metal recycling is conducted through these processes. In addition, materials to support these activities and the Off-Site Source Recovery Project are stored in the Wing 9 hot cell areas.

Large Vessel Handling. This capability would not begin until the Chemistry and Metallurgy Research Replacement Facility is operating. Large (6 to 8 feet [1.8 to 2.4 meters] in diameter) experimental vessels from the Dynamic Experiments Program would be cleaned and materials would be recovered for reuse or disposal. Large-vessel handling operations would begin with unloading and opening the vessel. The vessels would then be emptied and the contents would be sorted and packaged. Depending on the condition and quality of the special nuclear material recovered from the vessels, the material could be processed for reuse or prepared for disposal as transuranic waste. Other vessel contents would be disposed of as either low-level radioactive waste or transuranic waste. The empty vessel would be cleaned for disposal as low-level radioactive waste.

Replacement of Chemistry and Metallurgy Research Building. Because of the age and condition of the Chemistry and Metallurgy Research Building, NNSA decided to replace the building rather than upgrade it to meet structural requirements to address seismic concerns and code requirements for operation as a nuclear facility. As part of its decisionmaking process, NNSA prepared the *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (*CMRR EIS*) (DOE 2003d). The *CMRR EIS* evaluates potential impacts of the proposed relocation of analytical chemistry and materials characterization activities and associated R&D

capabilities that currently exist primarily at the Chemistry and Metallurgy Research Building to a newly constructed Chemistry and Metallurgy Research Replacement Facility, as well as the continued performance of those operations and activities at the new facility for the next 50 years. The *CMRR EIS* ROD (69 FR 6967) announced NNSA's decision to replace the Chemistry and Metallurgy Research Building with a new facility in TA-55, the Chemistry and Metallurgy Research Replacement Facility, followed by decontamination, decommissioning, and demolition (DD&D) of the existing Chemistry and Metallurgy Research Building. The replacement facility will comprise a nuclear facility portion (a Nuclear Hazard Category 2 laboratory building) and a separate radiological laboratory, administrative office, and support building.

Phased construction began in 2006. The radiological laboratory, administrative office, and support building will be constructed first and will house office space, training facilities, utility equipment, and laboratory space designed to handle small amounts of special nuclear material. Construction of the nuclear facility portion, capable of handling larger quantities of special nuclear material has been delayed until NNSA completes reconsideration of its 2004 decision to construct this facility at LANL. If located at LANL, the transition of capabilities and operations to the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility would begin at construction completion. Not all Chemistry and Metallurgy Research Building capabilities would be moved to the new facility: Wing 9 hot cell operations, medical isotope production, uranium production, surveillance activities, and other capabilities would be eliminated.

Transition of operations from one facility to the other is anticipated to occur in stages and is expected to take about 4 years to complete. During the transition period, both facilities would be operating, although at reduced levels. Activities would decrease at the Chemistry and Metallurgy Research Building while increasing at the new replacement facility. Routine onsite shipments of analytical chemistry and materials characterization samples would continue during the transition period.

The Key Facility would comprise both the Chemistry and Metallurgy Research Building and its replacement during the transition period. After the transition period, the Chemistry and Metallurgy Research Replacement Facility would become the Key Facility.

3.1.3.2 Sigma Complex

The Sigma Complex Key Facility, located in TA-3, consists of the main Sigma Building and its associated support structures, including the Beryllium Technology Facility, the Press Building, and the Thorium Storage Building. The Sigma Building contains four levels and approximately 200,000 square feet (60,960 square meters) of space.

The Sigma Complex supports a large multidisciplinary technology base in materials fabrication science. Primary activities are materials synthesis and processing, characterization of materials, and fabrication of metallic and ceramic items, including depleted uranium items used in the Stockpile Stewardship Program. Bulk depleted uranium is stored in the Sigma Building as supply and feed stock. Current activities in the Sigma Building focus on test hardware, prototype fabrication, and materials research for the DOE Nuclear Weapons Program, but also include activities related to energy, environment, industrial competitiveness, and strategic research.

Sigma Complex Key Facility capabilities include R&D on materials fabrication, coating, joining, and processing; characterization of materials; and fabrication of metallic and ceramic items. The following paragraphs describe the capabilities of this Key Facility. **Table 3–4** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–4 Sigma Complex Capabilities and Activity Levels

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Research and Development on Materials Fabrication, Coating, Joining, and Processing	Fabricate items from metals, ceramics, salts, beryllium, enriched and depleted uranium, and other uranium isotope mixtures. Fabrication techniques would include casting, forming, machining, polishing, coating, and joining.	Same as No Action Alternative	Same as No Action Alternative
Characterization of Materials	Perform research and development on properties of ceramics, oxides, silicides, composites, and high-temperature materials. Analyze up to 36 tritium reservoirs per year. Develop a library of aged nonspecial nuclear material from stockpiled weapons and develop techniques to test and predict changes. Characterize and store up to 2,500 nonspecial nuclear material samples per year, including uranium.	Same as No Action Alternative	Same as No Action Alternative
Fabrication of Metallic and Ceramic Items	Fabricate stainless steel and beryllium components for up to 80 pits per year. Fabricate up to 200 reservoirs for tritium per year. Fabricate components for up to 50 secondary assemblies (of depleted uranium, depleted uranium alloy, enriched uranium, deuterium, and lithium) per year. Fabricate nonnuclear components for research and development: 100 major hydrotests and 50 joint test assemblies per year. Fabricate beryllium targets. Fabricate targets and other components for accelerator production of tritium research. Fabricate test storage containers for nuclear materials stabilization.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades/DD&D			
	No activity	No activity	No activity

DD&D = decontamination, decommissioning, and demolition.
[a] DOE 1999a.
[b] LANL 2004c, 2006a.

Research and Development on Materials Fabrication, Coating, Joining, and Processing. Materials synthesis and processing work includes R&D related to making items out of difficult-to-work-with materials. Processes include applying coatings and joining materials using plasma arc welding and other techniques. Other activities include casting, forming, machining, and polishing. Materials used in fabrication are also reprocessed (separated into pure forms for reuse or storage).

Characterization of Materials. Materials characterization work conducted at the Sigma Complex includes activities to enhance understanding of the properties of metals, metal alloys, ceramic-coated metals, and other similar combinations. Materials characterization also includes activities to improve understanding of the effects of aging, chemical attack, mechanical stresses, and other agents on these materials and their properties.

Fabrication of Metallic and Ceramic Items. Materials fabrication at the Sigma Complex includes work with metallic and ceramic materials and combinations thereof. Items are fabricated as one-of-a-kind and prototype pieces, as well as on a limited-production basis. One specific set of applications for this technology is fabrication of nonnuclear weapons components.

3.1.3.3 Machine Shops

The Machine Shops Key Facility consists of two buildings, a Nonhazardous Materials Machine Shop and a Radiological Hazardous Materials Machine Shop. These buildings are located in TA-3 and are connected to each other by a 125-foot-long (38-meter-long) corridor. The Nonhazardous Materials Machine Shop is approximately 138,000 square feet (42,060 square meters), including a 13,500-square-foot (4,120-square-meter) administrative office area. This building contains a variety of lathes, mills, and other metal-forming equipment and also houses the old beryllium shop, which is ventilated through a high-efficiency particulate air filtration system. Equipment from the beryllium shop was moved to the Sigma Complex in 2000, and beryllium operations ceased in 2001. A number of modular units have been constructed on the north side of the Nonhazardous Materials Machine Shop to provide space in which to conduct prototype mockup operations for TA-55, PF-4 Building.

The Radiological Hazardous Materials Machine Shop has a total floor space of approximately 12,500 square feet (1,160 square meters) and contains a variety of metal fabrication machines. Depleted uranium represents the bulk of the materials used in this facility, although many other potentially hazardous materials, such as lithium compounds, are used.

Activities conducted at the machine shops include machining, welding, and assembly of various materials in support of major LANL programs and projects, principally those related to weapons manufacturing.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–5** indicates activity types and levels proposed under all three alternatives for each capability.

Fabrication of Specialty Components. The primary purpose of the Machine Shops Key Facility is fabrication of specialty components. Specialty components are unique, unusual, or one-of-a-kind parts, fixtures, tools, or other equipment.

Fabrication Utilizing Unique Materials. Parts and components are fabricated using unique or exotic materials at the machine shops. Components are fabricated from depleted uranium or lithium in support of NNSA programs, for example.

Table 3–5 Machine Shops Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Fabrication of Specialty Components	Provide fabrication support for the Dynamic Experiments Program and explosives research studies. Support up to 100 hydrodynamic tests annually. Manufacture 50 joint test assembly sets annually. Provide general laboratory fabrication support as requested.	Same as No Action Alternative	Same as No Action Alternative
Fabrication Using Unique Materials	Fabricate items using unique and unusual materials such as depleted uranium and lithium.	Same as No Action Alternative	Same as No Action Alternative
Dimensional Inspection of Fabricated Components	Perform dimensional inspections of finished components. Perform other types of measurements and inspections.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades/DD&D			
	No activity	No activity	No activity

DD&D = decontamination, decommissioning, and demolition.
[a] DOE 1999a.
[b] LANL 2004c, 2006a.

Dimensional Inspection of Fabricated Components. Dimensional inspection of the finished component is a standard step in the fabrication process. It involves numerous measurements to ensure that the component is the correct size and shape to fit into its allotted space and perform its intended function.

3.1.3.4 Material Sciences Laboratory

This Key Facility comprises several buildings in TA-3 (3-32, 3-34, 3-1698, 3-1819, and 3-2002). The main Material Sciences Laboratory (Building-3-1698), a two-story, approximately 55,000-square-foot (5,100-square-meter) laboratory building, contains 27 laboratories, 60 offices, and 21 materials research and support areas. This Key Facility supports four major types of experimentation: materials processing, mechanical behavior in extreme environments, advanced materials development, and materials characterization. These four areas contain operational capabilities that support materials research activities related to energy, environment, nuclear weapons, and industrial competitiveness. Collaboration with private industry is also an important feature of much of the work performed at the Material Sciences Laboratory. Given the dynamic nature of research, the types and number of experiments will continue to evolve. These changes, however, can be sufficiently characterized to allow analysis of their consequences within the context of this SWEIS.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–6** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–6 Material Sciences Laboratory Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Materials Processing	Support development and improvement of technologies for materials formulation. Support development of chemical processing technologies, including recycling and reprocessing techniques to solve environmental problems.	Same as No Action Alternative	Same as No Action Alternative
Mechanical Behavior in Extreme Environments	Study fundamental properties of materials and characterize their performance, including research on the aging of weapons. Develop and improve techniques for these and other types of studies.	Same as No Action Alternative	Same as No Action Alternative
Advanced Materials Development	Synthesize and characterize single crystals and nanophase and amorphous materials. Perform ceramics research, including solid-state, inorganic chemical studies involving materials synthesis. A substantial amount of effort in this area would be dedicated to producing new high-temperature superconducting materials. Provide facilities for synthesis and mechanical characterization of materials systems for bulk conductor applications. Develop and improve techniques for development of advanced materials.	Same as No Action Alternative	Same as No Action Alternative
Materials Characterization	Perform materials characterization activities to support materials development.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades/DD&D			
	No activity	No activity	No activity

DD&D = decontamination, decommissioning, and demolition.
[a] DOE 1999a.
[b] LANL 2004c, 2006a.

Materials Processing. Materials processing supports formulation of a wide range of useful materials through development of materials fabrication and chemical processing technologies. Wet chemistry, thermomechanical processing, microwave processing, heavy-equipment materials processing, single-crystal growth, amorphous alloys, and powder processing are synthesis and processing techniques that represent some of the capabilities available for this research area.

Some of the laboratories housing heavy equipment for novel mechanical processing of powders and nondense materials are configured to explore net shape and zero-waste manufacturing processes. Several laboratories are dedicated to development of chemical processing technologies, including recycling and reprocessing techniques to solve current environmental problems.

Mechanical Behavior in Extreme Environments. These laboratories contain equipment for mechanical testing of materials subjected to a broad range of mechanical loadings to study their fundamental properties and characterize their performance. Laboratories utilized for this major area of materials science include dedicated space for mechanical testing; mechanical fabrication, assembly, and machining research; metallography; and dynamic testing.

The mechanical testing laboratory offers capabilities to study multi-axial, high-temperature, and high-load behaviors of materials. Assembly areas consist of metalworking and experimental assembly areas that house a variety of electrically or hydraulically powered machines that twist, pull, or compress samples. The most energetic of these is a gas launcher, which projects a sample against an anvil at very high velocities. The Material Sciences Laboratory's dynamic materials behavior laboratory is used by researchers to study high-deformation-rate behaviors. The dynamic testing equipment allows materials to be subjected to high-rate loadings, including impact up to 1.2 miles (2 kilometers) per second. The metallography area contains equipment for sectioning, mounting, polishing, and photographing samples.

Advanced Materials Development. The various laboratories are configured for development of advanced materials for high-strength and high-temperature applications. Capabilities involve research in synthesis and characterization using ceramics, superconductors, and new materials.

Materials Characterization. The materials characterization capability aids researchers in understanding the properties and processing of materials and applying that understanding to materials development. Capabilities at these laboratories include x-ray, optical metallography, spectroscopy, and surface-science chemistry.

The x-ray laboratory allows for the study of samples at temperatures up to 4,892 degrees Fahrenheit (°F) (2,700 degrees Celsius [°C]) and pressures up to 80 kilobars. Optical characterization is conducted with the latest equipment in the metallography and ceramography support laboratory. Subnanometer to micrometer structures are characterized using electron microscopy, including chemical analysis and high-resolution electron holography. The optical spectroscopy laboratory performs ultrafast and continuous-wave, tunable-resonance Raman scattering spectroscopy; high-resolution Fourier Transform infrared absorption; and ultraviolet-visible to near-infrared absorption spectroscopy. Surface-science studies and corrosion characterization of materials are carried out in additional laboratories.

3.1.3.5 Nicholas C. Metropolis Center for Modeling and Simulation

The Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center) is a new Key Facility and an integral part of the tri-laboratory (LANL, Lawrence Livermore National Laboratory, and Sandia National Laboratories) mission to maintain, monitor, and ensure the Nation's nuclear weapons performance through the Advanced Simulation and Computing Program. The facility is housed in a three-story, 303,000-square-foot (28,200-square-meter) structure in TA-3 and has been in operation since 2002. High-performance, complex computing operations are performed at this facility. Together with the Laboratory Data Communication Center, Central Computing Facility, and Advanced Computing Laboratory, the Metropolis Center forms the center for high-performance computing at LANL.

Under the No Action Alternative, the Metropolis Center computing platform would operate at up to 50 teraflops.[1] Computer operations are performed 24 hours a day, with personnel occupying

[1] *A teraflop is a trillion floating point operations per second.*

the control room to support computer operation activities during prime business hours and other times as necessary. Operations consist of office-type activities, light laboratory work such as computer and support equipment assembly and disassembly, and computer operations and maintenance. The Metropolis Center has capabilities to enable remote-site users access to the computing platform, and its co-laboratories and theaters are equipped for distance operations to allow collaboration between weapons designers and engineers across the DOE weapons complex.

The following paragraph describes the capabilities of this Key Facility. **Table 3–7** indicates activity levels proposed under all three alternatives.

Computer Simulations. Computer simulations have become the only means of integrating the many complex processes that occur in the nuclear weapon lifespan. Large-scale calculations are now the primary tools for estimating nuclear yield and evaluating the safety of aging weapons in the nuclear stockpile. Continued certification of aging stockpile safety and reliability depends upon the ability to perform highly complex, three-dimensional computer simulations.

Table 3–7 Nicholas C. Metropolis Center for Modeling and Simulation Capabilities and Activity Levels

Capability	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Computer Simulations	Perform complex three-dimensional computer simulations to estimate nuclear yield and aging effects to demonstrate nuclear stockpile safety. Apply computing capability to solve other large-scale, complex problems.	Same as No Action Alternative	Same as No Action Alternative, plus: Operate computing platform at higher computational capabilities.
Construction/Upgrades/DD&D			
Metropolis Center Increased Level of Operations	No activity	No activity	Install additional processors to increase functional capability. This expansion would involve addition of mechanical and electrical equipment, including chillers, cooling towers, and air-conditioning units (see Appendix J).

DD&D = decontamination, decommissioning, and demolition.
Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

3.1.3.6 High Explosives Processing Facilities

High Explosives Processing Facilities are located in six TAs: TA-8, TA-9, TA-11, TA-16, TA-22, and TA-37. This Key Facility includes production and assembly buildings, analytical laboratories, explosives storage magazines, and a building to treat wastewater contaminated with explosives. Activities under the No Action Alternative would require an estimated 82,700 pounds (37,500 kilograms) of explosives and 2,910 pounds (1,320 kilograms) of mock explosives annually (this is an indicator of overall activity levels in this Key Facility).

The following paragraphs describe the capabilities of this Key Facility. **Table 3–8** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–8 High Explosives Processing Facilities Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Volume of Explosives Required (indicator of overall activity levels)	High-explosives processing activities would use approximately 82,700 pounds (37,500 kilograms) of explosives and 2,910 pounds (1,320 kilograms) of mock explosives annually.	High-explosives processing activities would use approximately 66,160 pounds (30,000 kilograms) of explosives and 2,330 pounds (1,060 kilograms) of mock explosives annually, a 20 percent reduction in activity levels from the No Action Alternative.	Same quantity of explosives as the No Action Alternative, plus: Increase to 5,000 pounds (2,270 kilograms) of mock explosives.[b]
High Explosives Synthesis and Production	Perform high explosives synthesis and production research and development. Produce new materials for research, stockpile, military, security-interest, and other applications. Formulate, process test, and evaluate explosives.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
High Explosives and Plastics Development and Characterization	Evaluate stockpile returns and materials of specific interest. Develop and characterize new plastics and high explosives for stockpile, military, and security interest improvements. Improve predictive capabilities. Research high explosives waste treatment methods.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
High Explosives and Plastics Fabrication	Perform stockpile surveillance and process development. Supply parts to the Pantex Plant for surveillance and stockpile rebuilds and joint test assemblies. Fabricate materials for specific military, security-interest, hydrodynamic, and environmental testing.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
Test Device Assembly	Assemble test devices. Perform radiographic examination of assembled devices to support stockpile-related hydrodynamic tests, joint test assemblies, environmental and safety tests, and R&D activities. Support up to 100 major hydrodynamic test device assemblies annually.	Reduce activity levels by 20 percent from the No Action Alternative, including supporting up to 80 major hydrodynamic test device assemblies annually.	Same as No Action Alternative
Safety and Mechanical Testing	Conduct safety and environmental testing related to stockpile assurance and new materials development. Conduct up to 15 safety and mechanical tests annually.	Reduce activity levels by 20 percent from the No Action Alternative, including conducting up to 12 safety and mechanical tests annually.	Same activities as No Action Alternative, plus: Increase up to 500 safety and mechanical tests conducted annually.[c]

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Research, Development, and Fabrication of High-Power Detonators	Continue to support stockpile stewardship and management activities. Manufacture up to 40 major product lines per year. Support DOE-wide packaging and transport of electro-explosive devices.	Reduce activity levels by 20 percent from the No Action Alternative, including manufacturing up to 32 major product lines per year.	Same as No Action Alternative
Construction/Upgrades/DD&D			
Engineering and Science Applications Consolidation Project	Complete construction of TA-16 Engineering Complex. Remove or demolish vacated structures that are no longer needed.	Same as No Action Alternative	Same as No Action Alternative

R&D = research and development; DD&D = decontamination, decommissioning, and demolition; TA = technical area.
[a] DOE 1999a.
[b] LANL 2004c.
[c] LANL 2006a.

High Explosives Synthesis and Production. Activities under this capability include explosive manufacturing capacity such as synthesizing new explosives and manufacturing pilot-plant quantities of raw and plastic-bonded explosives. These operations allow the LANL contractor to develop and maintain expertise in explosive materials and processes that is essential for long-term maintenance of stockpile weapons and materials.

High Explosives and Plastics Development and Characterization. Activities included in this capability provide characterization data for explosives applications in nuclear weapons technology. Information on the initiation and detonation properties of high explosives coupled with non-high explosives component information for modeling is essential to weapons design and safety analysis. A wide range of plastic and composite materials is used in nuclear weapons such as adhesives, potting materials, flexible cushions and pads, thermoplastics, and elastomers. A thorough understanding of the chemical and physical properties of these materials is necessary to effectively model weapons behavior.

High Explosives and Plastics Fabrication. High explosives powders are typically compacted into solid pieces and machined to final specified shapes. Some small pieces are pressed into final shapes, and some powders, based upon their properties, are melted into stock pieces. Fabrication of plastic materials and components is a core capability associated with high explosives processing, and a wide variety of plastic and composite materials may be fabricated.

Test Device Assembly. This capability provides the capacity to assemble test devices ranging from full-scale nuclear-explosive-like assemblies (where fissile material has been replaced by inert material) to materials characterization tests. In addition to assembly operations, this Key Facility conducts explosives testing support and radiography examinations of the final assemblies.

Safety and Mechanical Testing. Capabilities exist for measuring mechanical properties of explosives samples, including tensile, compression, and creep properties (change of materials shapes over time). Test assemblies can be instrumented with strain or pressure gauges or other diagnostic equipment.

Research, Development, and Fabrication of High-Power Detonators. This capability includes activities such as detonator design; printed circuit manufacture; metal deposition and joining; plastic materials technology development; explosives loading, initiation, and diagnostics; laser production; and explosives systems design, development, and manufacture safety. Detonators, cables, and firing systems for tests are built as part of this capability.

Construction, Upgrades, and DD&D. Under all three alternatives, the Engineering and Science Applications Consolidation would be completed. This consolidation was evaluated in the *Environmental Assessment for the Proposed TA-16 Engineering Complex Refurbishment and Consolidation at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2002e), and involves constructing or remodeling TA-16 Engineering Complex offices, laboratories, and shops. Operations and personnel would be consolidated from facilities in TA-3, TA-8, TA-11, TA-50, and other areas of TA-16. Six new buildings (two office buildings, two machine shops, a crafts support building, and a calibration laboratory) would be constructed, and two other existing TA-16 Engineering Complex buildings would be remodeled. Some vacated structures would be removed or demolished. Existing Engineering Complex roads, parking, fencing, and utilities would be modified or upgraded. Proposed construction sites are located in areas that were once occupied by buildings or structures, are within existing paved parking areas, or are in areas immediately adjacent to existing buildings and parking areas.

3.1.3.7 High Explosives Testing Facilities

The major High Explosives Testing Facilities buildings are located in TA-15 and include the Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility. These buildings are used primarily for R&D, test operations, and detonator development and testing related to the DOE Stockpile Stewardship Program. Building types include preparation and assembly facilities, bunkers, analytical laboratories, high explosives storage magazines, and office areas. Firing sites are located in five TAs (TA-14, TA-15, TA-36, TA-39, and TA-40). All of the firing sites are in remote locations within canyons and specialize in experimental studies of the dynamic properties of materials under high-pressure and -temperature conditions. The firing sites, which occupy approximately 22 square miles (57 square kilometers) of land area, represent more than half of LANL's total 40 square miles (104 square kilometers).

The No Action Alternative includes about 1,800 experiments per year, 100 of which would be characterized as major hydrodynamic tests. Up to 6,900 pounds (3,130 kilograms) of depleted uranium would be expended in experiments annually. Firing site activities would include expenditures of materials that are considered to be useful indicators of overall test activity.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–9** indicates activity types and levels proposed under all three alternatives for each capability.

Hydrodynamic Tests. Hydrodynamic tests are dynamic integrated systems tests of mockup nuclear packages during which high explosives are detonated and resulting motions and reactions of materials and components are observed and measured. Explosively generated pressures and temperatures cause some materials to behave hydraulically (like a fluid). Surrogate materials such as depleted uranium replace actual weapons materials in the mockup nuclear weapons package to ensure there is no potential for a nuclear explosion. Most hydrodynamic tests are conducted at TA-15; others are conducted at TA-36.

Table 3–9 High Explosives Testing Facilities Capabilities and Activity Levels

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Volume of Materials Required (indicator of overall activity levels)	Conduct about 1,800 experiments per year. Use up to 6,900 pounds (3,130 kilograms) of depleted uranium in experiments annually.	Reduce activity levels by 20 percent from the No Action Alternative: - Conduct about 1,440 experiments per year. - Use up to 5,500 pounds (2,500 kilograms) of depleted uranium in experiments annually.	Same as No Action Alternative
Hydrodynamic Tests	Develop containment technology. Conduct baseline and code development tests of weapons configurations. Conduct 100 major hydrodynamic tests per year.	Reduce activity levels by 20 percent from the No Action Alternative. Conduct approximately 80 major hydrodynamic tests per year.	Same as No Action Alternative
Dynamic Experiments	Conduct dynamic experiments to study properties and enhance understanding of the basic physics and equation of state and motion for nuclear weapons materials, including some special nuclear material experiments.	Reduce activity levels by 20 percent from the No Action Alternative: No experiments would use special nuclear material.	Same as No Action Alternative
Explosives Research and Testing	Conduct tests to characterize explosive materials.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
Munitions Experiments	Support the U.S. Department of Defense with R&D on conventional munitions. Conduct experiments to study external-stimuli effects on munitions.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
High Explosives Pulsed-Power Experiments	Conduct experiments using explosively driven electromagnetic power systems.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
Calibration, Development, and Maintenance Testing	Perform experiments to develop and improve techniques to prepare for more involved tests.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
Other Explosives Testing	Conduct advanced high explosives or weapons evaluation studies.	Reduce activity levels by 20 percent from the No Action Alternative.	Same as No Action Alternative
Construction/Upgrades/DD&D			
Dynamic Experimentation Consolidation Project [c]	Complete construction of 15 to 25 new structures (offices, laboratories, and shops) within the Two-Mile Mesa Complex to replace about 59 structures currently used for dynamic experimentation operations. Remove or demolish vacated structures.	Same as No Action Alternative	Same as No Action Alternative
DARHT EIS [d]	Install dynamic experimentation structure at TA-15.	Same as No Action Alternative	Same as No Action Alternative

R&D = research and development; DD&D = decontamination, decommissioning, and demolition; DARHT = Dual Axis Radiographic Hydrodynamic Test Facility; EIS = environmental impact statement; TA = technical area.

[a] DOE 1999a.

[b] LANL 2004c, 2006a.

[c] DOE 2003e.

[d] DOE 1995a.

Dynamic Experiments. A dynamic experiment is an experiment that provides information regarding basic physics of materials or characterizes physical changes or motion of materials under influence of high explosives detonations. Most dynamic experiments are conducted at TA-15 and TA-36; some are conducted at TA-39 and TA-40. DOE could perform dynamic experiments using plutonium in the future at DARHT and other facilities. Dynamic experiments involving plutonium would be conducted inside containment vessels.

Explosives Research and Testing. Explosives research and testing activities would be conducted primarily to study properties of the explosives themselves as opposed to explosive effects on other materials. Examples include tests to determine effects of aging on explosives, safety and reliability of explosives from a quality assurance point of view, and fire resistance of explosives. Explosives research and testing activities could be performed at any of the High Explosives Testing sites.

Munitions Experiments. Munitions experiments study the influence of external stimuli, for example, projectiles or other impacts on explosives. These studies include work on conventional munitions for the U.S. Department of Defense. Most of the munitions experiments are performed at TA-36 and TA-39, but any of the firing sites could be used as required.

High Explosives Pulsed-Power Experiments. High explosives pulsed-power experiments are conducted to develop and study new concepts based on explosively driven electromagnetic power systems. These experiments are conducted primarily at TA-39.

Calibration, Development, and Maintenance Testing. This testing involves experiments conducted primarily to prepare for more elaborate tests and includes tests to develop, evaluate, and calibrate diagnostic instrumentation or other systems. Calibration, development, and maintenance testing activities are concentrated at TA-15 and TA-36, but could involve any of the High Explosives Testing sites. Activities within this capability also include image processing capability maintenance.

Other Explosives Testing. This capability includes activities such as advanced high explosives development and work to improve weapons evaluation techniques.

Construction, Upgrades, and DD&D. Under all three alternatives, portions of this Key Facility would be relocated to one centralized area, as analyzed in the *Final Environmental Assessment for the Proposed Consolidation of Certain Dynamic Experimentation Activities at the Two-Mile Mesa Complex, Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2003e). This project would consolidate operations of the LANL organization responsible for dynamic experimentation within the Two-Mile Mesa Complex (portions of TA-6, TA-22, and TA-40). The project includes constructing 15 to 25 new structures over a 10-year timeframe to replace about 59 structures in a number of TAs. These new structures would consist of two to five combination office and laboratory buildings, a Characterization of Highly Energetic Materials Laboratory, an Engineering Diagnostic Facility, five Contained Firing Capability buildings and associated support structures, a High-Bay Laboratory, a Detonator Qualification Laboratory, two to four Gas Gun Facility buildings, a machine shop, a Classified High Explosives Storage Building, and a lecture hall. This project would also involve upgrading or constructing new roads, parking, fencing, and utilities within the Two-Mile Mesa Complex, including construction of a new road and security gate to provide access to the Dynamic Experimentation Facility. In addition, the project provides for removal or demolition of some of the vacated structures.

Another project for this Key Facility would be the possible assembly, installation, and operation of a containment structure for assembling components into test assemblies for dynamic experimentation. Currently, test components are assembled in TA-16. Completed test assemblies are then transported to TA-8 for radiographic examination, after which they are transported to the firing site in TA-15. The proposed structure, to be located at TA-15, is designed to contain any explosions that could occur during test component assembly. The *Final Environmental Impact Statement*, *Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility* (*DARHT EIS*) (DOE 1995a) evaluates containment options for dynamic experiments at the DARHT facility, including containment vessels and a building addition.

Assembly and radiography operations would be collocated in this containment structure at the DARHT firing site, which would reduce test assembly transportation. This would reduce security risks and the risk of vibration-induced explosions during transport. Risks to the environment and collocated workers would also be substantially reduced compared to those associated with facilities currently used for these activities. The containment structure would be brought to the LANL site in sections for assembly adjacent to the DARHT firing site in TA-15, and could be used to support other DARHT tests.

3.1.3.8 Tritium Facilities

The Weapons Engineering Tritium Facility in TA-16 is the principal building in this Key Facility. The Tritium Science and Fabrication Facility in TA-21 had been part of this Key Facility, but operations in this building have ceased and those operations have been moved to the Weapons Engineering Tritium Facility and another DOE site as discussed in Section 3.1.2.3. In the past, tritium operations were conducted in the Tritium Systems Test Assembly Facility in TA-21, but that building is no longer used and is also no longer part of the Tritium Facilities Key Facility. Some equipment is being removed from the building, and the building is in surveillance and maintenance mode. Residual tritium is present in the Tritium Systems Test Assembly and will remain until completion of decontamination activities.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–10** indicates activity types and levels proposed under all three alternatives for each capability. The activity levels shown in the table may not be possible during the entire period covered by this SWEIS. An updated probabilistic seismic hazard analysis (LANL 2007a) was completed in 2007 which indicated a greater seismic risk than previously recognized. To mitigate the accident risk associated with the increased seismic risk, a limitation on the amount of tritium used in the Weapons Engineering Test Facility was imposed pending completion of a facility-specific seismic analysis (LANL 2007b, NNSA 2007c).

Table 3–10 Tritium Facilities Capabilities and Activity Levels [a]

Capability	*No Action Alternative* [b]	*Reduced Operations Alternative*	*Expanded Operations Alternative*
High-Pressure Gas Fills and Processing	Handle and process tritium gas in quantities of about 3.5 ounces (100 grams) approximately 65 times per year at the Weapons Engineering Tritium Facility.	Same as No Action Alternative	Same as No Action Alternative
Gas-Boost System Testing and Development	Conduct gas-boost system R&D and testing and gas processing operations at the Weapons Engineering Tritium Facility approximately 35 times per year using quantities of about 3.5 ounces (100 grams) of tritium.	Same as No Action Alternative	Same as No Action Alternative
Diffusion and Membrane Purification	Conduct research on gaseous tritium movement and penetration through materials—perform up to 100 major experiments per year. Use this capability for effluent treatment.	Same as No Action Alternative	Same as No Action Alternative
Metallurgical and Material Research	Conduct metallurgical and materials research and application studies, and tritium effects and properties R&D. Small amounts of tritium would be used for these studies.	Same as No Action Alternative	Same as No Action Alternative
Gas Analysis	Measure the composition and quantities of gases (in support of tritium operations).	Same as No Action Alternative	Same as No Action Alternative
Calorimetry	Perform calorimetry measurements in support of tritium operations.	Same as No Action Alternative	Same as No Action Alternative
Solid Material and Container Storage	Store about 35 ounces (1,000 grams) of tritium inventory in process systems and samples, inventory for use, and waste.	Same as No Action Alternative	Same as No Action Alternative for TA-16 operations. Eliminate TA-21 activities.
Hydrogen Isotopic Separation	Perform R&D of tritium gas purification and processing in quantities of about 7 ounces (200 grams) of tritium per test.	Same as No Action Alternative	Same as No Action Alternative
Radioactive Liquid Waste Pretreatment	Pretreat liquid low-level radioactive waste at TA-21 prior to transport for treatment. Activity ends with decommissioning of TA-21 tritium buildings.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades /DD&D			
TA-21 Structure DD&D Project	No activity	No activity	Implement *TA-21 Structure DD&D Project (see Section 3.3.2.2)*: - DD&D of TA-21 buildings. - Eliminate TA-21 buildings from Tritium Key Facilities.

R&D = research and development; DD&D = decontamination, decommissioning, and demolition; TA = technical area.

[a] Activity levels shown may not be met while there are restrictions on operations instituted due to seismic concerns related to the updated probabilistic seismic hazard analysis (LANL 2007a). Pending evaluation of the need for and implementation of corrective actions, limitations have been imposed on the amount of tritium allowed in the Weapons Engineering Test Facility (LANL 2007b, NNSA 2007c).

[b] DOE 1999a, LANL 2006a.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

High-Pressure Gas Fills and Processing. High-pressure gas fills and processing operations for R&D and nuclear weapons systems are performed at the Weapons Engineering Tritium Facility. High-pressure gas containers (reservoirs) are filled with tritium or deuterium gas mixtures, or both, to specified pressures in excess of 10,000 pounds per square inch (6,900 newtons per square meter). This capability is also used for filling experimental devices (for example, filling small inertial confinement fusion targets that require high-pressure tritium gas).

Gas-Boost System Testing and Development. Modern nuclear weapons are equipped with gas-boost systems that use hydrogen isotopes, including tritium. These systems and their components need ongoing maintenance, testing, development, gas replacement, and modifications to maintain safety and reliability. The Weapons Engineering Tritium Facility provides highly specialized system function testing and experimental equipment for conducting gas-boost system R&D and testing for existing systems, new gas-boost systems development and testing, and gas processing operations.

Diffusion and Membrane Purification. The Weapons Engineering Tritium Facility has the operational capability to separate and purify tritium from gaseous mixtures using diffusion and membrane purification techniques. The facility conducts research on gaseous tritium penetration of, and movement through, materials. This capability could also be used on a continuing basis for effluent treatment.

Metallurgical and Material Research. Tritium-handling capabilities at the Weapons Engineering Tritium Facility accommodate a wide variety of metallurgical and material research activities, such as studying methods to remove hydrogen isotopes (including tritium) from a flowing stream of nitrogen and other inert gases. Metallurgical and materials research, including metal getter research and application studies, and tritium effects and properties R&D, is conducted at the Weapons Engineering Tritium Facility.

Gas Analysis. Spectrometry and other techniques, such as beta scintillation counting, are used to measure composition and quantities of gas samples on a real-time or batch basis.

Calorimetry. This nondestructive method is used for measuring the amount of tritium in containers. No tritium leaves the container during these measurements.

Solid Material and Container Storage. Tritium gas may be stored in either specially designed dual-wall containers or certified shipping containers, and tritium oxide (tritiated water) can be stored in solid form when it is adsorbed (gathered on a surface in a condensed layer) on molecular sieves. Tritium is also present in process systems and samples, inventory for use, and waste. Most tritium would be stored in the Weapons Engineering Tritium Facility, which has an administrative limit of 35 ounces (1,000 grams) of tritium inventory.

Hydrogen Isotopic Separation. Tritium gas purification R&D activities are an important capability of this Key Facility. Methods such as hydrogen isotopic separation are used at the Weapons Engineering Tritium Facility.

Radioactive Liquid Waste Pretreatment. Tritium-contaminated liquid low-level radioactive waste is collected in storage tanks. As needed, it is pretreated by adjusting the acidity prior to transfer to TA-50 for treatment in the Radioactive Liquid Waste Treatment Facility or to TA-53 for solar evaporation.

3.1.3.9 Pajarito Site

The Pajarito Site Key Facility is located entirely within TA-18 and contains the Los Alamos Critical Experiments Facility and other experimental facilities. This Key Facility consists of a main building, three outlying remote-controlled critical assembly and storage areas, and several smaller support buildings. In 2002, NNSA prepared the *TA-18 EIS* (DOE 2002i) to evaluate relocating the Pajarito Site Key Facility capabilities and materials. In the ROD, NNSA announced its decision to relocate Security Category I and II capabilities and related materials to the Device Assembly Facility at the Nevada Test Site, in effect initiating Pajarito Site Key Facility closure. No decisions were made, however, about relocation of Security Category III and IV materials and activities or the Solution High-Energy Burst Assembly (SHEBA). The ROD indicated that additional NEPA analysis would be required to support those decisions, and this SWEIS provides that NEPA analysis. Implementation of the ROD for Security Category I and II removal activities was initiated in 2004.

Under the No Action Alternative, only Security Category III and IV nuclear materials would be stored at TA-18. The only critical assembly remaining at TA-18 would be SHEBA, which would be operated in its Security Category III configuration. To ensure that specific programs continue uninterrupted, certain activities would occur intermittently at TA-18. These activities could involve temporary use of Security Category I or II materials that would be transported to TA-18 for the day and afterwards returned to storage elsewhere at LANL. Sealed sources retrieved from other locations under the Off-Site Source Recovery Project would continue to be received at TA-3 and repackaged as necessary for storage at LANL locations, including the Pajarito Site, pending shipment to the Waste Isolation Pilot Plant (WIPP) or other offsite locations for final disposition. Experiments and activities to support NNSA's Second Line of Defense Program, Nuclear Nonproliferation Research and Development Testing, and Emergency Response Program activities would continue. Training activities, including nuclear criticality training courses, would also continue.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–11** indicates activity types and levels proposed under all three alternatives for each capability. Although the ability to perform some of these activities would be reduced or eliminated as the Pajarito Site is being closed, these capabilities are included in the No Action Alternative for evaluation of potential impacts.

Dosimeter Assessment and Calibration. Nuclear accident dosimetry studies are conducted using critical assembly radiation to simulate criticality accident radiation.

Detector Development. The Pajarito Site offers the capability to configure nuclear materials to develop and validate instruments and methods used in nuclear nonproliferation programs, assess potential threats from terrorist organizations, and train nuclear emergency search team personnel to use these instruments.

Table 3–11 Pajarito Site Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Dosimeter Assessment and Calibration	Perform criticality experiments.	No activity	No activity
Detector Development	Develop safeguards instrumentation and perform R&D for nuclear materials and materials processing.	No activity	No activity
Materials Testing	Perform criticality experiments. Develop safeguards instrumentation and perform R&D for nuclear materials and materials processing.	No activity	No activity
Subcritical Measurements	Perform criticality experiments. Develop safeguards instrumentation and perform R&D for nuclear materials and materials processing.	No activity	No activity
Fast-Neutron Spectrum	Perform criticality experiments. Develop safeguards instrumentation and perform R&D for nuclear materials and materials processing.	No activity	No activity
Dynamic Measurements	Perform criticality experiments. Develop safeguards instrumentation and perform R&D for nuclear materials and materials processing.	No activity	No activity
Skyshine Measurements	Perform criticality experiments.	No activity	No activity
Vaporization	Perform criticality experiments.	No activity	No activity
Irradiation	Perform criticality experiments. Develop safeguards instrumentation and perform R&D for nuclear materials and materials processing.	No activity	No activity
Other Activities	Continue Security Category III and IV nuclear activities at TA-18. Operate SHEBA in its Security Category III configuration. Receive and store sealed radioactive sources retrieved under the Off-Site Source Recovery Project. These would be repackaged as necessary for storage at LANL pending shipment to WIPP or other offsite locations for final disposition. Support experiments and activities for: - NNSA Second Line of Defense Program - Nuclear Nonproliferation Research and Development Testing - Emergency Response Program activities Continue training activities, including nuclear criticality training courses.	No activity	Cease operations at Pajarito Site. Move Security Category III and IV materials to other LANL facilities (see Appendix H).
Construction/Upgrades/DD&D			
DD&D of TA-18 Structures	No activity	Cease operations at Pajarito Site. Place in surveillance and maintenance mode. Eliminate Pajarito Site as a Key Facility.	Implement *TA-18 Closure Project*: - Shut down Pajarito Site. - DD&D Pajarito Site buildings as appropriate. Eliminate Pajarito Site as a Key Facility.

R&D = research and development; TA = technical area; SHEBA = Solution High-Energy Burst Assembly; NNSA = National Nuclear Security Administration; DD&D = decontamination, decommissioning, and demolition.

[a] DOE 1999a, 2002i; LANL 2004c.

[b] DOE 2002i.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Materials Testing. The primary purpose of the Pajarito Key Facility is to characterize and evaluate materials, primarily by measuring their nuclear properties. Materials evaluated are typically structural materials or those used for shielding or neutron absorbers. Materials testing typically involves use of radiation sources or critical assemblies as radiation generators and measurement of radiation levels under a variety of conditions.

Subcritical Measurements. Subcritical measurements are those performed on arrays of fissile material that are below the critical mass for material in a given form. Subcritical experiments can vary any or all factors that influence criticality (mass, density, shape, volume, concentration, moderation, reflection, neutron absorption, enrichment, and interactions). Associated measurement techniques involve measuring some aspect of the neutron or gamma population in the material to assess its criticality state.

Fast-Neutron Spectrum. There are bare and reflected metal critical assemblies that operate on a fast-neutron spectrum. These assemblies typically have irradiation cavities in which flux foils, small replacement samples, or small experiments can be inserted. Typical experiments include evaluation of material reactivity, irradiation of novel neutron and gamma measuring instrumentation, and testing and calibrating radiation dosimeters.

Dynamic Measurements. Two fast-pulsed assemblies produce controlled, reproducible pulses of neutron and gamma radiation from tens of microseconds to several tens of milliseconds in duration. These pulses are useful for applications such as neutron physics measurements, instrumentation development, dosimetry, and materials testing.

Skyshine Measurements. The study of skyshine (radiation transported point-to-point without a direct line of sight) is a component of dosimetry that is primarily applicable to neutron-producing processes and facilities. Critical assemblies can be used to produce radiation fields to mimic those found around nuclear weapons production and dismantlement facilities and in storage and experimental areas.

Vaporization. Fast-pulsed assemblies have the capability of vaporizing fissile materials placed in a thermalizing material next to the assembly or in an internal cavity. These vessels are placed inside multiple containment vessels to prevent leakage of vaporized materials and fission products. This capability is useful for testing materials, measuring fissile materials properties, and testing reactor fuel materials in simulated accident conditions.

Irradiation. Several critical assemblies can have varying spectral characteristics in both steady-state and pulsed modes. These assemblies are typically used for irradiating fissile materials and other energetic-response materials to test and verify computer code calculations.

3.1.3.10 Target Fabrication Facility

The Target Fabrication Key Facility comprises three main buildings (35-213, 35-455, and 35-458). The main building is a two-story structure with approximately 61,000 square feet (5,700 square meters) of floor space located in TA-35. Laboratories and offices are located on both floors. Approximately 48,000 square feet (4,500 square meters) is laboratory space; the remainder is used for offices. The Target Fabrication Key Facility houses activities related to weapons production and laser fusion research. These activities are accomplished through high-technology material science, effects testing, characterization, and technology development.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–12** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–12 Target Fabrication Facility Capabilities and Activity Levels

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Precision Machining and Target Fabrication	Provide targets and specialized components for approximately 12,400 laser and physics tests per year. Perform approximately 100 high-energy density physics tests per year. Analyze up to 36 tritium reservoirs annually.	Same as No Action Alternative	Same as No Action Alternative
Polymer Synthesis	Produce polymers for targets and specialized components for approximately 12,400 laser and physics tests per year. Perform approximately 100 high-energy density physics tests per year.	Same as No Action Alternative	Same as No Action Alternative
Chemical and Physical Vapor Deposition	Coat targets and specialized components for approximately 12,400 laser and physics tests per year. Support approximately 100 high-energy density physics tests per year. Support plutonium pit rebuild operations.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades/DD&D			
	No activity	No activity	No activity

DD&D = decontamination, decommissioning, and demolition.
[a] DOE 1999a, LANL 2006a.
[b] LANL 2006a.

Precision Machining and Target Fabrication. Considered the primary measurement of activity for this Key Facility, precision machining operations produce sophisticated devices consisting of very accurate part shapes and often optical-quality surface finishes. A variety of processes are used to produce the final parts, which include conventional machining, ultraprecision machining, lapping, and electron discharge machining. Dimensional inspections are performed during part production using a variety of mechanically and optically based inspection techniques. Tritium reservoirs are analyzed at the Target Fabrication Facility.

Polymer Synthesis. Polymer synthesis science formulates new polymers, studies their structure and properties, and fabricates them into various devices and components. Capabilities exist at the Target Fabrication Facility for developing and producing polymer foams by organic synthesis, liquid crystalline polymers, polymer host dye laser rods, microfoams and composite foams, high-energy density polymers, electrically conducting polymers, chemical sensors, resins and membranes for actinide and metal separations, thermosetting polymers, and organic coatings. The materials and devices are typically prepared using solvents at temperatures ranging from 70 to 302 °F (20 to 150 °C) or by melt-processing at temperatures from room temperature up to

572 °F (300 °C). A wide variety of analytical techniques are used to determine the structure and behavior of polymers, including spectroscopy, microscopy, x-ray scattering, thermal analysis, chromatography, rheology, and mechanical testing.

Chemical and Physical Vapor Deposition. Chemical vapor deposition and infiltration are processes used to produce metallic and ceramic bulk coatings, various forms of carbon (including pyrolytic graphite, amorphous carbon, and diamond), nanocrystalline films, powder coatings, thin films, and a variety of shapes up to 3.5 inches (9 centimeters) in diameter and 0.5 inches (1.25 centimeters) in thickness. Chemical vapor deposition and infiltration coating processes are routine operations that use a variety of methods such as thermal hot wall, cold wall, and fluidized bed techniques; laser-assisted, laser ablation, radiofrequency and microwave plasma techniques; direct-current glow discharge and hollow cathode techniques; and organometallic chemical vapor deposition techniques. Polymer processing and extensive characterization is performed in conjunction with this work.

Physical vapor deposition capabilities can be used to apply layers of various materials on sophisticated devices with high precision. These layers, applied by various coating techniques, include a wide range of metals and metal oxides, as well as some organic materials.

3.1.3.11 Bioscience Facilities (formerly Health Research Laboratory)

Major Bioscience Facilities buildings include the main Health Research Laboratory; four buildings in TA-43; and additional offices and laboratories located in three buildings in TA-35, several buildings in TA-3, and six buildings in TA-46. There is also some activity in TA-16. This Key Facility focuses on the study of intact cells, cellular components (ribonucleic acid [RNA], deoxyribonucleic acid [DNA], and proteins), instrument analysis (laser and mass spectroscopy), and cellular systems (repair, growth, and response to stressors). Activities other than theoretical or paper studies are subject to review and approval by internal organizations such as the LANL Bioscience Oversight Review Board. External organizations such as the Centers for Disease Control and Prevention and the National Institutes of Health also review and approve projects for which they provide funding. Work with biohazardous agents is reviewed and approved by the LANL Institutional Biosafety Committee, which includes members that are both internal and external to LANL organizations.

Work with biological materials at LANL is governed by LANL Biosafety Program requirements, which are based on the document *Biosafety in Microbiological and Biomedical Laboratories* (HHS 2007) published by the Centers for Disease Control and Prevention. This document establishes requirements for workplace safety by biosafety level, of which there are four. These biosafety levels consist of progressively more stringent protocols for laboratory practices, techniques, safety equipment, and laboratory facilities. LANL has laboratories that operate at Biosafety Level 1 and Biosafety Level 2. (These levels are defined in Appendix C, Section C.3.3.) Work with select agents, specifically regulated pathogens and toxins defined in 42 CFR Part 73, is limited at LANL to Biosafety Level 2 activities. A new facility intended for work requiring Biosafety Level 3 conditions was constructed in 2004, but the building has not been occupied or used for this purpose. NNSA is currently preparing the *Environmental Impact Statement for the Operation of the Biosafety Level 3 Facility at the Los Alamos National Laboratory* to analyze potential impacts of operating this facility.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–13** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–13 Bioscience Facilities Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Biologically Inspired Materials and Chemistry (Biomaterials and Chemistry in the *1999 SWEIS*)	Determine formation and structure of biomaterials. Synthesize biomaterials. Characterize biomaterials.	Same as No Action Alternative	Same as No Action Alternative
Cell Biology	Study stress-induced effects and responses on cells. Study host-pathogen interactions. Determine effects of beryllium exposure.	Same as No Action Alternative	Same as No Action Alternative
Computational Biology	Collect, organize, and manage information on biological systems. Develop computational theory to analyze and model biological systems.	Same as No Action Alternative	Same as No Action Alternative
Environmental Microbiology	Study microbial diversity in the environment. Collect and analyze environmental samples. Study biochemical and genetic processes in microbial systems.	Same as No Action Alternative	Same as No Action Alternative
Genomic Studies	Analyze genes of living organisms such as humans, animals, microbes, viruses, plants, and fungi.	Same as No Action Alternative	Same as No Action Alternative
Genomic and Proteomic Science	Develop and implement high-throughput tools. Perform genomic and proteomic analysis. Study pathogenic and nonpathogenic systems.	Same as No Action Alternative	Same as No Action Alternative
Measurement Science and Diagnostics	Develop and use spectroscopic tools to study molecules and molecular systems. Perform genomic, proteomic and metabolomic studies.	Same as No Action Alternative	Same as No Action Alternative
Molecular Synthesis	Synthesize molecules and materials. Perform spectroscopic characterization of molecules and materials. Develop new molecules that incorporate stable isotopes. Develop chem-bio sensors and assay procedures. Synthesize polymers and develop applications for them. Utilize stable isotopes in quantum computing systems.	Same as No Action Alternative	Same as No Action Alternative
Structural Biology	Research three-dimensional structure and dynamics of macromolecules and complexes. Use various spectroscopy techniques. Perform neutron scattering. Perform x-ray scattering and diffraction.	Same as No Action Alternative	Same as No Action Alternative

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Pathogenesis	Perform genome-scale, focused and computationally enhanced experimental studies on pathogenic organisms.	Same as No Action Alternative	Same as No Action Alternative
Biothreat Reduction and Bioforensics	Analyze samples for biodefense and national security purposes. Identify pathogen strain signatures using DNA sequencing and other molecular approaches.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrades/DD&D			
New *Science Complex* in TA-62	No activity	No activity	Move most Bioscience operations to proposed *Science Complex* (see Appendix G). This new space would replace buildings vacated by Bioscience staff as the major component of the Bioscience Facilities.

DD&D = decontamination, decommissioning, and demolition; TA = technical area.
[a] LANL 2004c, 2006a.
Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Biologically Inspired Materials and Chemistry. This capability is used primarily to determine formation-structure-function relationships in biological and biologically relevant materials at macroscopic, microscopic, and molecular scales, with the goal of using this knowledge to create new biologically inspired materials with novel functionalities for a variety of applications. Synthesis and characterization of biological and biologically relevant materials at scales from the molecular to macroscopic are an integral part of this capability. Characterization tools include spectroscopy with laser sources, microscopy, spectral imaging, electrochemistry, mass spectrometry, and nuclear magnetic resonance spectroscopy. Stable isotopes are used to enable many of these characterization measurements.

Cell Biology. This research area focuses on understanding stress responses at the molecular level, within the whole cell, and in multicellular and cell environment systems. Historically, cellular response to ionizing radiation has been the primary focus. New focus areas include host-pathogen interactions, the human health effects of exposure to beryllium, and the regulation of plant growth for applications in carbon management and energy. Specific capabilities include culture and biochemical analysis of a variety of cell types, including nonpathogenic environmental microbes, infectious microbes (including viruses) under controlled conditions, and plant and mammalian cells.

Computational Biology. This capability is purely theoretical and does not involve any experimental, operational, or production activities. This capability includes collection, organization, and management of biological data and development of computational tools to analyze, interpret, and model biological information. Certain activities involve partnering with computational scientists to develop computation-based biological theory and to analyze and model biological systems.

Environmental Microbiology. This work focuses on gaining a better understanding of microbial systems and their environment. This capability underpins the ability of LANL scientists to achieve its goals in biothreat reduction and is key to work related to climate change, bioremediation, bioenergy, and environmental monitoring. Activities include collection of environmental samples containing microbes (including viruses), biochemical and genetic analysis of their distribution and functions in ecological systems, and growth and analysis of environmental isolates.

Genomic Studies. This capability involves conducting research using molecular and biochemical techniques to analyze the genetics of living organisms such as animals (particularly humans), microbes (including viruses), plants, fungi, and other species. Specifically, personnel develop strategies to analyze the nucleotide sequence of individual genes, especially those associated with genetic disorders, and to identify these genes and map the genetic diseases to locations on individual chromosomes. Part of this work is to map each nucleotide, in sequence, of each gene in all 46 chromosomes of the human genome.

Genomic and Proteomic Science. This capability emphasizes development and implementation of high-throughput tools and technologies for understanding biology at the systems level. Researchers perform production sequencing, finishing, clone selection, quality assurance, and bioinformatics and are involved in development of high-throughput technologies for high-affinity, high-specificity ligand generation, expression arrays, and proteomics. This capability focuses on pathogen and environmental microbial sequencing and comparative genomics and on affinity tag production for detection and sensing applications in support of biothreat reduction work.

Measurement Science and Diagnostics. These activities encompass a broad set of technologies including spectroscopy for understanding molecular dynamics and structure and for biomedical applications; imaging microscopy for exploring molecular events using ultrafast time resolution measurements, at times as short as 10 to 13 seconds; and flow-based analyses using flow cytometry methods for measuring everything from single molecules to multicellular spheroids, spanning a size range from 10 Angstroms to 100 microns. A developing area is mass spectrometry for proteomics and structural biology. These technologies provide the platforms and data that can lead to new strategies for detection and sensing technologies. Capabilities include a variety of spectroscopies for analysis of biomolecules and biomolecular complexes; flow-cytometry-based analysis of materials spanning the range from single molecules to intact chromosomes to single cells to multicellular spheroids; and mass spectrometry for proteomics, metabolomics, and structural biology.

Molecular Synthesis. Work in this area includes synthesis, materials preparation, and spectroscopic characterization of a variety of compounds. Current work is focused on creating new molecules using natural and enriched stable isotopes for biomolecular structure analysis, for observation of specific chemical groups, and for use as standards in detection of chemical agents and biological toxins. Additional work in this area includes linking antibodies to biomimetic surfaces, creating chemical and biological microsensors for detection and sensing, developing polymers to protect soldiers’ eyes from laser light, and using stable isotopes to demonstrate the feasibility of quantum information processing.

Structural Biology. This research focuses on determination and analysis of three-dimensional structures and dynamics of macromolecules and the complexes that they form. Experimental techniques include x-ray scattering and neutron diffraction, nuclear magnetic resonance, and time-resolved vibrational spectroscopies. State-of-the-art neutron protein crystallography capabilities provided as part of the Manuel Lujan Neutron-Scattering Center are accessed on a national level.

Pathogenesis. This work involves performing genome-scale, focused, and computationally enhanced experimental studies to gain a quantitative understanding of various aspects of pathogen lifecycle. The focus is on infections in humans, animals, and plants, as well as understanding the epidemiology and life cycle of pathogens in the environment.

Biothreat Reduction and Bioforensics. This capability, a collection of forensic and molecular biological capabilities, is used to analyze samples for biodefense and national security purposes. Analyses include DNA sequencing and other molecular approaches to identify pathogen strain signatures. This capability also includes the ability to undertake classified laboratory and information processing and analysis projects.

3.1.3.12 Radiochemistry Facility

The Radiochemistry Key Facility includes all of TA-48 (116 acres [47 hectares]), although the main research buildings are located together in an area of only 8.6 acres (3.5 hectares). These buildings include the Radiochemistry Laboratory, Machine and Fabrication Shop, Diagnostic Instrumentation and Development Building, Clean Chemistry/Mass Spectrometry Building, and Weapons Analytical Chemistry Facility. The Radiochemistry Facility fills three roles: research, production of medical radioisotopes, and support services to other LANL organizations, primarily through radiological and chemical analyses of samples. Research supports environmental management projects such as the Yucca Mountain Project, plutonium stabilization, catalysis, basic energy, and other scientific efforts. Chemistry research is performed in the areas of inorganic, actinide, organometallic, environmental, geochemistry, and nuclear chemistry. Production activities use a hot cell located in the Radiochemistry Laboratory Building to separate and package radioisotopes for medical research and clinical uses.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–14** indicates activity types and levels proposed under all three alternatives for each capability.

Radionuclide Transport. Chemical and geochemical investigations address concerns about hydrologic flow and transport of radionuclides. Areas of study include the sorption (binding) of actinides, fission products, and activation products in minerals and rocks and the solubility and speciation of actinides in various chemical environments such as those associated with waste disposal. Paired with model development, these studies are used to evaluate various activities and phenomena such as parameters for performance assessment of mined geologic disposal systems.

Table 3–14 Radiochemistry Facility Capabilities and Activity Levels

Capability	No Action Alternative [a]	Reduced Operations Alternative	Expanded Operations Alternative [b]
Radionuclide Transport Studies	Conduct 80 to 160 actinide transport, sorption, and bacterial interaction studies annually. Develop models for evaluation of groundwater. Assess performance or risk of release for radionuclide sources at proposed waste disposal sites.	Same as No Action Alternative	Same as No Action Alternative
Environmental Remediation and Risk Mitigation	Conduct background contamination characterization pilot studies. Conduct performance assessments, soil remediation research and development, and field support. Support environmental remediation activities.	Same as No Action Alternative	Same as No Action Alternative, plus: - Perform beryllium dispersion and mitigation assessments.
Ultra-Low-Level Measurements	Perform chemical isotope separation and mass spectrometry at current levels.	Same as No Action Alternative	Same as No Action Alternative
Nuclear and Radiochemistry Separations	Conduct radiochemical operations involving quantities of alpha-, beta-, and gamma-emitting radionuclides at current levels for nonweapons and weapons work.	Same as No Action Alternative	Same as No Action Alternative
Isotope Production	Conduct target preparation, irradiation, and processing to recover medical and industrial application isotopes to support approximately 150 offsite shipments annually.	Same as No Action Alternative	Same as No Action Alternative
Actinide and Transuranic Chemistry	Perform radiochemical separations involving alpha-emitting radionuclides.	Same as No Action Alternative	Same as No Action Alternative
Data Analysis	Reexamine archive data and measure nuclear process parameters of interest to weapons radiochemists.	Same as No Action Alternative	Same as No Action Alternative
Inorganic Chemistry	Conduct synthesis, catalysis, and actinide chemistry activities: - Conduct chemical synthesis of organo-metallic complexes. - Conduct structural and reactivity analysis, organic product analysis, and reactivity and mechanistic studies. - Conduct synthesis of new ligands for radiopharmaceuticals. - Conduct environmental technology development activities: – Ligand design and synthesis for selective extraction of metals, – Soil washing, – Membrane separator development, and – Ultrafiltration.	Same as No Action Alternative	Same as No Action Alternative
Structural Analysis	Perform synthesis and structural analysis of actinide complexes at current levels. Conduct x-ray diffraction analysis of powders and single crystals.	Same as No Action Alternative	Same as No Action Alternative

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Sample Counting	Measure the quantity of radioactivity in samples using alpha-, beta-, and gamma-ray counting systems.	Same as No Action Alternative	Same as No Action Alternative
Hydrotest Sample Analysis	Measure beryllium contamination from simulated nuclear weapons hydrotesting.	Reduce activity levels consistent with High Explosive Processing and Testing	Same as No Action Alternative
Atom Trapping	No activity	No activity	Implement atom trapping capability for fundamental and applied research.
Construction/Upgrades/DD&D			
Radiological Sciences Institute	No activity	No activity	Construct and operate the new *Radiological Sciences Institute*. Construct and operate the Institute for Nuclear Nonproliferation Science and Technology (see Appendix G). Relocate Security Category III and IV capabilities and materials that would remain at LANL from TA-18 to the Institute for Nuclear Nonproliferation Science and Technology. Reconstruct CMR Building Wing 9 hot cell capabilities in the Radiological Sciences Institute.

DD&D = decontamination, decommissioning, and demolition; TA = technical area, CMR = Chemistry and Metallurgy Research.
[a] DOE 1999a.
[b] LANL 2006a.
Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Environmental Remediation and Risk Mitigation. Characterization and remediation of soils contaminated with radionuclides and toxic metals and data analysis and integrated site-wide assessment are the two functions provided by this capability. A major objective of characterizing and remediating soils is to minimize generation of large volumes of metal- and radionuclide-contaminated soils. The objective of data analysis and integrated site-wide assessment is to accelerate remediation through improved sampling schemes, clearer and more efficient evaluation of characterization data, and more effective tools for assigning priority to cleanup targets.

Ultra-Low-Level Measurements. Isotopic tracers and high-sensitivity measurement technologies have been developed to support the U.S. nuclear weapons program. Isotopic tracers can include both radioactive and nonradioactive isotopes, although this capability emphasizes nonradioactive tracers. Specialty applications include developing analytical techniques for a variety of problems in nuclear, environmental, and biological sciences. Typical analyses include determining the origin of radioactive contamination in an environmental sample (for example, whether the contamination results from a nearby nuclear facility or from radioactive fallout from global weapons testing). This capability can also be used to trace the migration of radioactive contamination through the environment.

Nuclear and Radiochemistry Separations. Activities under this capability include developing radiation detectors, conducting radiochemical separations, and performing nuclear chemistry. Development, calibration, and use of radiation detectors include the use of off-the-shelf systems for routine measurement of radioactivity and development of new radiation detection systems for a number of special applications. LANL personnel conduct both routine and special separations of radioactive materials from other radioactive species and stable impurities. These experiments have provided support to Hanford waste tank treatment activities and production of medical isotopes. Separations are based on traditional approaches that use commercially available ion-exchange media and chemical reagents. LANL staff have also developed new separations techniques based on experimental chemical systems, using radioactive tracers to synthesize the chemicals and to characterize their performance. In addition, nuclear chemistry-related activities use exotic laser-based atom traps to probe the interactions of energy and atoms in energy regimes that are not easily accessed by other techniques. This work requires conducting extensive laser spectroscopy, handling of radioactive materials, and interpreting the resulting data. Other nuclear chemistry-related activities include irradiating targets at the Los Alamos Neutron Science Center (LANSCE) or at offsite reactors to produce specific radioactive isotopes. These isotopes are then separated from impurities, and their neutron-capture cross sections are measured at the Radiochemistry Laboratory.

Isotope Production. Activities under this capability include the production, chemical separation, and distribution of isotopes to medical and industrial users. Activities also include preparing the target packages to be irradiated using the LANSCE accelerator, processing in the Radiochemistry Laboratory hot cell to recover the desired isotopes, and packaging the isotopes for offsite shipment.

Actinide and Transuranic Chemistry. Activities in the Alpha wing of the Radiochemistry Laboratory are essentially the same as the radiochemical separations carried out in the rest of the building, but with different materials. The materials handled are actinides and transuranics that require the special safe handling environment provided in this wing.

Data Analysis. Data analysis is the evaluation of experimental data to interpret results of experiments, measurements, and other activities. This capability includes evaluation of archived data in support of weapons programs.

Inorganic Chemistry. Inorganic chemistry work includes two main categories of activities: (1) synthesis, catalysis, and actinide chemistry; and (2) development of environmental technology. The former category includes chemical synthesis of new organometallic complexes, structural and reactivity analysis, organic product analysis, reactivity and mechanistic studies, and synthesis of new ligands for radiopharmaceuticals. Development of environmental technology includes designing and synthesizing ligands for selective extraction of metals, soil washing, development of membrane separators, photochemical processing, and ultrafiltration.

Other work involves oxidation-reduction studies on uranium and other metals for both environmental restoration and advanced processing.

Structural Analysis. Structural analysis includes the synthesis, structural analysis, and x-ray diffraction analysis of actinide complexes in both single-crystal and powder form. This capability supports programs in basic energy sciences, materials characterization, stockpile stewardship, and environmental management.

Sample Counting. Sample counting, the measurement of the quantity of radioactivity present in a sample, is accomplished with a variety of radiation detectors, each customized to the type of radiation being counted and the expected levels of radioactivity. All samples counted in the counting facility are sealed items placed inside appropriate detectors for specified periods of time. Data are automatically processed through the computer system and results are presented to the users.

Hydrotest Sample Analysis. This capability involves the measurement of beryllium contamination from hydrotesting simulated nuclear weapons. This work includes analysis, ligand binding, materials characterization, field sampling, fundamental beryllium chemistry, and beryllium mitigation (LANL 2006g).

3.1.3.13 Waste Management Operations: Radioactive Liquid Waste Treatment Facility

The Radioactive Liquid Waste Treatment Key Facility is located in TA-50 and consists of four primary structures: the Radioactive Liquid Waste Treatment Facility Building, the Pump House and Influent Storage Building, the acid and caustic solution tank farm, and a 100,000-gallon (380,000-liter) influent holding tank. The Radioactive Liquid Waste Treatment Facility treats radioactive liquid waste generated by other LANL facilities and houses analytical laboratories to support waste treatment operations. The Radioactive Liquid Waste Treatment Facility Building is the largest structure in TA-50, with 40,000 square feet (3,720 square meters) under roof. Construction of a new 300,000-gallon (1,100,000-liter) influent storage facility is complete, but it is not yet operational.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–15** indicates activity levels proposed under all three alternatives for each capability.

Waste Transport, Receipt, and Acceptance. Most radioactive liquid waste is conveyed directly to the Radioactive Liquid Waste Treatment Facility through an underground pipeline system. Pipelines for liquid radioactive waste exist in TA-3, TA-35, TA-48, TA-50, TA-55, and TA-59.[2] Waste from generators not connected by the underground pipeline system is transferred by tanker truck to the Radioactive Liquid Waste Treatment Facility. Generators of small quantities of radioactive liquid waste collect their waste in drums, which are then trucked to TA-50.

[2] *The pipelines in TA-53 move waste only within that TA (as part of LANSCE), and do not connect to or pump radioactive liquid waste to the Radioactive Liquid Waste Treatment Facility.*

Table 3–15 Waste Management Operations: Radioactive Liquid Waste Treatment Facility Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Waste Transport, Receipt, and Acceptance	Collect radioactive liquid waste from generators and transport it to RLWTF in TA-50. Support, certify, and audit generator characterization programs. Maintain the waste acceptance criteria for RLWTF. Send approximately 66,000 gallons (250,000 liters) of evaporator bottoms to an offsite commercial facility for solidification annually. (Approximately 25 cubic yards [20 cubic meters] of solidified evaporator bottoms would be returned annually for disposal as low-level radioactive waste at TA-54 Area G.) Transport annually to TA-54 for storage or disposal: - 330 cubic yards (250 cubic meters) of low-level radioactive waste; - 3 cubic yards (2 cubic meters) of mixed low-level radioactive waste; - 13 cubic yards (10 cubic meters) of transuranic waste; and - 880 pounds (400 kilograms) of hazardous waste.	Same as No Action Alternative	Same as No Action Alternative, except: - Send approximately 80,000 gallons (300,000 liters) of evaporator bottoms to an offsite commercial facility for solidification annually. (Approximately 30 cubic yards [23 cubic meters] of solidified evaporator bottoms would be returned annually for disposal as low-level radioactive waste at TA-54 Area G.) - Transport annually to TA-54 for storage or disposal: – 390 cubic yards (300 cubic meters) of low-level radioactive waste; – 3 cubic yards (2 cubic meters) of mixed low-level radioactive waste; – 18 cubic yards (14 cubic meters) of transuranic waste; and – 1,100 pounds (500 kilograms) of hazardous waste.
Radioactive Liquid Waste Treatment	Pretreat 30,000 gallons (110,000 liters) of liquid transuranic waste annually. Solidify, characterize, and package 16 cubic yards (12 cubic meters) of transuranic waste sludge annually. Treat 4 million gallons (15 million liters) of liquid low-level radioactive waste annually. Dewater, characterize, and package 70 cubic yards (50 cubic meters) of low-level radioactive waste sludge annually. Process 260,000 gallons (1 million liters) of secondary liquid waste generated by RLWTF treatment processes through the RLWTF evaporator annually. Discharge treated liquids through an NPDES outfall.	Same as No Action Alternative	Same as No Action Alternative, except: - Pretreat 50,000 gallons (190,000 liters) of liquid transuranic waste annually. - Solidify, characterize, and package 22 cubic yards (17 cubic meters) of transuranic waste sludge annually. - Treat 5 million gallons (20 million liters) of liquid low-level radioactive waste annually. - Dewater, characterize, and package 80 cubic yards (60 cubic meters) of low-level radioactive waste sludge annually. - Process 320,000 gallons (1,200,000 liters) of secondary liquid waste generated by RLWTF treatment processes through the RLWTF evaporator annually.

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Construction/Upgrades/DD&D			
RLWTF Upgrade	Construction of a new 300,000-gallon (1.1 million-liter) influent storage facility is complete.	Same as No Action Alternative	Same as No Action Alternative, plus: - Implement *RLWTF Upgrade Project* (see Appendix G): – Construct and operate a replacement for the existing RLWTF at TA-50. Start-up estimated in 2012. – Construct and operate evaporation tanks in TA-52 for treated effluent from RLWTF – DD&D portions of existing RLWTF.

RLWTF = Radioactive Liquid Waste Treatment Facility; TA = technical area; NPDES = National Pollutant Discharge Elimination System; DD&D = decontamination, decommissioning, and demolition.

[a] DOE 1999a, LANL 2006a.

[b] LANL 2006a.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

In addition to receiving and accepting radioactive liquid waste trucked to the TA-50 facility from other LANL locations, some radioactive liquid waste is trucked to the TA-53 facility for evaporation, and other radioactive liquid waste is shipped to an offsite commercial facility for solidification. Returned solidified waste and other solid wastes are sent from the Radioactive Liquid Waste Treatment Facility to waste management facilities in TA-54 for storage or disposal.

Radioactive Liquid Waste Treatment. Liquid transuranic waste and low-level radioactive waste are treated in sequential steps to remove and reduce the radioactive components of the liquid waste stream. Neutralization, precipitation, filtration, ion exchange, and reverse osmosis are among the treatment steps that can be used, depending on individual waste stream characteristics. Liquid effluents are discharged through a permitted National Pollutant Discharge Elimination System outfall. To meet discharge limits, liquids with higher concentrations of tritium are transported to TA-53, where they are treated in solar evaporation basins. Resultant low-level radioactive waste sludges are drummed and transferred to TA-54 for disposal. Transuranic waste sludges are cemented and transferred to TA-54 for storage until they are certified and sent to WIPP for disposal.

3.1.3.14 Los Alamos Neutron Science Center

LANSCE is located on a 750-acre (303-hectare) mesa top at TA-53 and contains approximately 400 structures. LANSCE is LANL's major accelerator R&D complex, consisting of a high-power 800-million-electron-volt proton linear accelerator, a proton storage ring, production targets at the Manuel Lujan Neutron-Scattering Center and the Weapons Neutron Research Facility, and a variety of associated experimental areas and spectrometers. Particle beams are used to conduct basic and applied research in the areas of condensed-matter science, materials science, nuclear physics, particle physics, nuclear chemistry, atomic physics, and defense-related experiments. LANSCE also produces medical radioisotopes.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–16** indicates activity types and levels proposed under all three alternatives for each capability.

Table 3–16 Los Alamos Neutron Science Center Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Accelerator Beam Delivery, Maintenance, and Development	Operate 800-million-electron-volt linear accelerator and deliver accelerator beam to Areas A, B, and C; Weapons Neutron Research Facility; Lujan Center; Dynamic Test Facility; and Isotope Production Facility for 10 months each year (6,400 hours). The H^+ beam current would be 1,250 microamps; the H^- beam current would be 200 microamps. Reconfigure beam delivery and support equipment to support new facilities, upgrades, and experiments.	LANSCE would be shut down, and all capabilities would cease except radioactive liquid waste treatment. Systems would be maintained in a condition to support future restart. LANSCE would be eliminated as a Key Facility.	Same as No Action Alternative
Experimental Area Support	Provide support to ensure availability of the beam lines, beam line components, handling and transport systems, and shielding, as well as radiofrequency power sources. Perform remote handling and packaging of radioactive materials and waste, as needed.	No activity	Same as No Action Alternative
Neutron Research and Technology	Conduct 1,000 to 2,000 different experiments annually, using neutrons from the Lujan Center and Weapons Neutron Research Facility. Support contained weapons-related experiments using small to moderate quantities of high explosives, including: - Approximately 200 experiments per year using nonhazardous materials and small quantities of high explosives; - Approximately 60 experiments per year using up to 10 pounds (4.54 kilograms) of high explosives and depleted uranium; - Approximately 80 experiments per year using small quantities of actinides, high explosives, and sources; - Shockwave experiments involving small amounts, up to nominally 1.8 ounces (50 grams) of plutonium; and - Support for static stockpile surveillance technology research and development.	No activity	Same as No Action Alternative

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Materials Test Station	Irradiate materials and fuels in a fast-neutron spectrum and in a prototypic temperature and coolant environment.	No activity	Same as No Action Alternative
Subatomic Physics Research	Conduct 5 to 10 physics experiments annually at the Manuel Lujan Center and Weapons Neutron Research Facility. Conduct up to 100 proton radiography experiments, including using small to moderate quantities of high explosives, including: - Dynamic experiments in containment vessels with up to 10 pounds (4.5 kilograms) of high explosives and 100 pounds (45 kilograms) of depleted uranium; and - Dynamic experiments in powder launcher with up to 10 ounces (300 grams) of Class 1.3 explosives (gun powder). Conduct research using ultracold neutrons; operate up to 10 microamperes per year of negative beam current.	No activity	Same as No Action Alternative
Medical Isotope Production	Irradiate up to 120 targets per year for medical isotope production at the Isotope Production Facility.	No activity	Same as No Action Alternative
High-Power Microwaves and Advanced Accelerators	Conduct R&D in high-power microwave and advanced accelerators in areas including microwave research for industrial and environmental applications.	No activity	Same as No Action Alternative
Radioactive Liquid Waste Treatment (Solar Evaporation at TA-53)	Treat about 140,000 gallons (520,000 liters) per year of radioactive liquid waste.	Treat about 5,000 gallons (20,000 liters) per year of radioactive liquid waste brought to TA-53 from other locations (not generated by LANSCE activities).	Same as No Action Alternative
Construction/Upgrades/DD&D			
	Install Material Test Station equipment in Experimental Area A. Construct Neutron Spectroscopy Facility within existing buildings (under High-Powered Microwaves and Advanced Accelerators Capability).	Shut LANSCE down. Cease capabilities except radioactive liquid waste treatment. Maintain systems in a condition to support future restart.	Same as No Action Alternative, plus: - Implement *LANSCE Refurbishment Project* to extend reliable operation of facility for the future (see Appendix G).

Lujan Center = Manuel Lujan Neutron-Scattering Center; LANSCE = Los Alamos Neutron Science Center; R&D = research and development; TA = technical area; DD&D = decontamination, decommissioning, and demolition.

[a] DOE 1999a; LANL 2004c, 2004f.

[b] LANL 2006a.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Accelerator Beam Delivery, Maintenance, and Development. The heart of the LANSCE Key Facility is the linear accelerator itself. The building housing the accelerator is more than 0.5 miles (0.8 kilometers) long, and has 316,000 square feet (29,400 square meters) of floor space. The building contains equipment to form hydrogen ion beams (protons and negative hydrogen ions) and to accelerate them to 84 percent of the speed of light. The beam tunnel itself is located 35 feet (11 meters) below ground level to provide shielding from the radiation. Above-surface structures house radiofrequency power sources used to accelerate the beam. Ancillary equipment is used to transport the ion beams, maintain vacuum conditions in the beam transport system, and provide ventilation and cooling. Creating and directing the ion beam requires large amounts of power, much of which is ultimately removed as excess heat.

This capability is responsible for development, configuration, and maintenance of components and support systems needed to deliver proton ion beams and for delivery of those beams. Generation and delivery of the proton ion beams require considerable development and maintenance capabilities for all components of the linear accelerator, including the ion sources and injectors, the mechanical systems in the accelerator (including cooling water), all systems for the proton storage ring and its associated transfer lines, and beam diagnostics in the accelerator and transfer lines. Beam development activities include beam dynamics studies and design and implementation of new capabilities. This activity requires the coordination of many disciplines, including accelerator physics, high-voltage and pulsed-power engineering, mechanical engineering, materials science, radiation shielding design, digital and analog electronics, high-vacuum technology, mechanical and electronics design, mechanical alignment, hydrogen furnace brazing, machining, and mechanical fabrication.

Experimental Area Support. Beam users (LANL organizations and external users such as scientists from universities, other laboratories, and the international scientific community) require support from TA-53 personnel, whether they are preparing for, performing, or closing out their experiments. This support capability focuses on the maintenance, improvement, and operational readiness of beam lines and experimental areas at LANSCE.

Support also includes the design, operation, and maintenance of remote-handling systems for highly activated components; the handling and transportation (usually for disposal) of highly activated components; and the specification, engineering, design, and installation of radiation shielding.

The linear accelerator requires large power sources and is supplied at TA-53 by radiofrequency power sources. The capability to design, fabricate, operate, and maintain radiofrequency systems for accelerators and other applications is an important support function for LANSCE operations. Radiofrequency technology development also supports microwave materials processing and radiofrequency system design.

Neutron Research and Technology. Fundamental research is conducted on the interaction of neutrons with various materials, molecules, and nuclei to advance condensed matter science (including material science and engineering and aspects of bioscience), nuclear physics, and the study of dynamic phenomena in materials. Applied neutron research is conducted to provide scientific and engineering support to weapons stockpile stewardship and nonproliferation surveillance. Efforts include resonance neutron spectroscopy and neutron radiography. Research is also performed to develop instrumentation and diagnostic devices by scientists from universities, other Federal laboratories, and industry.

Neutrons from the Manuel Lujan Neutron-Scattering Center and the Weapons Neutron Research Facility are used to conduct experiments at LANL. In addition, LANL continues to support contained weapons-related experiments using small-to-moderate quantities of high explosives and would provide support for static stockpile surveillance technology R&D.

Material Test Station. The Material Test Station capability would replace the Accelerator Transmutation of Waste capability analyzed in the *1999 SWEIS*. Similar to Accelerator Transmutation of Waste, the Material Test Station would provide the capability to safely irradiate materials and fuels in a fast-neutron spectrum and in a prototypic temperature and coolant environment. Two existing target locations would be replaced, and a spallation neutron source would be installed in an existing experimental area (Area A) at LANSCE. A fast-neutron irradiation environment would be produced by interaction of the proton beam with a tungsten target. The neutrons would be used to irradiate small samples of materials and fuels to conduct proof of performance experiments to prove the practicality of transmuting plutonium and high-level radioactive wastes into other elements or isotopes. This capability is anticipated to become operational in the 2009 to 2010 timeframe.

Subatomic Physics Research. This capability supports the conduct of physics experiments at the Manuel Lujan Center and the Weapons Neutron Research Facility, as well as the conduct of proton radiography experiments. Proton radiography experiments include contained experiments using small-to-moderate quantities of high explosives.

Medical Isotope Production. Radioisotopes used by the medical community for diagnostic procedures, therapeutic treatment, clinical trials, and biomedical research are produced at LANSCE. A new 100-million-electron-volt Medical Isotope Production Facility became fully operational in 2004. This new facility provides the ability to perform more selective and efficient isotope production while generating fewer byproduct isotopes than was previously possible.

In addition, an Isotope Production Facility would be established in an existing building. This facility would complement the 100-million-electron-volt Isotope Production Facility by using the 800-million-electron-volt proton beam available at the end of the linear accelerator to fabricate radioisotopes used by the medical community for diagnostic and other procedures.

Area A East would be stripped of existing contaminated and uncontaminated items for use as a staging area for shipments, receipts, equipment storage, and limited maintenance activities. Removal of existing items would generate an estimated 1,700 tons (1,540 metric tons) of waste for disposal, as detailed in Chapter 3, Section 3.2.11, of the *1999 SWEIS* (DOE 1999a).

High-Power Microwaves and Advanced Accelerators. R&D is conducted for advanced accelerator concepts, high-powered microwaves, room-temperature and superconducting linear accelerator structures, as well as in microwave chemistry for industrial and environmental applications. A neutron spectroscopy facility would be added under this capability for use in neutron research and technology. This facility would be constructed within existing buildings and would house photographic equipment and experiments contained within closed vessels.

Radioactive Liquid Waste Treatment. Wastes from LANSCE activities and certain wastes from TA-21 and TA-50 are treated in facilities at TA-53. Treatment includes wastewater storage to allow for short-lived radioisotope decay followed by solar evaporation. Radioactive liquid waste comes primarily from floor drains and accelerator magnet cooling water. Water flows by gravity into lift stations constructed adjacent to Experimental Area A and the Manuel Lujan Neutron-Scattering Center and is pumped from the lift stations through double-walled piping to one of three 30,000-gallon (113,562-liter) horizontal fiberglass tanks located in a building at the east end of TA-53. After allowing for decay, the radioactive liquid waste is pumped to one of two aboveground concrete evaporation basins. Each of the basins can hold 125,000 gallons (470,000 liters) of liquid and has impermeable liners and leak detection instrumentation.

3.1.3.15 Waste Management Operations: Solid Radioactive and Chemical Waste Facilities

The Solid Radioactive and Chemical Waste Facilities occupy over 200 structures in an area of 943 acres (382 hectares) in TA-54 and TA-50. This Key Facility processes, temporarily stores, and disposes of solid waste generated throughout LANL. A variety of wastes are managed, including toxic, hazardous, low-level radioactive, transuranic, and mixtures of these waste types. Most waste managed in TA-54 is in a solid physical state, although there are also small quantities of gaseous or liquid hazardous, toxic, and mixed wastes. Most low-level radioactive waste generated by LANL operations is disposed of onsite in TA-54. As evaluated in the *1999 SWEIS* and documented in the ROD, as disposal capacity in the currently active portion of Area G is used up, Zone 4 is being developed for continued low-level radioactive waste disposal. In addition to the operations at TA-54, transuranic waste is processed in the Waste Characterization, Reduction, and Repackaging Facility in TA-50 and is transported to TA-54 for assay and storage. Transuranic waste is stored onsite until it is transported to WIPP for disposal. Chemical and mixed radioactive wastes are transported to other offsite facilities for treatment and disposal.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–17** indicates activity types and levels proposed under all three alternatives for each capability.

Waste Characterization, Packaging, and Labeling. LANL supports, certifies, and audits generator characterization programs and maintains the waste acceptance criteria for LANL waste management facilities. LANL also manages compliance with the waste acceptance criteria for offsite treatment, storage, and disposal facilities. Deteriorating drums are overpacked, and small waste items are bulked (packaged together) to facilitate their management.

Capabilities include coring and visual inspection of a percentage of transuranic waste packages, ventilating packages of transuranic waste retrieved from below grade, maintaining compliance with the current version of the WIPP waste acceptance criteria, and coordinating with WIPP operations for disposal of LANL transuranic waste.

Table 3–17 Waste Management Operations: Solid Radioactive and Chemical Waste Facilities Capabilities and Activity Levels

Capability	*No Action Alternative* [a, b]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Waste Characterization, Packaging, and Labeling	Characterize 420 cubic yards (320 cubic meters) of newly generated transuranic waste annually. Characterize 11,000 cubic yards (8,400 cubic meters) of legacy transuranic waste. Characterize low-level radioactive, mixed low-level radioactive, and chemical waste, including waste from DD&D and remediation activities. Ventilate transuranic waste retrieved from belowground storage. Perform coring and visual inspection of a percentage of transuranic waste packages. Overpack and bulk small waste items as required. Support, certify, and audit generator characterization programs. Maintain waste acceptance criteria for LANL waste management facilities. Maintain waste acceptance criteria for offsite treatment, storage, and disposal facilities. Maintain WIPP waste acceptance criteria compliance and liaison with WIPP operations.	Same as No Action Alternative	Same as No Action Alternative, plus: - Characterize an additional 290 cubic yards (220 cubic meters) of newly generated transuranic waste annually. - Characterize approximately 3,100 cubic yards (2,400 cubic meters) of contact-handled and 130 cubic yards (100 cubic meters) of remote-handled legacy transuranic waste retrieved from belowground storage. - Characterize additional low-level radioactive, mixed low-level radioactive, and chemical waste, including waste from DD&D and remediation activities.
Waste Transport, Receipt, and Acceptance	Ship 420 cubic yards (320 cubic meters) of newly generated transuranic waste to WIPP annually. Ship 11,000 cubic yards (8,400 cubic meters) of legacy transuranic waste to WIPP. Ship low-level radioactive wastes to offsite disposal facilities. Ship 70 cubic yards (55 cubic meters) of mixed low-level radioactive waste for offsite treatment and disposal in accordance with EPA land disposal restrictions annually. Ship 7,100 tons (6,400 metric tons) of chemical wastes for offsite treatment and disposal in accordance with EPA land disposal restrictions annually. Ship low-level radioactive, mixed low-level radioactive, and chemical waste from DD&D and remediation activities. Collect chemical and mixed wastes from LANL generators and transport them to Consolidated Remote Storage Sites and TA-54. Receive, on average, 5 to 10 shipments annually of low-level radioactive waste and transuranic waste from offsite locations.	Same as No Action Alternative	Same as No Action Alternative, plus: - Ship 290 cubic yards (220 cubic meters) of additional transuranic waste to WIPP annually. - Ship approximately 3,000 cubic yards (2,340 cubic meters) of contact-handled and 130 cubic yards (100 cubic meters) of remote-handled legacy transuranic waste to WIPP. - Ship additional low-level radioactive, mixed low-level radioactive, and chemical waste from DD&D and remediation activities.

Capability	***No Action Alternative*** [a, b]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Waste Retrieval	No activity	No activity	Retrieve remaining legacy transuranic waste (approximately 3,100 cubic yards [2,400 cubic meters] of contact-handled and 130 cubic yards [100 cubic meters] of remote-handled) from belowground storage in TA-54 Area G, including: Pit 9, above Pit 29, Trenches A–D, and Shafts 200-232, 235-243, 246-253, 262-266, and 302-306 (see Appendix H). [c]
Waste Treatment	Compact up to 3,000 cubic yards (2,540 cubic meters) of low-level radioactive waste annually. Process 3,000 cubic yards (2,400 cubic meters) of transuranic waste through size reduction at the Decontamination and Volume Reduction System. Demonstrate treatment (e.g., electrochemical) of liquid mixed low-level radioactive waste. Stabilize 1,100 cubic yards (870 cubic meters) of uranium chips.	Same as No Action Alternative	Same as No Action Alternative, plus: - Process newly generated transuranic waste through new TRU Waste Facility (formerly called the Transuranic Waste Consolidation Facility).
Waste Storage	Stage chemical and mixed wastes prior to shipment to offsite treatment, storage, and disposal facilities. Store transuranic waste until it is shipped to WIPP. Store mixed low-level radioactive waste pending shipment to a treatment facility. Store low-level radioactive waste uranium chips until sufficient quantities are accumulated for stabilization campaigns. Manage and store sealed sources for the Off-Site Source Recovery Project.	Same as No Action Alternative	Same as No Action Alternative, plus: - *Increase types and quantities of sealed sourced stored for the Off-Site Source Recovery Project* (see Appendix J). - Store transuranic waste generated by DD&D and remediation activities.
Waste Disposal	Dispose 110 cubic yards (84 cubic meters) of low-level radioactive waste in shafts, 30,000 cubic yards (23,000 cubic meters) of low-level radioactive waste in pits, and small quantities of radioactively contaminated polychlorinated biphenyls in shafts in Area G annually. Migrate operations in Area G to Zones 4 and 6 as necessary to allow continued onsite disposal of low-level radioactive waste.	Same as No Action Alternative	Same as No Action Alternative, plus: - Dispose additional low-level radioactive waste generated by DD&D and remediation activities.

Capability	***No Action Alternative*** [a, b]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Decontamination Operations (Part of RLWTF operations in the *1999 SWEIS*)	Decontaminate approximately 700 personal respirators and 300 air-proportional probes per month for reuse. Decontaminate vehicles and portable instruments for reuse as required. Decontaminate precious metals for resale using an acid bath. Decontaminate scrap metals for resale by sand-blasting the metals. Decontaminate 260 cubic yards (200 cubic meters) of lead for reuse by grit-blasting.	Same as No Action Alternative	Same as No Action Alternative
Construction/Upgrade/DD&D			
Waste Management Facilities Transition Project	No activity	No activity	As described in Appendix H: - Construct and operate equipment and facilities for retrieval, characterization, and packaging of stored remote-handled transuranic waste. - Procure additional and upgraded equipment and facilities to increase throughput of stored transuranic waste drums being processed for shipment to WIPP. - Construct and operate a new *TRU Waste Facility*. - Construct and operate new access control station, low-level radioactive waste compactor building, and low-level radioactive waste certification building. - Relocate hazardous and mixed low-level radioactive waste storage facilities within TA-54, Area L, or move to other LANL locations.

WIPP = Waste Isolation Pilot Plant; TA = technical area; EPA = U.S. Environmental Protection Agency;
RLWTF = Radioactive Liquid Waste Treatment Facility; TRU = transuranic; DD&D = decontamination, decommissioning, and demolition.

[a] DOE 1999a.

[b] LANL 2006a.

[c] LANL 2005e.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Waste Transport, Receipt, and Acceptance. Hazardous and mixed wastes are collected from LANL generators, transported to the consolidated remote storage sites and TA-54, and shipped offsite for treatment and disposal in accordance with U.S. Environmental Protection Agency (EPA) land disposal restrictions. Legacy and newly generated transuranic wastes are prepared for disposal and shipped to WIPP. Fewer than 10 shipments a year of low-level radioactive waste and transuranic waste are received from offsite locations. Receipt of offsite waste is not routine and must be approved by NNSA. Once received, the wastes are managed along with similar wastes generated at LANL. These wastes are generated by LANL activities at other locations and by other DOE facilities that do not have the capability to manage the wastes.

Waste Retrieval. This capability involves the retrieval and management of waste stored in pits, shafts, and trenches in TA-54 Area G so that the waste can be processed for eventual disposition.

Waste Treatment. This capability involves a variety of activities to prepare different waste types for storage and disposal: compaction, size reduction, and special treatment of wastes on an as-needed basis. Low-level radioactive waste generated onsite is compacted to reduce its volume prior to disposal.

Larger pieces of transuranic waste are reduced in size at the Decontamination and Volume Reduction System to make them suitable to be packaged for shipment to WIPP. This system is intended to handle large metal items. Processes include decontamination to low-level radioactive waste levels, as well as cutting and compacting so waste fits in containers accepted at WIPP.

On an as-needed basis, Waste Management Operations demonstrates treatment of liquid mixed low-level radioactive waste, stabilizes uranium chips, and accepts environmental restoration soils for disposal at Area G as low-level radioactive waste.

Waste Storage. LANL stores chemical and mixed wastes prior to shipment to offsite treatment, storage, and disposal facilities; legacy transuranic waste until it is shipped to WIPP; mixed low-level radioactive waste until it is transported to a treatment facility; sealed sources from the Off-Site Source Recovery Project until a disposition path is available; and low-level radioactive waste uranium chips until sufficient quantities are accumulated for stabilization campaigns.

Waste Disposal. Solid low-level radioactive waste is disposed of in cells, pits, and shafts in TA-54 Area G. The Consent Order requires investigation and remediation of environmental contamination at LANL, including certain subsurface units in MDA G in Area G. For this reason, and because the currently active portion of Area G is reaching the limit of its disposal capacity, the existing disposal units will be closed and disposal operations will be moved to Zone 4 in TA-54 to provide new disposal capacity and facilitate closure of MDA G. Zone 6 in TA-54 is also available for future expansion.

Decontamination Operations. This capability was relocated from the Radioactive Liquid Waste Treatment Facility in 2000. Decontamination is performed either to enable reuse or to reduce the contamination of materials before disposal. Items generally decontaminated include respirators, vehicles, portable equipment, scrap and precious metals, and lead shielding.

3.1.3.16 Plutonium Facility Complex

The Plutonium Facility Complex Key Facility is located on 40 acres (16 hectares) in TA-55 and consists of six primary buildings and a number of support, storage, security, and training structures located throughout the TA. The Plutonium Facility, a two-story laboratory of approximately 151,000 square feet (14,000 square meters), is the major R&D facility in the complex. The Plutonium Facility Complex has the capability to process and perform research on actinide materials, although plutonium is the principal actinide used in the facility.

The following paragraphs describe the capabilities of this Key Facility. **Table 3–18** indicates activity types and levels proposed under all three alternatives for each capability.

Plutonium Stabilization. This capability employs a variety of plutonium and other actinide recovery operations to improve the storage condition of legacy plutonium in the LANL inventory. Cleaning metallic plutonium, converting metal to oxide, reprocessing scrap material, and high-firing oxides are among the routine Plutonium Complex chemical processing capabilities.

Manufacturing Plutonium Components. This capability involves the manufacture of plutonium pits and parts, and fabrication of samples for R&D activities. This capability also includes fabrication of parts for dynamic and subcritical experiments.

Surveillance and Disassembly of Weapons Components. This capability provides for the disassembly of plutonium pits for examination. Destructive and nondestructive techniques are used for examination.

Actinide Materials Science and Processing Research and Development. Research would be conducted on plutonium (and other actinide) materials, including metallurgical and other characterization of samples and measurements of mechanical and physical properties. This includes continued operation of the 40-millimeter Impact Test Facility and other apparatus. Research is also conducted to develop new techniques that are useful for such research or for enhanced surveillance. In addition, research is performed to support development and assessment of technology for manufacturing and fabrication of components, including activities in areas such as welding; bonding; fire resistance; and casting, machining, and other forming technologies.

Special recovery processes are performed, including demonstration of the disassembly and conversion of plutonium pits using hydride-dehydride processes and development of expanded disassembly capacity. Neutron sources (plutonium and beryllium, and americium-241 and beryllium) can be processed at TA-55. Included in this capability is the technology to process neutron sources other than sealed sources, process items through the Special Recovery Line (tritium separation), and perform oralloy decontamination of uranium components.

Table 3–18 Plutonium Facility Complex Capabilities and Activity Levels

Capability	*No Action Alternative* [a]	*Reduced Operations Alternative*	*Expanded Operations Alternative* [b]
Plutonium Stabilization	Recover, process, and store existing plutonium residue inventory.	Same as No Action Alternative	Same as No Action Alternative
Manufacturing Plutonium Components	Produce up to 20 plutonium pits per year. Fabricate parts and samples for research and development activities, including parts for dynamic and subcritical experiments.	Same as No Action Alternative, except: - Produce less than 20 plutonium pits per year.	Same as No Action Alternative except: - Produce up to 80 pits per year.
Surveillance and Disassembly of Weapons Components	Disassemble, surveil, and examine up to 65 plutonium pits per year.	Same as No Action Alternative	Same as No Action Alternative
Actinide Materials Science and Processing Research and Development	Perform plutonium (and other actinide) materials research, including metallurgical and other characterization of samples and measurements of mechanical and physical properties. Operate the 40-millimeter Impact Test Facility and other test apparatus. Develop expanded disassembly capacity and disassemble up to 200 pits per year. Process up to 5,000 curies of neutron sources (including plutonium and beryllium and americium-241 and beryllium). Process neutron sources other than sealed sources. Process up to 900 pounds (400 kilograms) of actinides per year between TA-55 and the CMR Building. Process pits through the Special Recovery Line (tritium separation). Perform oralloy decontamination of 28 to 48 uranium components per month. Conduct research in support of DOE actinide cleanup activities and on actinide processing and waste activities at DOE sites. Stabilize specialty items and residues from other DOE sites. Fabricate and study nuclear fuels used in terrestrial and space reactors. Fabricate and study prototype fuel for lead test assemblies. Develop safeguards instrumentation for plutonium assay. Analyze samples.	Same as No Action Alternative	Same as No Action Alternative, except (some of these are higher activity levels; some are additional activities): - Develop expanded disassembly capacity and disassemble up to 500 pits per year. - Process up to 1,800 pounds (800 kilograms) of actinides, including polishing up to 460 pounds (210 kilograms) of plutonium oxide, annually. - Provide support for dynamic experiments. - Conduct plutonium research, development, and support: prepare, measure, and characterize samples for fundamental research and development in areas such as aging, welding and bonding, coatings, and fire resistance.
Fabrication of Ceramic-Based Reactor Fuels	Make prototype mixed oxide fuel. Build test reactor fuel assemblies. Continue R&D on other fuels.	Same as No Action Alternative	Same as No Action Alternative

Capability	***No Action Alternative*** [a]	***Reduced Operations Alternative***	***Expanded Operations Alternative*** [b]
Plutonium-238 Research, Development, and Applications [c]	Process, evaluate, and test up to 55 pounds (25 kilograms) of plutonium-238 per year in production of materials and parts to support space and terrestrial uses. Recover, recycle, and blend up to 40 pounds (18 kilograms) per year of plutonium-238.	Same as No Action Alternative	Same as No Action Alternative
Storage, Shipping, and Receiving	Provide interim storage of up to 7.3 tons (6.6 metric tons) of the LANL special nuclear material inventory, mainly plutonium. Store working inventory in the vault in Building 55-4; ship and receive as needed to support LANL activities. Provide temporary storage of Security Category I and II materials removed in support of TA-18 closure, pending shipment to the Nevada Test Site and other DOE complex locations. Store sealed sources collected under DOE's Off-Site Source Recovery Project. Store mixed oxide fuel rods and fuel rods containing archive and scrap material from mixed oxide fuel lead assembly fabrication.	Same as No Action Alternative	Same as No Action Alternative, plus: - Conduct nondestructive assay on special nuclear material at TA-55-4 to identify and verify the content of stored containers. - Cut mixed oxide fuel rods and fuel rods containing archive and scrap materials from mixed oxide fuel lead assembly fabrication into smaller pieces, repackage, and continue to store.
Construction/Upgrades/DD&D			
Plutonium Facility Complex Refurbishment Project	No activity	No activity	Implement *Plutonium Facility Complex Refurbishment Project*, involving major systems repairs and replacements to extend reliable operation of facility for the future (see Appendix G).
TA-55 Radiography Facility Project	No activity	No activity	Construct and operate TA-55 Radiography Facility (see Appendix G).

R&D = research and development; TA = technical area; CMR = Chemistry and Metallurgy Research; DD&D = decontamination, decommissioning, and demolition.

[a] DOE 1999a.

[b] LANL 2006a.

[c] The *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems* (DOE 2005c) evaluates consolidation of radioisotope power system nuclear operations, including those currently performed at the Plutonium Facility at LANL, at a single site. The Proposed Action would consolidate these activities at Idaho National Laboratory. Should DOE decide to implement consolidation, associated operations would cease at LANL and be transferred. However, other activities involving plutonium-238, such as the plutonium-238 fuel aging studies and plutonium-238 calibration standards activities would remain at LANL.

Note: Italicized entries indicate projects for which project-specific impact analyses are included in appendices to this SWEIS.

Research in support of DOE's actinide cleanup activities and on actinide processing and waste activities at DOE sites is conducted. In addition, LANL staff would stabilize specialty items and residues from other DOE sites; fabricate and study nuclear fuels used in terrestrial and space reactors; fabricate and study prototype fuel for lead test assemblies; develop safeguards instrumentation for plutonium assay; and analyze samples.

Fabrication of Ceramic-Based Reactor Fuels. Development and demonstration of ceramic fuel fabrication technologies is conducted. R&D continues on other fuels.

Plutonium-238 Research, Development, and Applications. Radioisotope thermoelectric generators and milliwatt generators using plutonium-238 as an energy source are developed and fabricated under this capability. As part of R&D and testing, plutonium-238 is processed, recovered, recycled, and blended. Materials and parts are fabricated and units are tested in support of space and terrestrial uses.

Storage, Shipping, and Receiving. The Plutonium Facility provides storage, shipping, and receiving activities for the majority of the LANL special nuclear material inventory, mainly plutonium. This includes temporary storage of Security Category I and II materials removed from TA-18 in support of TA-18 closure until these materials are shipped to the Nevada Test Site and other DOE sites. In addition, sealed sources collected under DOE's Off-Site Source Recovery Project are stored at TA-55 or sent to other LANL locations for storage pending final disposition. When appropriate, mixed oxide fuel materials stored at TA-55 would be transported to other DOE sites.

3.2 Reduced Operations Alternative

At the site-wide and TA levels, the Reduced Operations Alternative is the same as the No Action Alternative. Differences between the Reduced and No Action Alternatives occur only within Key Facilities as described in this section.

Under the Reduced Operations Alternative, the following Key Facilities would maintain the same capabilities and operate at the same activity levels as under the No Action Alternative (see Section 3.1 of this SWEIS):

- Sigma Complex
- Machine Shops
- Material Sciences Laboratory
- Nicholas C. Metropolis Center for Modeling and Simulation
- Tritium Facilities
- Target Fabrication Facility
- Bioscience Facilities
- Radiochemistry Facility

- Waste Management Operations: Radioactive Liquid Waste Treatment Facility
- Waste Management Operations: Solid Radioactive and Chemical Waste Facilities

The six Key Facilities discussed in the following paragraphs would operate at levels reduced from those described for the No Action Alternative.

3.2.1 Chemistry and Metallurgy Research Replacement Facility

Under the Reduced Operations Alternative, NNSA would not construct and operate the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility. Operations at the Chemistry and Metallurgy Research Building would continue to provide LANL's analytical chemistry and materials characterization research and mission support capabilities beyond 2010, while most administrative offices and support functions would move to TA-55 once construction of the new Chemistry and Metallurgy Research Replacement radiological laboratory, administrative office, and support building was completed. Operations remaining at the Chemistry and Metallurgy Research Building would likely be reduced and consolidated from Wings 3, 5 and 7 (operations have already been halted within Wings 2 and 4); ultimately Wing 7 might become the last remaining operable wing of the building before its total shutdown and closure. Operations overall within the Chemistry and Metallurgy Research Building would be reduced and nuclear materials stored within the building would also be reduced. Overall support to production activities would not be adequate to support a 20 pit-per-year rate.

3.2.2 High Explosives Processing Facilities

Under the Reduced Operations Alternative, capabilities described in the No Action Alternative for the High Explosives Processing Facilities Key Facility would remain the same, but their activity levels would be reduced by 20 percent (see Section 3.1.3.6). These activities would require an estimated 66,200 pounds (30,000 kilograms) of explosives and 2,300 pounds (1,100 kilograms) of mock explosives annually. Table 3–8 presents activity levels proposed under this alternative for each capability.

Construction of the TA-16 Engineering Complex would be completed as under the No Action Alternative, including removing or demolishing unneeded vacated structures.

3.2.3 High Explosives Testing Facilities

Under the Reduced Operations Alternative, capabilities for the High Explosives Testing Facilities would remain the same as those described in the No Action Alternative, but their activity levels would be reduced by 20 percent (see Section 3.1.3.7). Further, no special nuclear material would be used in dynamic experiments. Table 3–9 indicates activity levels proposed under all three alternatives for each capability. Under this alternative, up to 5,500 pounds (2,500 kilograms) of depleted uranium would be expended in experiments annually.

The same construction projects would be implemented as under the No Action Alternative: 15 to 25 new structures (new offices, laboratories, and shops) would be built within the Two-Mile Mesa Complex to consolidate activities currently conducted in various locations around LANL. Vacated structures would be removed or demolished as appropriate, and the dynamic experimentation assembly structure would be installed at TA-15.

3.2.4 Pajarito Site

Under the Reduced Operations Alternative, operations at the Pajarito Site would cease. The Pajarito Site would be placed in surveillance and maintenance mode and would be eliminated as a Key Facility. Table 3–11 identifies differences between the three alternatives for the Pajarito Site Key Facility.

3.2.5 Los Alamos Neutron Science Center

Under the Reduced Operations Alternative, LANSCE would be closed, placed into safe shutdown mode, and eliminated as a Key Facility. Systems would be maintained in a condition to support future restart. This shutdown would be a major change at LANL because LANSCE accounts for more than 90 percent of all radioactive air emissions from LANL and provides a source of neutron and proton beams that is not readily available elsewhere in the DOE complex. Radioactive liquid waste treatment would continue at TA-53, with approximately 5,000 gallons (20,000 liters) per year transported from TA-50 for solar evaporation. Table 3–16 identifies differences between the three proposed alternatives for LANSCE.

3.2.6 Plutonium Facility Complex

Under the Reduced Operations Alternative, the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility would not be constructed and analytical chemistry and materials characterization research would continue at the Chemistry and Metallurgy Research Building. As discussed in Chapter 1, Section 1.3.2, and in Section 3.2.1, overall support to pit production activities would not be adequate to support a 20 pit-per-year production rate.

3.3 Expanded Operations Alternative

This alternative considers LANL operations at a higher level than the No Action Alternative, as well as implementation of additional projects at the site-wide, TA, and Key Facility levels. Many capabilities would remain unchanged. Some projects that would be implemented, such as for the Pajarito Site Key Facility, would result in closure and demolition of facilities and loss of capabilities at LANL. Each proposed new construction project or major modification to existing facilities is described and the potential impacts are evaluated in an appendix to this SWEIS. Each of these appendices includes a proposed timeline for construction and operation.

3.3.1 Los Alamos National Laboratory Site-Wide Projects

Under the Expanded Operations Alternative, three major site-wide projects would be undertaken. The Security-Driven Transportation Modifications Project, remedial activities required to comply with the Consent Order, and an increase in the types and quantities of sealed sources managed at LANL by the Off-Site Source Recovery Project are described in this section.

3.3.1.1 Security Needs

As part of its ongoing security improvement effort, NNSA has determined there is a continuing need to upgrade physical protection in the area of the Pajarito Corridor West. Under the Expanded Operations Alternative, additional Security-Driven Transportation Modifications involving extensive changes to general traffic flow patterns and site infrastructure identified in Table 3–1 would be implemented.

Under this approach, vehicular traffic in the Pajarito Corridor West between TA-48 and TA-63 could be limited, according to the security level, to only Government vehicles and physically inspected service vehicles. Access for staff and visitors to this controlled area would be provided by an internal shuttle system linked to large parking areas at TA-48 and TA-63. Surface parking lots for both private vehicles and commuter buses would be constructed at these two termini. A shuttle bus system would be deployed within the restricted area.

Modifications to certain existing roads and construction of new roads would be required. Retaining walls and security barriers would be constructed as needed to provide physical separation of the security-controlled portion of the Pajarito Corridor West from the parking areas and other roadways. A pedestrian and bicycle pathway system including shelters and related amenities would be provided at various locations within the project area. Pedestrian and vehicular crossings would be constructed between TA-63 and TA-35 over a branch of Mortandad Canyon (known locally as Ten Site Canyon).

Two auxiliary actions could also be implemented. Auxiliary Action A involves the construction of a two-lane bridge crossing Mortandad Canyon between TA-35 and Sigma Mesa (in TA-60) with a new road proceeding west through TA-60 to TA-3. Auxiliary Action B, which would be dependent on implementation of Auxiliary Action A, involves constructing a two-lane bridge over Sandia Canyon between TA-60 and TA-61, and a new road proceeding northward to East Jemez Road. The proposed project and an evaluation of the potential impacts are presented in Appendix J.

3.3.1.2 Remediation and Closure Activities

For several years, LANL personnel have conducted an environmental restoration program to identify locations where hazardous constituents may have been released into the environment and to carry out corrective measures in compliance with the Atomic Energy Act and the Hazardous and Solid Waste Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA). Under RCRA and related legislation, corrective action is enforced nationally by EPA and locally by the New Mexico Environment Department pursuant to the New Mexico Hazardous Waste Act. Since 1990, LANL personnel have conducted investigations and corrective actions at sites subject to HSWA in accordance with the LANL Hazardous Waste Facility Permit. The Consent Order signed on March 1, 2005, however, stipulates a more specific program of studies and corrective measures and requires cleanup to be completed by 2015.

The Consent Order establishes requirements for investigation and remediation of a large number of potential release sites, including several former MDAs, and specifies both the set of investigations and the schedule for their completion. Investigations by LANL staff would include installation of wells at the MDAs and in adjoining canyons, collection of soil and rock samples at the MDAs, collection of vapor samples from the MDAs, collection of alluvial sediment and groundwater samples in the adjoining canyons, and other related activities. These investigations would involve similar, if not identical, technologies that have been used for many years at LANL with few, if any, environmental impacts. If, at the conclusion of the investigation process, the New Mexico Environment Department determines that corrective measures are needed to protect human health or the environment, LANL staff would evaluate a set of remedial options and recommend to the New Mexico Environment Department a preferred corrective measure. The New Mexico Environment Department would decide, however, which method should be implemented and is not obligated to select the preferred corrective measure.

Two scenarios for environmental restoration have been evaluated to bound the range of possible consequences of implementing corrective measures required by the Consent Order.[3] A Capping Option, a Removal Option, and a No Action Option are assumed and evaluated in Appendix I of this SWEIS. The No Action Option is the base case in which remedial investigations and cleanup activities would continue at a level comparable to that of recent years. Briefly, the Capping Option reflects the assumption that the waste and contamination within the MDAs would be left in-place and stabilized by installation of evapotranspiration caps as a mitigation measure. The Removal Option reflects the assumption that the waste and contamination within the MDAs covered by the Consent Order would be removed. For both the Capping and Removal Options, several additional potential release sites such as firing sites and outfalls would be remediated annually. These options are intended to bound the range of possible corrective measures and do not represent the preferred action NNSA would propose to the New Mexico Environment Department.

The Los Alamos County Solid Waste Landfill is an unlined facility that does not meet current regulatory standards. In lieu of bringing the landfill up to required standards, Los Alamos County will close the landfill, but has proposed to the New Mexico Environment Department that the landfill remain open through 2008 to achieve final waste grade (LAC 2007). Following closure, any remaining requirements would be addressed under the Consent Order as part of investigating and remediating the Upper Sandia Canyon Aggregate Area. The Investigation Work Plan for Upper Sandia Canyon Aggregate Area, including proposed groundwater monitoring, is due to the New Mexico Environment Department in 2008.

3.3.1.3 Increase in the Type and Quantity of Sealed Sources Managed at Los Alamos National Laboratory by the Off-Site Source Recovery Project

Under the Expanded Operations Alternative, the types and quantities of sealed sources accepted under the Off-Site Source Recovery Project would increase. In 2004, the scope of the Off-Site Source Recovery Project was expanded to include:

- all concentrations of the sources in the original scope commonly found in sealed sources;
- additional isotopes such as cobalt-60, cesium-137, iridium-192, radium-226, and californium-252, all of which are commonly found in sealed sources; and strontium-90, which is used in radioisotope thermoelectric generators (DOE 2004c).

[3] *NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.*

The Off-Site Source Recovery Project would use the same approach to manage these additional sealed sources as it does for those already managed under the No Action Alternative. The sealed sources would be brought to LANL for safe storage when other reasonable disposition options such as reuse or commercial disposal were not available. The potential impacts of the increased scope of the Off-Site Source Recovery Project at LANL are analyzed in Appendix J of this SWEIS.

3.3.2 Technical Area Projects

LANL activities discussed in this section would occur at TA-3, TA-21, TA-62, and TA-72. Proposed activities for TA-18, the Pajarito Site Key Facility, are discussed in Section 3.3.3.5.

3.3.2.1 Technical Area 3

Physical Science Research Complex Project

The Physical Science Research Complex Project (formerly the Center for Weapons Physics Research) would provide a new modern facility in which to consolidate staff currently located in TA-3 and other LANL locations in temporary structures or aging permanent buildings in poor condition. The new complex would collocate approximately 750 weapons scientists from various LANL organizations and disciplines to facilitate stockpile stewardship and certification activities. Security would be enhanced with construction of the Physical Science Research Complex, which would enable efficient conduct of classified work in a properly engineered security environment. Productivity is expected to be enhanced by collocating similar functions and organizations.

Under the Expanded Operations Alternative, the new Physical Science Research Complex would be constructed in a currently developed area of TA-3. The preliminary proposal is for a complex of four buildings, with a total floor space of approximately 350,000 square feet (32,500 square meters). Approximately 30 percent of the floor space would be laboratories (primarily laser). These laboratories would have an improved heating, ventilation, and air conditioning system; special flooring to limit vibration; extensive electrical grounding; and the use of pressurized air, helium, and nitrogen gas. The gases would be provided from a central location. No wet chemistry is expected to be performed. The complex would include both classified and unclassified workspace, a clean room, and vault space for classified weapons designers. A substantial amount of electrical power would be required to operate equipment.

Approximately 74,000 square feet (6,900 square meters) of existing structures at TA-3 would be removed to accommodate construction of the proposed new facility. Additionally, an undetermined number of other facilities could be demolished when the Physical Science Research Complex is complete. The potential impacts of this proposed project are evaluated in Appendix G.

Replacement Office Buildings Project

A complex of replacement office buildings and associated structures has been proposed for TA-3. The buildings would provide new modern structures to allow consolidation of staff currently located throughout TA-3 or other parts of LANL in temporary structures or aging permanent buildings in failing and poor condition. The office complex would be located partially on undeveloped land south of West Jemez Road and partially in developed areas of the existing Wellness Center building. The project would consist of nine new buildings (one of which would be available to house DOE's Los Alamos Site Office) and two new parking structures, one located north of Mercury Road and one located south of West Jemez Road. The existing Wellness Center would be demolished to accommodate later phases of this project. Three new office buildings already under construction would become part of this complex through connecting parking and siting proximity.

The proposed Los Alamos Site Office Building would be a 45,500-square-foot (4,200-square-meter) building housing approximately 150 staff. The remaining office complex buildings would be two-story structures, each with a footprint of 8,000 to 9,000 square feet (740 to 840 square meters). These new buildings would provide approximately 15,000 to 17,500 gross square feet (1,400 to 1,600 square meters) of office space and house approximately 50 to 70 staff each. Staff would be transferred from other offices at LANL. Appendix G provides an analysis of the potential impacts of this project. Construction of the Los Alamos Site Office Building has begun.

3.3.2.2 Technical Area 21 Structure Decontamination, Decommissioning, and Demolition Project

Under the Expanded Operations Alternative, all or some of the structures located within the boundaries of TA-21 would undergo DD&D. Structures involved could range from only those that interfere with site investigations and remediation to all existing TA-21 structures: process buildings, administrative and logistics buildings, and support facilities. Infrastructure such as gas, water, and waste piping; electrical and communication lines; and fences that cross TA-21 en route to other LANL facilities would also be removed as necessary.

The Consent Order requires investigation and remediation of environmental contamination at LANL, including areas in TA-21. In many cases, these investigations and remedial actions would be hampered by buildings that are above or adjacent to proposed investigation areas. To facilitate investigation of these areas, decommissioning and decontamination of many of the structures is planned. Decommissioning and decontamination of the structures would be optimized by grouping structures with similar contaminant profiles, interrelated systems, and construction types. The composition of those groups is identified in Appendix H, which evaluates the potential impacts of DD&D of structures in TA-21.

Field activities include preparation work and establishment of waste staging areas, utility management, removal of internal equipment, abatement or decontamination, removal of roofing and exterior equipment, above- and below-grade structural demolition, limited removal of underlying soil and structures, verification sampling, and site restoration. Many buildings are extensively contaminated and have residual radiological material in systems and on surfaces. Drainage, ventilation, and other utility systems also could contain residual hazardous materials.

Heavy equipment, specialty equipment, safety systems, and waste processing systems could be used in the decommissioning and decontamination effort. This equipment would be operated inside and adjacent to the structures. Removal of the foundation, substructures, and underlying soil would be limited to a depth of about 5 feet (1.5 meters) adjacent to and 2 feet (0.6 meters) below structure footprints. Remedial investigations and cleanup of the contaminated areas would be addressed by environmental restoration efforts as described in Section 3.3.1.2 and Appendix I of this SWEIS.

Actions would be taken on a schedule to support the investigation and corrective actions required under the Consent Order. DD&D of buildings and structures that might have an interim use, such as the steam plant and piping and administrative and logistics facilities, might be deferred. Appendix H lists buildings and structures identified for DD&D under this alternative and evaluates the potential impacts of these proposed activities.

3.3.2.3 Science Complex Project in Technical Area 62

The Science Complex is proposed to be built in TA-62; other siting options include the Research Park and south TA-3. The complex would consist of two buildings providing approximately 402,000 gross square feet (37,300 square meters) of office and light laboratory space along with the necessary supporting infrastructure and an auditorium, and would replace an equal amount of outdated and inefficient space that would be retired from service and eventually demolished. A parking structure of 504,000 square feet (46,800 square meters) would also be constructed. The complex would provide space for scientific staff involved in research in biosciences, computer and computational sciences, earth and environmental sciences, theoretical research, nonlinear studies, and geophysics and planetary physics.

Construction of the Science Complex would provide NNSA an opportunity to improve the quality of facilities that would be used to carry out current and future research programs in support of NNSA's Defense Program mission and to decrease and control operational and maintenance costs for LANL facilities. In addition, by providing consolidated space for staff performing work in related areas, peer groups would have frequent interactions that could contribute to collaborations and creative innovation and achieve efficiency.

NNSA's goal is to retain as much of the natural setting, vegetation, and overall environmental integrity of the site as practical. Potential environmental impacts of the construction and operation of the new Science Complex are analyzed in Appendix G.

3.3.2.4 Remote Warehouse and Truck Inspection Station Project in Technical Area 72

The proposed warehouse and truck inspection station in TA-72 would allow consolidation of truck inspections and warehousing operations at a location that is remote from core areas at LANL. The remote location would provide enhanced security because commercial vehicle shipments would be received and inspected before entering the more densely populated areas of LANL. The new Remote Warehouse and Truck Inspection Station would be sited on the southwest side of East Jemez Road, approximately 1 mile (1.6 kilometers) west of NM 4. Shipments would be offloaded and searched at the warehouse, then shipped to their onsite destinations.

The new facility would consolidate current distribution center activities into a modern facility that is safe, secure, cost-efficient, and environmentally compliant. The facility would replace existing LANL warehouse facilities that are over 50 years old and in poor condition and would solve existing operational problems. The new Truck Inspection Station would replace the temporary station located on the north side of East Jemez Road.

This complex would include an 85,000-square-foot (7,900-square-meter) distribution warehouse building, a 12,000-square-foot (1,100-square-meter) office building, a 400-square-foot (37-square-meter) rest area, and a 600-square-foot (55-square-meter) guardhouse and dog kennel. The warehouse would contain a vault, loading docks, leveling ramps, conveyor belts, and a materials handling area. The office building would house support personnel for the warehouse and truck inspection station operations. In addition, there would be approximately 50,000 square feet (4,600 square meters) of paved area for the Truck Inspection Station.

After the proposed facility is in operation, the temporary truck inspection station would be demolished and the area would be returned to a natural condition. Potential impacts of the construction and operation of this new Remote Warehouse and Truck Inspection Station are evaluated in Appendix G.

3.3.3 Key Facilities

The following Key Facilities would maintain the same capabilities and operate at the same activity levels under the Expanded Operations Alternative as under the No Action Alternative (see Section 3.1 of this SWEIS):

- Sigma Complex
- Machine Shops
- Material Sciences Laboratory
- High Explosives Testing Facilities
- Target Fabrication Facility

Changes to the other Key Facilities are described in the following paragraphs.

3.3.3.1 Chemistry and Metallurgy Research Building

Under the Expanded Operations Alternative, activities and anticipated construction would proceed as under the No Action Alternative described in Section 3.1.3.1, with a few additions. The Actinide Research and Development capability and the Fabrication and Processing capability would include several new or expanded activities, as outlined in Table 3–3. Under the Expanded Operations Alternative, Chemistry and Metallurgy Research Building Wing 9 hot cell operations would be moved to the Radiological Sciences Institute proposed for TA-48 rather than being eliminated, and operations would be overseen by Radiochemistry Laboratory personnel. Potential impacts of construction and operation of the new Radiological Sciences Institute are evaluated in Appendix G.

3.3.3.2 Nicholas C. Metropolis Center for Modeling and Simulation

Operations levels for the Metropolis Center are described in Table 3–7. Under the Expanded Operations Alternative, the computing platform would operate at higher computational levels, initially estimated to be up to 100 teraflops, and could approach 1,000 teraflops (1 petaflops). The level to which operations could increase would be limited by the amount of electricity and water needed to support the increased capabilities. Increases in operational levels requiring more than 15 megawatts of electricity or 51 million gallons (193 million liters) of water per year would require additional NEPA analysis before implementation. Expansion of computational capabilities would be supported by installation of additional processors and mechanical and electrical equipment. Potential impacts of increasing the level of operation at the Metropolis Center are evaluated in Appendix J.

3.3.3.3 High Explosives Processing Facilities

Activity levels for the High Explosives Processing Facilities are shown in Table 3–8. Activities under the Expanded Operations Alternative would require an estimated 82,700 pounds (37,500 kilograms) of explosives and an increase to 5,000 pounds (2,300 kilograms) of mock explosives annually. In addition, the Safety and Mechanical Testing capability would operate at a higher level; the number of safety and mechanical tests conducted annually would increase from approximately 15 per year up to 500 tests per year. The remaining capabilities would operate at the same levels described for the No Action Alternative (see Section 3.1.3.6).

3.3.3.4 Tritium Facilities

Tritium Facilities capabilities and activity levels are described in Table 3–10. Under the Expanded Operations Alternative, activity levels would be the same as described for the No Action Alternative (see Section 3.1.3.8). Once all tritium operations are finished at the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility, however, the buildings would undergo DD&D as part of the TA-21 structure DD&D (see Section 3.3.2.2).

3.3.3.5 Pajarito Site

The Pajarito Site capabilities and activity levels are described in Table 3–11. Under the Expanded Operations Alternative, Security Category III and IV materials would be relocated to the proposed Institute for Nuclear Nonproliferation Science and Technology, which is part of the proposed Radiological Sciences Complex at TA-48, or to another location at LANL as evaluated in Appendices G and H. Sealed sources managed under the Off-Site Source Recovery Project would be moved to other LANL storage locations, and the remaining operations at the Pajarito Site would be discontinued. Buildings would be decontaminated and decommissioned, as appropriate. Except for a cabin structure and other historic properties from the Manhattan Project and Cold War eras that would be preserved, buildings at TA-18 would be demolished and the Pajarito Site would be eliminated as a Key Facility.

3.3.3.6 Bioscience Facilities

Under the Expanded Operations Alternative, most of the Bioscience Facilities operations would move to the proposed Science Complex described in Section 3.3.2.3 and evaluated in

Appendix G. Moving Bioscience Facilities operations to the Science Complex would facilitate eventual replacement of the Health Research Laboratory in TA-43.

3.3.3.7 Radiochemistry Facility

Under the Expanded Operations Alternative, most capabilities would operate at the same levels as under the No Action Alternative, as described in Table 3–14. In addition, there would be one new activity under an existing capability and one new capability. Beryllium dispersion and mitigation assessments would be performed as part of the Environmental Remediation and Risk Mitigation capability. The new capability, Atom Trapping, would use a high-efficiency magneto-optical trap coupled to an offline mass separator to efficiently trap radioactive atoms for fundamental and applied research efforts.

The Expanded Operations Alternative would also include construction of the first component of the new consolidated and integrated Radiological Sciences Institute. The new institute would be constructed over about 20 years in a phased approach. Construction would begin on the first phase, the Institute for Nuclear Nonproliferation Science and Technology, during the timeframe analyzed in this SWEIS. The Institute for Nuclear Nonproliferation Science and Technology would include a Security Category I and II training center with a Security Category I vault, several Security Category III and IV laboratories, a field security test laboratory, a secure radiochemistry facility, and associated office and support facilities. Security Category III and IV capabilities and materials from TA-18 remaining at LANL would be relocated to the Institute for Nuclear Nonproliferation Science and Technology.

Once the new complex is completed, existing Radiochemistry Facility capabilities, as well as those from several other buildings, would be relocated to the new Radiological Sciences Institute and the old buildings currently housing those operations would undergo DD&D. In addition, capabilities from the Chemistry and Metallurgy Research Building Wing 9 hot cell would be reconstructed in the new Radiological Sciences Institute, and responsibility for those operations would transfer to the Radiochemistry Key Facility. Potential impacts of construction and operation of the new Radiological Sciences Institute are evaluated in Appendix G.

3.3.3.8 Waste Management Operations: Radioactive Liquid Waste Treatment Facility

Radioactive Liquid Waste Treatment Facility capabilities and activity levels are described in Table 3–15. Under the Expanded Operations Alternative, the Waste Transport, Receipt, and Acceptance capability and the Radioactive Liquid Waste Treatment capability would operate at increased levels. In addition to operating the new influent storage facility, a replacement for the existing Radioactive Liquid Waste Treatment Facility Building would be constructed in TA-50, with an estimated start of operations in 2012. New low-level radioactive waste and transuranic waste treatment facilities would be constructed, and low-level radioactive waste and transuranic waste processes would be modified to achieve greater reliability, redundancy, and flexibility. Portions of the existing facility would be demolished. New equipment would be purchased; some existing equipment might be used to supplement the new equipment. Evaporation tanks would be installed in TA-52 to minimize the discharge of treated liquid effluent from the Radioactive Liquid Treatment Waste Facility to the environment. Treated effluent would be conveyed to the evaporation tanks through a pipeline installed between TA-50 and TA-52. Potential impacts of this project are evaluated in Appendix G.

3.3.3.9 Los Alamos Neutron Science Center

Under the Expanded Operations Alternative, there would be no change in activity levels from the No Action Alternative, described in Table 3–16. The LANSCE Refurbishment Project, however, would be implemented. This project, which would include renovations and improvements to the existing facility to increase its reliability and extend its operation into the future, is described in Appendix G.

3.3.3.10 Waste Management Operations: Solid Radioactive and Chemical Waste Facilities

Under the Expanded Operations Alternative, most capabilities would continue to operate at the same activity levels described for the No Action Alternative in Table 3–17. Activity levels for the Waste Characterization, Packaging, and Labeling; and the Waste Transport, Receipt, and Acceptance capabilities would increase to accommodate additional transuranic waste resulting from increased pit production at the Plutonium Facility Complex. Storage and shipment of transuranic waste and disposal of low-level radioactive waste from DD&D and remediation activities would increase. In addition, the Waste Retrieval capability would be restarted to retrieve the transuranic waste stored in pits, shafts, and trenches in TA-54, Area G, as described in Table 3–17.

Within the Waste Storage capability, efforts to support the Off-Site Source Recovery Project would be expanded to accommodate expansion of the project to include additional types and concentrations of sealed sources. This project, which involves recovery of radioactive sources and devices (primarily sealed sources) that pose a potential risk to health, safety or national security, is evaluated in Appendix J.

Several new construction and upgrade projects would be implemented at the Solid Chemical and Radioactive Waste Facilities under the Expanded Operations Alternative. These projects would include construction and operation of a facility and equipment to retrieve and process remote-handled transuranic waste; procurement of additional and upgraded equipment for transuranic waste processing; construction and operation of a new TRU (Transuranic) Waste Facility (formerly the Transuranic Waste Consolidation Facility) in a TA along the Pajarito Road corridor; and construction and operation of a new access control station, low-level radioactive waste compactor building, and low-level radioactive waste certification building in TA-54. Potential impacts of construction and operation of these projects are analyzed in Appendix H.

3.3.3.11 Plutonium Facility Complex

Under the Expanded Operations Alternative, the Plutonium Facility Complex at TA-55 would increase pit production to up to 80 pits per year to meet the near-term needs of the Stockpile Stewardship Program. Increased pit production would impact all capabilities at the Plutonium Facility Complex, as shown in Table 3–18, and would also cause changes in activity levels at other Key Facilities. For example, a portion of the increased levels of transuranic waste processing that would occur at the Solid Radioactive and Chemical Waste Facilities under this alternative would result from increased pit production.

In addition, under the Expanded Operations Alternative, activities in support of mixed oxide fuel fabrication would increase. Up to 500 pits would be disassembled and up to 460 pounds (210 kilograms) of plutonium oxide would be polished annually and stored pending shipment to the Savannah River Site for use at the Mixed Oxide Fuel Fabrication Facility. Also, mixed oxide fuel stored in TA-55 would be reconfigured for more compact storage and eventual transportation offsite. Two containers with approximately 1,455 pounds (660 kilograms) of mixed oxide fuel in the form of ceramic pellets enclosed in fuel rods are stored at the Plutonium Facility Complex in their Type B shipping containers. Under this alternative, the pellets would be removed from the fuel rods and repackaged into smaller containers for storage in the special nuclear material vault pending transport to other DOE sites in Type B containers.

The Plutonium Facility Complex Refurbishment Project has been proposed to modernize and upgrade existing facilities and infrastructure at the TA-55 complex. This project is part of a comprehensive, long-term strategy to extend the life of TA-55 so that it can continue to operate safely, securely, and effectively for at least another 25 years. The project would be executed through a series of subprojects at TA-55; 21 high-priority subprojects and other less-critical subprojects have been proposed. The subprojects focus on high-priority facility systems and components that would improve overall Plutonium Facility reliability and are critical to facility and program operations. Proposed upgrades and renovations are described and potential impacts evaluated in Appendix G.

Another proposed project is construction and operation of a high-energy x-ray radiography facility in TA-55 to relocate this capability from TA-8. Examination of nuclear items and components through radiography is a key process in verifying the safety and reliability of the U.S. nuclear weapons stockpile. Movement of these nuclear items and components between TA-55 and TA-8, a distance of 4.5 miles (7.2 kilometers), was difficult prior to September 11, 2001, but was stopped after that date because increased demands on security personnel impacted the availability of security resources. The capability for high-energy x-ray radiography that eliminates the need for transporting nuclear items and components outside the security perimeter of TA-55 is needed to meet mission milestones and deadlines.

The proposed new facility in TA-55 would have between 5,000 to 8,500 square feet (460 to 790 square meters) of floor space and would be no more than two stories high, with the second floor below ground level. Constructing and operating this facility in TA-55 would eliminate the need to move nuclear components and items from TA-55 and would allow this type of nondestructive examination to resume at LANL. The proposed facility is described and potential impacts evaluated in Appendix G.

3.4 Preferred Alternative

NNSA's Preferred Alternative for continued operation of LANL is the Expanded Operations Alternative. This alternative includes fabrication of up to 80 pits per year at the Plutonium Facility Complex in TA-55, as well as increased activity levels at certain other Key Facilities (such as the Chemistry and Metallurgy Research Replacement Facility) to support this level of pit production. Proposed increases in activity levels would be implemented and new capabilities would be added to existing Key Facilities. Capabilities, activity levels, and projects identified under the No Action Alternative that remain unchanged under the Expanded Operations Alternative would continue as described. NNSA would undertake activities to facilitate compliance with the Consent Order and remediation of the MDAs, as well as other closure and DD&D projects. The proposed projects discussed in the appendices to this SWEIS would proceed, commensurate with funding.

However, full implementation of the Preferred Alternative may be affected by future programmatic decisions. NNSA is reconsidering its 2004 decision (69 FR 6967) to construct and operate the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility, pending evaluations and decisions related to Complex Transformation. NNSA may decide to proceed with construction and operation of the nuclear facility portion at LANL, as announced in the 2004 ROD, or to establish these capabilities as part of a consolidated plutonium center or an integrated part of a consolidated nuclear production center. Both the consolidated plutonium center and the consolidated nuclear production center are analyzed in the *Complex Transformation SPEIS*. A ROD for the *Complex Transformation SPEIS* is expected in late 2008.

3.5 Alternatives Considered but Not Analyzed in Detail in the Site-Wide Environmental Impact Statement

Among the comments received during the scoping process were suggestions for additional alternatives that should be considered in the SWEIS, including a "Greener Alternative" and a "true No Action Alternative" (or shutdown alternative).

A Greener Alternative was evaluated in the *1999 SWEIS*. The name and general description of the alternative were provided by interested citizens as a result of the scoping process for that SWEIS. This alternative included LANL capabilities existing at that time with an emphasis on work performed in support of basic science, waste minimization and treatment, nuclear weapons dismantlement, nonproliferation, and other areas of national and international importance. While the Greener Alternative contained components of both the No Action and the Expanded Operations Alternatives evaluated in the *1999 SWEIS*, the operational focus was on science, waste management, and nuclear weapons dismantlement. NNSA is not evaluating a similar alternative in this SWEIS because, as stated in the *1999 SWEIS* ROD (see Appendix A), a Greener Alternative would not support the nuclear weapons mission assigned to LANL. It should be noted, however, that important aspects of the Greener Alternative evaluated in the *1999 SWEIS*, specifically optimization of work in the field of nonproliferation of weapons of mass destruction, as well as enhanced weapons dismantlement work, have been incorporated into the No Action Alternative analyzed in this new SWEIS. Other aspects of the Greener Alternative in the *1999 SWEIS* also incorporated into the No Action Alternative of this SWEIS include enhanced research related to national health issues, waste minimization and environmental restoration technologies, and international nuclear safety.

The alternative characterized as a "true No Action Alternative," in which all operations at LANL, including production and testing in support of stockpile stewardship would cease, is not a reasonable alternative. Thus, NNSA is not analyzing it in this SWEIS. Ceasing operations would result in a loss of support to nonproliferation efforts and research aiding the fight against terrorism. Because these activities are vital to national security and are among the major components of the mission assigned to LANL by NNSA, this alternative is not considered a reasonable alternative. This SWEIS updates previous EISs that have provided information supporting a number of decisions about operations at LANL. In such situations, an alternative that assumes LANL would cease all mission-related work is not reasonable.

3.6 Summary of Environmental Consequences

This section summarizes the impacts analyses performed for this SWEIS to provide an understanding of the overall consequences of each of the proposed alternatives and how the alternatives compare to each other. Chapter 5 of this SWEIS contains the detailed environmental analyses. Section 3.6.1 presents an overview for each of the resource areas, highlighting issues, concerns, or positive impacts. **Table 3–19** (located at the end of Section 3.6.1) summarizes the potential consequences of each alternative by resource area. Section 3.6.2 is a summary of the cumulative impacts analyses that considers operating LANL in the context of other past, present, and reasonably foreseeable actions.

The Expanded Operations Alternative includes implementation of specific projects evaluated in the appendices to this SWEIS. As discussed in Chapter 1, however, NNSA may make decisions on individual projects or proposed activities rather than making a single decision to implement an entire alternative. While Section 3.6.1 summarizes the impacts from these projects as part of the Expanded Operations Alternative, Section 3.6.3 summarizes the environmental consequences of each of the individual proposed projects evaluated in Appendices G, H, I, and J. This individual treatment is intended to facilitate the decision process by providing an understanding of how each of the proposed projects could affect the overall impacts of continued operations at LANL. Implementing the proposed projects may result in impacts to potential release sites covered under the Consent Order. As needed, these impacts would be addressed through the accelerated cleanup process described in Section VII.F of the Consent Order. NNSA intends to implement the actions necessary to comply with the Consent Order regardless of whether it implements decisions it makes on other actions analyzed in this SWEIS.

3.6.1 Comparison of Potential Consequences of Alternatives for Continued Operation at Los Alamos National Laboratory

This section focuses on the overall LANL site, providing an overview of impacts for each SWEIS alternative and resource area to provide an understanding of the total potential impacts of each alternative. Table 3–19, located at the end of this section, compares the environmental consequences of the three SWEIS alternatives.

Land Use

Under the No Action Alternative, the conveyance of land from LANL to Los Alamos County and the New Mexico Department of Transportation, and transfer of land to the Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) would continue. Of the 4,078 acres (1,650 hectares) identified under Public Law 105-119 (Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998), about 1,820 acres (737 hectares) remain to be transferred. This land conveyance and transfer, and the Power Grid

Upgrades Project, could impact site and regional land use. Effects of these actions include reduction in the size of LANL, possible changes in offsite land use from development following transfer, loss of recreational opportunities, and changes in site land use. Impacts would be similar under the Reduced Operations Alternative. Under the Expanded Operations Alternative, in addition to the impacts of the No Action Alternative, changes to land use could occur as the result of projects such as the Replacement Office Buildings Project, Radiological Sciences Institute Project, TA-18 Closure Project, MDA Remediation Project,[4] Radioactive Liquid Waste Treatment Facility Upgrade Project, Waste Management Transition Project, Science Complex Project, Remote Warehouse and Truck Inspection Station Project, and Security-Driven Transportation Modifications Project. While actions associated with these projects would in many cases be compatible with existing land use plans, there is no provision in the current plans for the new bridge that could be constructed over Sandia Canyon under Auxiliary Action B of the Security-Driven Transportation Modifications Project. Although no major changes in land use would occur in most cases, environmental remediation occurring for all alternatives could lead to fewer restrictions on land use. The fewest restrictions on land use would occur under the Removal Option for the MDA Remediation Project upon completion of remedial actions.

Visual Environment

Under the No Action Alternative, possible development following conveyance and transfer of land could degrade the views of presently undeveloped areas. For many projects, impacts to the visual environment would be limited to the construction phase. Once complete, most projects would be minimally visible from offsite locations, but more noticeable from closer vantage points; however, near views are often restricted to LANL employees. Under all alternatives, environmental remediation activities at some potential release sites could be publicly visible while remediation occurs. Power grid upgrades could adversely impact the views in previously undisturbed areas. Impacts under the Reduced Operations Alternative would be similar to those identified for the No Action Alternative.

Although in many cases impacts to the visual environment from implementation of the Expanded Operations Alternative would be similar those associated with the No Action Alternative, a number of proposed projects would cause noticeable changes to the visual environment. Capping or removing MDAs under the MDA Remediation Project would temporarily disturb areas or involve the use of temporary enclosures that could be visible in some cases. MDA Remediation Project activities would increase the visibility of the borrow pit in TA-61; and the Security-Driven Transportation Modifications Project would cause the construction of roads, parking lots, and new bridges over a site canyon. Additional visible bridges could be constructed over site canyons if the auxiliary actions were selected. In addition, new buildings associated with the Replacement Office Buildings and Science Complex Projects would be readily visible from West Jemez or Pajarito Roads. The new building associated with the Remote Warehouse and Truck Inspection Station would be visible from East Jemez Road. Establishment of evaporation tanks for final treatment of effluent from the Radioactive Liquid Waste Treatment Facility would cause a permanent change to the visual environment in the area near the border of TA-52 and TA-5. There would be a break in forest cover that could be seen from areas west of

[4] *The phrase MDA Remediation Project is used in this SWEIS as a general term for environmental remediation activities under the Consent Order, addressing MDAs and other potential release sites.*

LANL. The removal of old buildings would enhance the visual environment at both TA-18 and TA-21, and the visual environment at TA-21 could further change in the longer term if development takes place. Also, removal of the domes in TA-54 as part of the Waste Management Facilities Transition Project would have a beneficial impact on views of the site from both near (including the Pueblo of San Ildefonso) and far. Construction of the TRU Waste Facility, however, has the potential to impact the visual environment, including views from San Ildefonso Pueblo lands, depending on its location.

Geology and Soils

There is little difference in the impacts on geologic resources for the No Action and Reduced Operations Alternatives; however, the impacts from the Expanded Operations Alternative would be distinctly different. Under the Expanded Operations Alternative, facility construction and DD&D for the following projects would impact geologic materials: Physical Science Research Complex, Replacement Office Buildings, Radiological Sciences Institute, Radioactive Liquid Waste Treatment Facility Upgrade, TA-55 Radiography Facility, Science Complex, Remote Warehouse and Truck Inspection Station, TA-21 DD&D, Waste Management Facilities Transition, and the Security-Driven Transportation Modifications. A total of approximately 3.2 million cubic yards (2.5 million cubic meters) of soil and rock would be disturbed if all of these projects were implemented.

In addition, MDA remediation in compliance with the Consent Order would have a major impact on geologic resources. MDA remediation would require 1.2 million to 2.5 million cubic yards (0.9 million to 1.9 million cubic meters) of crushed tuff and other materials for evapotranspiration covers under the Capping Option, or up to 2.2 million cubic yards (1.7 million cubic meters) of backfill and surface materials under the Removal Option. These geologic resources would be available either at LANL or from nearby offsite sources.

Under all three alternatives, remediation of potential release sites would continue to remove existing contaminants from soils and shallow bedrock at LANL. This impact would be greatest under the Expanded Operations Alternative because the largest area and volume of contaminated soil would be remediated. The use of standard construction methods and best management practices would minimize the potential for erosion and release of soils during construction and decrease the potential for erosion, slope failure, and contaminant releases after remediation is complete.

Water Resources

There would be only minor adverse impacts on surface water quality and quantity from the No Action Alternative. There could be significant beneficial impacts on Sandia Canyon if the effluent from the Sanitary Wastewater Systems Plant is used as cooling water at the Metropolis Center for Modeling and Simulation. Under the Reduced Operations Alternative, the elimination of cooling tower effluent from LANSCE would result in a significant reduction of effluent discharge to Los Alamos Canyon. The Expanded Operations Alternative could have beneficial impacts on surface water quality due to the installation of new treatment technologies associated with the Radioactive Liquid Waste Treatment Facility Upgrade Project, and the possible elimination of the Radioactive Liquid Waste Treatment Facility discharge to Mortandad Canyon if the auxiliary action to evaporate treated effluents were implemented. Complete DD&D of TA-21 under the Expanded Operations Alternative would eliminate two industrial effluent outfalls, which would have a minor beneficial impact on Los Alamos Canyon. Environmental remediation under all alternatives would have positive impacts on surface water quality; implementation of the MDA Remediation Project under the Expanded Operations Alternative would have additional beneficial impacts on surface water quality due to the potential removal or stabilization of contaminants at the MDAs. Removal of the flood retention structure in Pajarito Canyon under all the alternatives could impact floodplains downstream immediately following removal. None of the alternatives would likely have any other impacts on floodplains.

There would be no changes in the flow of contaminants to the alluvial or regional groundwater as a result of the No Action Alternative, except for that achieved from continuing the environmental remediation program that existed before the Consent Order. Most impacts to groundwater resources identified as occurring under the No Action Alternative would also occur under the Reduced Operations Alternative. Long-term impacts might be reduced by elimination of some of the canyon-outfalls and reduction of water use. Direct and indirect impacts to groundwater as a result of proposed construction and operations under the Expanded Operations Alternative would also be similar to those described for the No Action Alternative. Under the Expanded Operations Alternative, water usage would be greater than the range of LANL's water use over the last 7 years, but within the range of use over the last 14 years. Therefore, impacts to the water levels in the regional aquifer from withdrawals to supply LANL would be within historical levels. The effects of either an MDA Capping or Removal Option under the Expanded Operations Alternative would not appreciably affect the rate of transport of contaminants presently in the vadose zone in the near term, but would likely reduce very long-term migration of contaminants and corresponding impacts on the environment from wastes present in the MDAs.

Air Quality

Nonradiological air pollutant emissions from operations at LANL would continue within the limits of the operating air permit under all the alternatives. Reductions in emissions would occur under the Reduced Operations Alternative from reduced high explosives processing and testing, shutdown of LANSCE and the Pajarito Site (TA-18), and a smaller construction scope. A minor increase in operations emissions could occur under the Expanded Operations Alternative, but emissions would remain within the limits of the operating permit. Increased employment under the Expanded Operations Alternative could result in an increase in air pollutant emissions from additional vehicles of employees commuting from Santa Fe and Rio Arriba County and other locations and waste and materials shipments. Temporary localized increases in air pollutant emissions from construction, DD&D, and remediation activities would occur under all alternatives, but under the Expanded Operations Alternative the emissions would be larger. These activities could result in exceedances of short-term ambient standards for nitrogen oxides and carbon monoxide for some projects where activities are near the site boundary or public roads unless these activities are properly controlled. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements. Development by others of lands conveyed and transferred could result in air quality impacts.

Radiological air emissions from normal operations under the No Action Alternative would be dominated by short-lived gaseous mixed activation products emitted from LANSCE (TA-53). Under the Reduced Operations Alternative, a reduction in the activity levels of some Key Facilities (including the continued use of the Chemistry and Metallurgy Research Building), and the shutdown of LANSCE and the Pajarito Site (TA-18) would greatly reduce the amount of radiological air emissions. Under the Expanded Operations Alternative, some small increases in radiological air emissions compared to the No Action Alternative would result from increased LANL activities and the operation of new facilities. These emissions would be dominated by operations at LANSCE. There could be temporary additions to radiological air emissions if the New Mexico Environment Department selects exhumation as the corrective measure for any of the MDAs.

Noise

Under the No Action Alternative, noise impacts from operations at LANL would be similar to the impacts from recent operations, including noise from explosives testing and traffic. Construction, DD&D, and remediation activities would result in a minor increase in offsite noise impacts to the public from equipment use and traffic under the No Action and Reduced Operations Alternatives. Under the Reduced Operations Alternative, however, a minor reduction in explosives testing noise would occur, as well as a minor decrease in construction and DD&D noise impacts compared to the No Action Alternative. Under the Expanded Operations Alternative, minor to moderate increases in traffic noise could occur from changes in traffic patterns due to increased construction, MDA remediation, DD&D activities, and increased employment at LANL. In addition, increased equipment-related noise impacts would occur from additional construction, DD&D, and MDA remediation activities. Activities near the site boundary or increases in truck traffic noise under various MDA remediation options could result in some public annoyance. Development by others of lands conveyed and transferred could also result in noise impacts.

Ecological Resources

Under the No Action Alternative, a number of actions would result in impacts on ecological resources. For example, conveyance of land to the county could result in the loss of 770 acres (312 hectares) of habitat through possible future development. Therefore, impacts such as loss and displacement of wildlife would take place. The Wildfire Hazard Reduction Program would have short-term adverse impacts on wildlife due to activities such as tree trimming, but would produce long-term benefits from returning the forest to a condition similar to that which existed in the past. Increased forest health could also benefit the Mexican spotted owl at LANL and across the region. Impacts from the Reduced Operations Alternative generally would be similar to the No Action Alternative.

Under the Expanded Operations Alternative, however, impacts on ecological resources would be larger than those of the No Action Alternative. A number of projects could impact habitat and wildlife. Those impacts mostly would be temporary disturbances during construction and demolition; however, if all of the proposed projects were implemented, up to about 170 acres (69 hectares) of habitat would be lost; borrow pit expansion, if required, would disturb some additional acreage. Most habitat loss would be associated with the Security-Driven

Transportation Modifications Project (30 acres [12 hectares] and its two auxiliary actions (91 acres [37 hectares]). Temporary disturbances to habitat and displacement of wildlife could occur from environmental remediation under all alternatives; however, because material disposal areas are mostly grassy, open areas, temporary habitat disturbances associated with the MDA Remediation Project under the Expanded Operations Alternative would be mostly associated with remediation support activities such as operation of temporary storage areas for capping materials. Withdrawal of crushed tuff from the TA-61 borrow pit to support MDA remediation may cause loss of habitat at the borrow pit for the Mexican spotted owl; Section 7 consultation with the U.S. Fish and Wildlife Service would be required.

Impacts to the Mexican spotted owl, bald eagle, and southwestern willow flycatcher were evaluated in a biological assessment prepared by DOE (LANL 2006b). This biological assessment determined that activities associated with many projects may affect, but were not likely to adversely affect, these species. Regarding the Security-Driven Transportation Modifications Project, the U.S. Fish and Wildlife Service determined that provided that reasonable and prudent measures are taken, construction of a span bridge over Ten Site Canyon would not result in adverse affects to the Mexican spotted owl. Further consultation would be needed, however, if a land bridge was to be used. A determination of potential impacts from construction of the auxiliary action bridges associated with the Security-Driven Transportation Modifications Project could not be made because bridge locations and final designs were not known. Thus, further consultation with the U.S. Fish and Wildlife Service would be required prior to bridge construction. Depending on where the TRU Waste Facility would be located, consultation could be required prior to building this facility since construction could affect both core and buffer habitat of the Mexican spotted owl.

Human Health

None of the alternatives would result in an increase in latent cancer fatalities (LCFs) in the population; and all doses estimated for the maximally exposed individual (MEI), a hypothetical individual located at the site boundary, would meet the regulatory limit of 10 millirem per year (40 CFR 61.92). Under the No Action Alternative, radiological air emissions from LANSCE (TA-53) would be responsible for over 70 percent of the estimated population dose of 30 person-rem per year; emissions from the firing sites (TA-15 and TA-36) would contribute approximately 20 percent. Under the No Action Alternative, the dose to the MEI would be about 7.8 millirem per year, with 7.5 millirem attributable to emissions from LANSCE.[5] Under the Reduced Operations Alternative, estimated annual doses to the population and the MEI would be reduced by approximately 80 percent and 90 percent, respectively, compared to the No Action Alternative. This reduction would largely be due to the shutdown of LANSCE, along with minor reductions from termination of operations at the Pajarito Site, lower levels of high explosives processing and testing, and continued use of the Chemistry and Metallurgy Research Building. Under the Expanded Operations Alternative, there would be small increases in emissions from the Plutonium Facility Complex from increased pit manufacturing activity and reduced emissions from the Pajarito Site and TA-21, which would result in slight increases in the estimated doses to

[5] *Administrative controls established at LANSCE to regulate beam operations as emissions levels increase require operational changes to prevent the generation of excessive radioactive air emissions, so that the maximum dose to the LANL site-wide MEI from air emissions at LANSCE is 7.5 millirem per year or less.*

the public and the MEI from routine operations compared to the No Action Alternative. In addition, there could be temporary increases in offsite doses if the Removal Option were implemented for MDA cleanup. The annual population dose could increase by about 20 percent to approximately 36 person-rem per year, and the MEI dose could increase by about 5 percent to approximately 8.2 millirem per year.

On an individual worker basis, impacts to worker health would be the same across all alternatives. Application of procedures designed to ensure safe worker environments would control exposure to radiation, chemicals, and biohazardous material. Individual radiation doses would be maintained below the DOE limit of 5 rem per year, with a goal of limiting the dose to 2 rem per year from external exposure. Under normal operating conditions, no adverse effects from chemical or biological exposures would be expected.

The collective dose for workers would be about 280 person-rem per year under the No Action Alternative. Under the Reduced Operations Alternative, the dose would drop to 257 person-rem annually due to the cessation of TA-18 activities and the shutdown of LANSCE. Under the Expanded Operations Alternative, collective doses would differ depending on the actions taken to remediate the MDAs. If the MDA Capping Option were implemented, the collective dose would be about 407 person-rem per year. This increase in dose over the No Action Alternative is primarily associated with manufacturing up to 80 pits per year at the Plutonium Facility Complex. If the MDA Removal Option were implemented, waste in the MDAs would be removed rather than capped in place. In this case, the collective dose would be about 543 person-rem annually. The average annual dose to the worker population contributed by the MDA Remediation Project alone would range from about 1 (MDA capping) to 137 (MDA removal) person-rem.

Cultural Resources

Under the No Action Alternative, potential impacts to cultural resources include conveyance or transfer of lands containing cultural resources from DOE. Further, there is potential for damage to these resources from development and for adverse effects on historic buildings from demolition and remodeling. From a positive standpoint, the Trails Management Program could enhance cultural resource protection by limiting public access to certain trails or trail segments. Documentation could be required to resolve possible adverse effects from demolishing and remodeling historic buildings involved in high explosives processing and testing. Impacts from the Reduced Operations Alternative generally would be similar to those described for the No Action Alternative.

Under the Expanded Operations Alternative, many impacts would also be similar to those that would occur under the No Action Alternative. In general, individual projects would have a minimal potential for impacting archaeological resources because most projects would not be located in the immediate area of archaeological sites; however, the proposed TRU Waste Facility has the potential to directly impact archaeological resources depending on its location, which has yet to be determined. Potentially affected resources would be protected by LANL requirements for protecting sensitive areas. Additionally, the implementation of LANL requirements would ensure that any proposed demolition or modification of existing historic buildings and structures would be in keeping with *A Plan for the Management of Cultural Heritage at Los Alamos*

National Laboratory, New Mexico (LANL 2006f). If the auxiliary actions to build bridges across canyons as part of the Security-Driven Transportation Modifications Project were implemented, certain traditional cultural properties could be adversely affected. Also, the proposed TRU Waste Facility has the potential to impact the view from traditional cultural properties if constructed within certain locations of the Pajarito Road corridor. Removal of the domes from Area G of TA-54 as part of the Waste Management Facilities Transition Project, however, would have a positive effect on views from Pueblo of San Ildefonso lands.

Possible impacts to cultural resources from environmental restoration would be reviewed for all potential release sites and protective measures taken as needed. There would be no direct impacts to cultural resources from either capping or removing material disposal areas under the Expanded Operations Alternative. Any temporary support areas needed for MDA remediation would be located and operated to be protective of cultural resources.

Socioeconomics

Under the No Action Alternative, no change in the socioeconomic impacts on the region from those currently being observed would be expected. As a major employer, LANL provides large socioeconomic contributions to the region. Impacts from the Reduced Operations Alternative would be similar to those associated with the No Action Alternative. Under the Reduced Operations Alternative, however, direct employment at LANL would be expected to decrease by about 3.7 percent (500 jobs) due to the closure of LANSCE, the reduction in high explosives processing and testing, and the cessation of TA-18 activities. This decrease in LANL employment would also be expected to indirectly result in additional job losses in the region. The combined loss of employment due to both direct and indirect job losses would be approximately 1,030 positions, but these losses are not expected to have a major adverse impact on the regional economy because the losses would be small in comparison to the total employment base for the region (less than 1 percent).

Under the Expanded Operations Alternative, jobs would be added at LANL to support the increased workload. It is projected that, compared to the 2005 level, up to 600 jobs by 2007 and 1,890 jobs by 2011 would be added at LANL, in addition to 640 indirect jobs by 2007 and 2,000 indirect jobs by 2011. Although the addition of these positions would be beneficial from an economic standpoint, the influx of workers would place demands on the regional infrastructure in terms of additional housing needs, schools, and community services. There is currently a housing shortage in Los Alamos County, although the county is planning for additional housing that could allow more employees to live within its borders. Rio Arriba and Santa Fe counties also would be expected to grow as a result of LANL employment increases. Considering that LANL positions are some of the highest paying positions in the region, the benefits associated with these positions in terms of increased revenues and taxes should more than offset any drawbacks. This is especially true in light of regional growth projections that show the region growing at a rate in line with LANL's projected growth rate under the Expanded Operations Alternative.

Infrastructure

Utility infrastructure demands for electricity, natural gas, and water are projected to increase in the LANL region of influence through 2011 regardless of the alternative selected in this SWEIS, mainly due to increasing demands among other Los Alamos County users who rely upon the same utility systems as LANL. Total projected utility infrastructure requirements are summarized for LANL operations and for other Los Alamos County users in Table 3–19. Under the No Action Alternative, the total energy and peak load requirements would be about 49 percent and 74 percent, respectively, of the capacity of the power pool serving the Los Alamos area. Natural gas requirements and water requirements respectively would be about 27 percent and 90 percent of system capacity. For the Reduced and Expanded Operations Alternatives, respectively, projected electricity requirements would be about 39 and 63 percent of capacity, peak load demand would be about 54 percent and 96 percent of capacity, natural gas requirements would be about 27 percent and 29 percent of capacity, and water requirements would be about 85 percent and 98 percent of capacity. Projections for natural gas demand show less variation across the alternatives because the demand is controlled mainly by space heating requirements, which are affected less than other utilities by operational levels. LANSCE operations have a major effect on LANL's demand for water and electricity. LANSCE has historically accounted for as much as 25 percent of total water demand and 50 percent of electrical demand at LANL.

Under the Expanded Operations Alternative, peak load demand would approach the capacity of the Los Alamos Power Pool. Similarly, the water demand under the Expanded Operations Alternative could approach the Los Alamos Water Supply System's available water rights. This potential exists because of the projected infrastructure requirements for increased operations at LANL and the forecasted demands of other non-LANL users in Los Alamos County. Completion of a new transmission line and other upgrades, however, would reduce any concerns about peak load capacity. Also there are plans to install a second new combustion turbine generator at the TA-3 Co-Generation Complex, if needed. The second generator would add an additional 20 megawatts (175,200 megawatt-hours) of generating capacity. As for future water needs, Los Alamos County, as owner and operator of the Los Alamos Water Supply System, is currently pursuing use of the San Juan-Chama Transmountain Diversion Project to secure additional water for its customers, including LANL. This would supply the Los Alamos area with up to an additional 391 million gallons (1,500 million liters) of water per year, an increase in capacity of approximately 20 percent.

Waste Management

Under the No Action Alternative, waste management impacts from LANL operations would remain within the capacity of LANL's infrastructure. Most wastes, with the exception of low-level radioactive waste, would be disposed of offsite at facilities designed for specific categories of wastes. The expansion into TA-54, Area G, Zones 4 and 6, as necessary, would provide onsite disposal capacity for low-level radioactive waste from operations through 2016 and beyond. Due to the uncertainties of predicting environmental remediation wastes, variances from projections are likely in future years. The waste management infrastructure at LANL would be adequate, in terms of staffing and facilities, to manage the quantities of waste expected to be generated under the No Action Alternative.

Under the Reduced Operations Alternative, waste management impacts from LANL operations would be similar to those under the No Action Alternative, with some reductions in waste quantities from operations due to the closure of LANSCE and the Pajarito Site, reduced operational levels at the high explosives facilities, and a smaller construction scope. Although some reductions in operational waste volumes are expected, continued generation of low-level radioactive waste would be expected to result in the expansion of future disposal operations into Zone 4. Wastes generated by environmental restoration and DD&D activities would be expected to be the same as those generated under the No Action Alternative. The LANL waste management infrastructure would be capable of managing the projected quantities.

The Expanded Operations Alternative includes implementing a large number of projects involving major construction and DD&D, as well as increases in operation levels at a number of Key Facilities, so larger volumes of all waste types would be generated than under the other alternatives. Retrieval and processing of transuranic waste stored below grade in Area G of TA-54 would also generate additional volumes of transuranic and low-level radioactive waste. To accommodate the processing and storage of legacy and newly generated transuranic waste from LANL operations, NNSA is proposing to install and operate additional waste management equipment and facilities, and upgrade existing processes, as identified in Appendix H, Section H.3.

Full implementation of the MDA Removal Option is conservatively estimated to generate about 1.1 million cubic yards (840,000 cubic meters) of low-level radioactive waste and 22,000 cubic yards (17,000 cubic meters) of transuranic waste, most of which DOE buried before 1970. Final waste volumes may be smaller than the maximum volumes analyzed in this SWEIS because waste generation is dependent on future regulatory decisions by the New Mexico Environment Department. In addition, the estimates are based on the volume of waste as excavated (including soil) and the removal of all major MDAs; no credit has been taken for waste volume reduction techniques such as sorting.

Onsite disposal capacity for low-level radioactive wastes may be sufficient, depending upon the actual volumes generated by remediation; disposal capacity would be supplemented by offsite facilities if needed. The transportation analysis includes the impacts of shipping all low-level radioactive waste offsite. In this SWEIS, it is assumed that the transuranic waste would be disposed of at WIPP. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste plus all transuranic waste buried before 1970 across the DOE complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs, if generated, would be based on the needs of the entire DOE complex. Any transuranic waste that may be generated at LANL without a disposal pathway would be safely stored until disposal capacity becomes available.

Transportation

Under all alternatives, radioactive, hazardous, and commercial materials would be transported onsite and to and from various offsite locations. The evaluation of impacts in this SWEIS focuses on repeated shipments of materials to and from offsite locations. The specific locations analyzed were the Pantex Plant in Texas, the Y-12 Complex and Oak Ridge National Laboratory in Tennessee, the Lawrence Livermore National Laboratory in California, the Nevada Test Site in Nevada, and the Savannah River Site in South Carolina for transport of special nuclear material (such as plutonium, highly enriched uranium [mainly uranium-235], and uranium-233); WIPP in New Mexico for the transport of transuranic wastes; the Nevada Test Site and a commercial disposal site for low-level radioactive wastes; and multiple locations for disposal of hazardous and nonhazardous waste materials.

It is unlikely that transportation of radioactive materials under any of the alternatives would cause a fatality as a result of radiation either from incident-free operations or postulated accidents. The highest risks to the public would result from the Expanded Operations Alternative if all of the large MDAs were exhumed under the MDA Remediation Project and the Nevada Test Site was the main option for disposal of low-level radioactive waste. This alternative could result in about 122,440 shipments of radioactive materials (both special nuclear material and radioactive waste). It is estimated that there could be about three fatalities from nonradiological traffic accidents associated with the transportation activities required to implement this alternative.

All trucks carrying radioactive materials to or from LANL would travel the section of road from LANL to Pojoaque; many of these trucks would also travel the section of road from Pojoaque to Santa Fe. The radiological risks to the population along these two sections of road are very small under all alternatives. The nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) are greater than the radiological risks; however, even under the scenario involving the largest amount of transportation, the Expanded Operations Alternative with the MDA Removal Option, no fatalities would be expected along these routes.

Local traffic flows would be expected to remain at current levels under the No Action Alternative because employment would stay at current levels. Under the Reduced Operations Alternative, traffic through LANL would decline by about 4 percent, mainly as a result of the projected decrease in employment. Under the Expanded Operations Alternative, traffic would be expected to increase by up to 18 percent (averaged across all LANL entrances) due to the projected increases in employment and construction, DD&D, and remediation activities. Transportation of waste and fill material by truck for DD&D and MDA remediation could accelerate wear on local roads and exacerbate traffic problems.

Environmental Justice

Executive Order 12898 (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*) requires every Federal agency to analyze whether its Proposed Actions and alternatives would have disproportionately high and adverse impacts on minority or low-income populations. Based on the analysis of impacts for other resource areas, NNSA expects no high and adverse impacts from the continued operation of LANL under any of the alternatives. For all alternatives the radiological dose from emissions associated with normal operations are slightly lower for members of Hispanic, Native American, total minority, and low-income populations than for the members of the population that are not in these groups. The maximum annual dose for the average member of any of the minority or low-income populations was 0.092 millirem compared to a dose of 0.10 millirem for a member of the general population and a dose of 0.11 millirem for a member of the population that does not belong to a minority or low-income group.

NNSA also analyzed human health impacts from exposure through special pathways, including subsistence consumption of native vegetation (pinyon nuts and Indian Tea [Cota]), locally grown produce and farm products, groundwater, surface waters, fish (game and nongame), game animals, other foodstuffs, and incidental consumption of soils and sediments (on produce, in surface water, and ingestion of inhaled dust). The special pathways could be important to the environmental justice analysis because some of these pathways may be more important or viable for the traditional or cultural practices of members of minority populations in the area. Analyses, however, show that the human health impacts associated with these special pathways would not present disproportionately high and adverse impacts on minority or low-income populations.

Facility Accidents

There is little difference among the alternatives for the maximum potential wildfire, seismic, or facility accident at LANL because actions under each alternative do not, for the most part, affect the location, frequency, scenario, or material at risk of the postulated accidents. Facility accident impacts are presented in terms of consequences and risks. Reported consequences assume that the accident occurs and do not account for how probable the accident is. The risk associated with an accident reflects the probability of the accident occurring; it is calculated by multiplying the consequences times the probability of occurrence.

In 2000, the Cerro Grande Fire burned a heavily forested canyon area to within about 0.75 miles (1.2 kilometers) of the waste storage domes in TA-54, but none were burned and there were no radiological releases from domes. Additional fuel reduction has been conducted since the Cerro Grande Fire, both to the vegetation surrounding the TA-54 area and within the domes themselves (for example, wooden pallets have been replaced with metal pallets), to further decrease the potential for a waste storage dome fire occurring as a result of a site wildfire. In the event of a wildfire that impacted LANL, burned the waste storage domes at TA-54, and caused their contents to be released to the environment, the radiological releases from those waste storage domes would dominate the potential impacts to LANL workers and to the public from the fire. Should such an accident scenario occur in which the contents of the waste storage domes actually caught on fire and burned, the MEI would likely develop a fatal cancer during his or her lifetime and an additional 55 LCFs could be expected in the general area population. Any onsite worker located within 110 yards (100 meters) of the facility during such an accident would likely develop a fatal cancer during his or her lifetime. Taking into account the probability of occurrence, the annual risks are estimated to be about 1 chance in 20 of an LCF for the MEI or for an onsite worker and an additional 3 (calculated value of 2.7) LCFs in the offsite population. These risks assume that workers and members of the public do not take evasive action in the event of a wildfire. It is likely that workers and members of the public would be evacuated, as happened during the Cerro Grande Fire. These risks would decrease as transuranic waste is removed from the domes and transported to WIPP for disposal. In terms of chemical risks from a wildfire, the accidental release of formaldehyde from the Bioscience Facilities in TA-43 would expose the public and noninvolved workers to the greatest risks, similar to those associated with a seismic event, as discussed below.

The seismic event that presents the largest risk to the public would be a postulated Performance Category 3 earthquake (Seismic 2 scenario). If this accident were to occur, there would be widespread damage at LANL and across the region resulting in a large number of fatalities and injuries unrelated to LANL operations. Facilities at LANL would be affected and the public and workers at the site would be exposed to increased risks from both radiological and chemical releases. The consequences of such a seismic accident would be an increased lifetime risk of an LCF of 0.55 (1 chance in 1.8) for the MEI and an additional 22 LCFs could be expected in the population; a noninvolved worker 110 feet (100 meters) from certain failed buildings would likely develop an LCF.

The seismic accident scenarios (Seismic 1 and 2) analyzed in the SWEIS are based on the *Seismic Hazards Evaluation of the Los Alamos National Laboratory (February 24, 1995)*. The 1995 study concluded that a seismic event characterized by a peak horizontal ground acceleration of 0.22g (0.22 times the acceleration due to gravity) had an estimated annual probability of exceedance (probability of occurrence when calculating risk) of 0.001 (1 in 1,000). The study also showed that the more severe seismic event characterized by a peak ground acceleration of 0.31g had an estimated annual probability of exceedance of 0.0005 (1 in 2,000). An updated probabilistic seismic hazard analysis that provides an improved understanding of the seismic characteristics of LANL was completed in 2007 (LANL 2007a). The new study indicates that the seismic hazard is higher than previously understood; that is, the likelihood of earthquakes capable of producing strong ground shaking at the LANL site is greater than previously estimated. For example, the annual probabilities of exceedance for the previously analyzed peak ground accelerations are now estimated to be about 1 in 700 rather than 1 in 1,000 and 1 in 1,250 rather than 1 in 2,000. Using the assumptions inherent in the accident source terms developed for the SWEIS Seismic 1 (Performance Category 2 earthquake) and Seismic 2 (Performance Category 3 earthquake) accident scenarios, the most conservative effect on accident risks would be an increase of 50 percent and 60 percent, respectively. Although the greater probability of exceedance results in a higher risk from seismic events, these risks remain lower than those associated with other postulated accidents.

Taking into account the probability of occurrence, the annual risks from a Seismic 2 accident are estimated to be an increase of 1 chance in 2,200 of the MEI developing an LCF and no additional LCFs (a calculated risk much less than 1) in the offsite population. The largest chemical risk from such an event would result from a formaldehyde release from the Biosciences Facilities in TA-43, leading to life-threatening concentrations at the locations of the noninvolved worker and the MEI. The seismic event that presents the largest risk to a noninvolved worker is the Seismic 1 accident (a Performance Category 2 earthquake) with a frequency of once every 700 years. The annual increased risk of a LCF to the noninvolved worker would be about 0.0015 or 1 in 700.

Just as the updated probabilistic seismic hazards analysis used new data and advanced methods to calculate LANL seismic hazards, revised structural analysis tied to damage states credited in the safety assessments will be used to update the seismic structural integrity evaluation of LANL facilities. The effect of the higher values of peak horizontal ground acceleration on calculated seismic accident consequences and risks will be analyzed in future LANL facility safety analyses and incorporated as appropriate into future LANL NEPA documents. NNSA and the LANL contractor will undertake an evaluation of LANL facility performance in terms of the updated seismic hazard information. Until a revised analysis is completed, facility operations are authorized based on NNSA approval of a contractor-prepared justification for continued operation.

Under all alternatives, the facility accident with the highest radiological risk to the offsite population would be a lightning strike fire at the Radioassay and Nondestructive Testing Facility. If this accident were to occur, there could be six additional LCFs in the offsite population. Under the Expanded Operations Alternative, if the Chemistry and Metallurgy Research Building fire involving sealed sources were to occur, the consequence to the offsite population would be greater (seven LCFs) than that of the Radioassay and Nondestructive Testing Facility lightning strike fire; however, the estimated frequency is much less. Also, the consequences of that accident are based on a conservative assumption that the entire inventory of radiological material allowed in the Chemistry and Metallurgy Research Building is dedicated to a single isotope contained in sealed sources.

Under all alternatives, the individual facility accident with the highest estimated consequences to the MEI and noninvolved workers would be a fire at a waste storage dome in TA-54. If this accident were to occur as modeled, the noninvolved worker and the MEI would receive large radiation doses. Depending on the specific radionuclides released and the route of human exposure, radiation doses of this magnitude would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual, mitigating health impacts, or both. In addition to the conservative assumptions used to develop the source term (amount of radioactive material released) for this accident, the calculated doses are based on the assumptions that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs.

Taking into account the frequency of the postulated accidents, the estimated highest risk accident would be a lightning strike fire at the Radioassay and Nondestructive Testing Facility. The relatively large risk of the accident is due to the conservative assumption that any lightning strike at the Radioassay and Nondestructive Testing Facility has sufficient energy and occurs at a location that results in a building fire and concomitant source term. The increased risk of an LCF for this accident would be 0.06 (about 1 chance in 16) for the MEI, 0.12 (about 1 chance in 8) for the noninvolved worker,[6] and 0.8 for the offsite population (a risk of 1 LCF occurring in the population over approximately 1.3 years of operation).

For chemical accident risks, the individual facility accident with the largest risk to the public is a selenium hexafluoride release from TA-54. There is an annual risk of about 1 chance in 240 that members of the public could receive life-threatening exposures from this accident. For a chlorine gas release outside of TA-55, there is an annual risk of about 1 chance in 15 that noninvolved workers could receive a life-threatening exposure to this chemical from this accident. There is a great deal of uncertainty regarding how much and which chemicals were disposed of in the MDAs. The MDA closest to the public (and thus with the potentially greatest impacts on the public), MDA B, was chosen to bound the chemical accident impacts for MDA cleanup. Two chemicals, sulfur dioxide (a gas) and beryllium (assumed to be in powder form), were chosen based on their respective hazards to bound the impacts of chemicals possibly disposed of in the MDAs. Both of these chemicals, if present in the quantities assumed, would dissipate to below life-threatening concentrations very close to the release point, but would continue to present a risk to the public due to the short distance to the nearest public access point for MDA B.

Substantive details of terrorist attack scenarios and security countermeasures are not released to the public because disclosure of this information could be exploited by terrorists to plan attacks. Depending on the malevolent, terrorist, or intentionally destructive acts, impacts may be similar to or would exceed bounding accident impact analyses prepared for the SWEIS. A separate classified appendix to this Final SWEIS has been prepared that evaluates the underlying facility threat assumptions with regard to malevolent, terrorist, or intentionally destructive acts. These data provide NNSA with information upon which to base, in part, decisions supported by this SWEIS.

[6] *The lightning strike fire at the Waste Characterization, Reduction, and Repackaging Facility has a slightly higher risk for the noninvolved worker; an increased risk of an LCF of 0.14 (1 chance in 7) per year.*

Table 3–19 Summary of Environmental Consequences by Resource Area

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Land Use			
	Land Conveyance and Transfer - The remaining 1,820 acres (737 hectares) of the 4,078 acres (1,650 hectares) of land identified per Public Law 105-119 would be conveyed or transferred. - Development may occur on up to 826 acres (334 hectares). - Potential introduction of incompatible land uses. - Loss of recreational opportunities. *Electrical Power System Upgrades* - 473 acres (191 hectares) affected by upgrades. - Project generally compatible with existing land use.	Same as No Action Alternative.	Same as No Action Alternative, plus: *MDA Remediation Project* - Fewer restrictions on land use for Removal Option than for the Capping Option. - No major changes in land use designations in most cases because surrounding land uses would retain their current classification. *Security-Driven Transportation Modifications Project* - Most development would not conflict with current land use designations. - Auxiliary Action A - Within scope of current land use plans. - Auxiliary Action B - Partially within scope of current land use plans. Current plans, however, contain no provision for a bridge over Sandia Canyon. *Replacement Office Buildings Project* - 13 acres (5.3 hectares) of undeveloped land in TA-3 would be developed consistent with a change in future land use from Reserve to Physical/Technical Support. *TA-18 Closure Project* - Possible change in land use designation of TA-18 to Reserve after DD&D of the Pajarito Site. *TA-21 Structure DD&D Project* - Future LANL development could negate the proposed change in land use from the current designation to Reserve. *Radiological Sciences Institute Project* - 12.6 acres (5.1 hectares) of undeveloped land at or near TA-48 would be developed consistent with land use plans. *RLWTF Upgrade Project* - Up to 4 acres (1.6 hectares) of undeveloped land near the border of TA-5 and TA-52 could be developed for evaporation tanks. *Science Complex Project* - 5 acres (2 hectares) of undeveloped land at or near TA-62 would be developed; 15.6 acres (6.3 hectares) could undergo a change in land use plans to Experimental Science.

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative (Preferred Alternative)
			Remote Warehouse and Truck Inspection Station Project - 4 acres (1.6 hectares) of undeveloped land in TA-72 would be developed with a change in land use plans to Physical/Technical Support. *Waste Management Facilities Transition Project* - Up to 7 acres (2.8 hectares) of undeveloped land could be disturbed that could result in a change in land use designation.
Visual Environment			
	Land Conveyance and Transfer - Development could degrade views of presently undeveloped tracts. *Electrical Power System Upgrades* - Short-term visual impacts during construction. - Adverse visual impact in undisturbed areas. - No overall change in view from Bandelier National Monument. *Wildfire Hazard Reduction Program* - Forest would appear more park-like. - Some LANL facilities would be more visible. *Disposition of Flood Retention Structures* - Temporary impacts during removal if staging areas are located near Pajarito Road. Temporary impacts during construction of the CMRR Facility at TA-55. Temporary impacts during construction of replacement or new buildings and long-term enhancement of visual environment from removal of old buildings for the following projects: - High Explosives Processing Facilities, and - High Explosives Testing Facilities.	Same as No Action Alternative.	Same as No Action Alternative, plus: *MDA Remediation Project* - Temporary visual impacts during MDA capping or removal. - Borrow pit in TA-61 would become more visible due to the large quantities of material needed under both options. *Security-Driven Transportation Modifications Project* - Temporary impacts during construction. - Pronounced impacts due to parking lots, as well as vehicle and pedestrian bridges, especially for auxiliary actions involving bridges across canyons. *Physical Science Research Complex* - Temporary impacts during construction. - New structures would blend with other TA-3 construction. - Appearance of TA-3, TA-35, and TA-53 would improve with demolition of vacated structures. *Replacement Office Buildings Project* - Temporary impacts during construction. - New buildings and parking lot would be visible from West Jemez Road and Pajarito Road. *TA-18 Closure Project* - Temporary impact from demolition of Pajarito Site facilities at TA-18. - Long-term enhancement of visual environment as area is restored to more natural appearance. *TA-21 Structure DD&D Project* - Enhancement of visual environment from the removal of old structures from TA. Both conveyed and nonconveyed lands could undergo development which could change visual environment.

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative (Preferred Alternative)***
			Radiological Sciences Institute Project - Temporary impacts during demolition and construction. *RLWTF Upgrade Project* - Short-term impact from construction of new treatment building in TA-50. - Permanent change to the visual environment if evaporation tanks are built near the border of TA-5 and TA-52. *Waste Management Facilities Transition Project* - Beneficial impact on near and distant views from removal of domes in TA-54. - Minimal visual impact of the TRU Waste Facility to the public; possible impact on views from San Ildefonso Pueblo lands, depending on its location. - Temporary impacts during construction of structures at TA-54 and another location in the Pajarito Road corridor. *Science Complex Project* - Under Options 1 and 2, the new facility would be readily visible from West Jemez Road and forested buffer between LANL and Los Alamos Canyon would be lost; potential impacts to Los Alamos Canyon from night lighting. - Negligible impacts for Option 3. *Remote Warehouse and Truck Inspection Station Project* - 4 acres (1.6 hectares) would be cleared making the site readily visible from East Jemez Road; lighting could be visible from Tsankawi Unit of Bandelier National Monument.
Geology and Soils			
	Overall level of legacy contamination in soil should continue to decrease as a result of ongoing remediation projects including cleanup of suspected contamination at TA-21.	Same as No Action Alternative, except that the potential impact of LANL operations on soil could decrease because of the 20 percent reduction in high explosives testing activities.	Same as No Action Alternative, except: *MDA Remediation Project* - Use of large amounts of soil and rock for backfill or closure caps (up to 2.5 million cubic yards) (1.9 million cubic meters). - Positive impact from removal or containment of legacy waste. - TA-61 borrow pit would be expanded to provide additional soil and rock; other sources may be required. Temporary adverse impacts from excavation of large amounts of rock and soil during construction and DD&D, and positive impacts from removal of legacy contamination for the following projects: - *Physical Science Research Complex,* - *Replacement Office Buildings,* - *TA-18 Closure,*

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
			- TA-21 Structure DD&D, *- Radiological Sciences Institute* *- RLWTF Upgrade,* *- Waste Management Facilities Transition,* *- TA-55 Radiography Facility,* *- Science Complex,* *- Remote Warehouse and Truck Inspection Station, and* *- Security-Driven Transportation Modifications.*
Water Resources – Surface Water			
	Only minor impact on surface water quality or quantity, or floodplains from activities other than the project to remove flood retention structures. Removal of flood retention structures could result in potential impacts on Pajarito floodplains. Restoration of normal flow would cause sediments to alter channel and readjust floodplains.	Same as No Action Alternative, except shutdown of LANSCE operations would result in significant reductions of NPDES-permitted cooling tower discharges, particularly to Los Alamos Canyon.	Same as No Action Alternative, and: Potentially long-term positive impact from MDA remediation because water quality would be protected by removal or stabilization of waste or contaminants in soil. DD&D of TA-18 structures would eliminate potential contaminant sources, thereby enhancing protection of surface water quality. Complete Removal Option for DD&D of TA-21 would eliminate two NPDES-permitted outfalls reducing discharges to Los Alamos Canyon. Although increased pit production would increase RLWTF outfall volumes by 25 percent, this would have a negligible effect on surface water volumes in Mortandad Canyon because other facilities contribute 90 percent of the outfall flow in that canyon. Implementing the zero discharge option at the RLWTF (evaporation tanks) would have a minor effect on surface water volume, but would improve surface water quality by reducing the uptake of historical contaminations in the sediments downstream of that outfall.
Water Resources – Groundwater			
	Construction and DD&D activities are unlikely to affect groundwater resources. Operations-related impacts to groundwater are not likely to be significant in nature.	Same as No Action Alternative, except long-term impacts as a result of operations might be reduced by elimination of additional outfalls and reduction of water use.	Same as No Action Alternative, except impacts from water supply well withdrawals could increase and positive long-term impacts could occur from MDA remediation and the reduced potential for contaminant migration.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Nonradiological Air Quality			
	Minor temporary localized increases in air emissions from construction and demolition activities. Minor increases in air emissions from operations and remediation activities, including operation of new combustion turbine generators.	Same as No Action Alternative, except for reductions in emissions from reduced high explosives processing and testing activities and shutdown of LANSCE and the Pajarito Site (TA-18).	- Higher level of emissions from increased operations and proposed construction, demolition, and remediation including increases in emissions from commuter vehicles, and waste and materials shipments. - Hazardous air pollutants could increase by up to 2.5 percent from the High Explosives Processing Facilities resulting from the increased use of mock explosives. - Temporary construction-type releases of criteria pollutants would occur from MDA remediation, DD&D, and construction of new facilities. - Minor to moderate air quality impacts would result from remediating MDAs, and other PRSs, particularly for MDA removal.
Radiological Air Quality			
Curies per year:			
Tritium [a]	2,400	2,400	2,400 [b]
Americium-241	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6} [c]
Plutonium [d]	0.00082	0.000092	0.00084 [c]
Uranium [e]	0.15	0.12	0.15
Particulate and vapor activation products	30	0.014	30
Gaseous mixed activation products	30,600	100 [f]	30,600 [f]
Mixed Fission Products [g]	1,650	1,650	1,650
Emissions from remediation	Not applicable	Not applicable	Variable [h]

[a] Includes both gaseous and oxide forms of tritium.
[b] Tritium emissions would decrease to 1,850 curies per year after about 2009 following decontamination, decommissioning, and demolition of TA-21.
[c] Americium-241 emissions could increase to 1.1×10^{-5} curies per year and plutonium emissions to 0.00089 curies per year if the Decontamination and Volume Reduction System, the new TRU Waste Facility, and remote-handled transuranic waste retrieval activities operated simultaneously (estimated to occur from 2012 through 2015).
[d] Includes plutonium-238, plutonium-239, and plutonium-240.
[e] Includes uranium-234, uranium-235, and uranium-238.
[f] Gaseous mixed activation products emissions would decrease by 100 curies per year after about 2009 due to the permanent shutdown of TA-18, resulting in zero emissions of gaseous mixed activation products in the Reduced Operations Alternative and 30,500 curies per year in the Expanded Operations Alternative.
[g] Mixed fission products include krypton-85, xenon-131m, xenon-133, and strontium-90.
[h] There would be additional emissions from the remediation of the larger MDAs. These emissions would depend on radionuclides present, whether an MDA is being capped or removed, the number of MDAs being remediated at one time, and whether exhumation occurs under an enclosure (see Appendix I).

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative (Preferred Alternative)***
Noise			
	Operations noise levels would have little impact on the public with the exception of sporadic noise from explosives detonations and traffic noise. Temporary localized increases in noise levels would occur from construction, demolition, and remediation activities that would be expected to have little impact on the public.	Same as No Action Alternative, except minor reductions in noise levels from reduced high explosives testing activities and shutdown of LANSCE and Pajarito Site (TA-18).	Higher noise levels than the No Action Alternative from increased operations, construction, DD&D, and remediation activities. Increase in truck and personal vehicle traffic noise, some of which could occur during nighttime, could result in public annoyance: - Up to a 32 percent increase in traffic along DP Road affecting nearby businesses and residents. - Up to a 13 percent increase in traffic along East Jemez Road affecting residents.
Ecological Resources			
	Land Conveyance and Transfer - 770 acres (312 hectares) of habitat could be lost through development. - Transfer of resource protection responsibility could result in a less rigorous environmental protection review process. *Electrical Power System Upgrades* - Temporary displacement of wildlife due to construction-related activities. - Potentially positive impact by providing perching sites for larger birds. *Wildfire Hazard Reduction Program* - Short-term disturbance of wildlife due to forest thinning activities. - Increased forest health could benefit the Mexican spotted owl and other species. *Disposition of Flood Retention Structures* - Temporary displacement of wildlife due to construction-related activities. - Potentially minor impacts on downstream wetlands *Trails Management Program* - Temporary disturbance of wildlife during implementation activities. Clearing of some ponderosa pine forest in TA-48 and TA-55 for construction of CMRR Facility would cause loss or displacement of associated wildlife.	Same as No Action Alternative, plus: - Reduction in high explosives testing activities would reduce the number of times animals would be subjected to stress resulting from high explosives testing.	Same as No Action Alternative, plus: *MDA Remediation Project* - Short-term disturbance and displacement of wildlife during capping or waste removal. - Loss of habitat at borrow pit in TA-61, including buffer and core habitat for the Mexican spotted owl. Section 7 consultation with the U.S. Fish and Wildlife Service would be required. - Remediation activities may affect, but are not likely to adversely affect the Mexican Spotted Owl, bald eagle, and southwestern willow flycatcher. *Security-Driven Transportation Modifications Project* - Parking lot construction and placement of pedestrian and vehicle bridges would destroy up to 30 acres (12 hectares) of natural habitat. Construction of a span bridge over Ten Site Canyon would be unlikely to adversely affect the Mexican spotted owl. - Auxiliary Action A would disturb up to 25.4 acres (10.6 hectares) of undeveloped core and buffer Mexican spotted owl habitat. Auxiliary Action B would disturb up to 67.1 acres (27.2 hectares) of undeveloped core and buffer habitat. - Under both auxiliary actions, bridge traffic over the core zone of the Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest could cause long-term impacts. Section 7 consultation with the U.S. Fish and Wildlife Service would be needed. *Replacement Office Buildings Project* - Temporary displacement of wildlife due to construction-related activities.

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative (Preferred Alternative)***
	Short-term impacts in TA-6, TA-22, and TA-40 from construction of new High Explosives Test Facility buildings and demolition of old structures would cause loss or displacement of wildlife.		- Clearing 13 acres (5.3 hectares) of mixed conifer forest in TA-3 would result in loss or permanent displacement of wildlife. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. *TA-18 Closure Project* - Minor impact on wildlife during demolition of Pajarito Site structures in TA-18. DD&D activities may affect, but is not likely to adversely affect, the Mexican spotted owl and southwestern willow flycatcher. - Restoration of TA-18 (Pajarito Site) would create a more natural habitat and benefit wildlife, potentially including the Mexican spotted owl. *TA-21 Structure DD&D Project* - Minor disturbance of wildlife on adjacent land during demolition of structures. DD&D activities may affect, but is not likely to adversely affect, the Mexican spotted owl. *Radiological Sciences Institute Project* - Temporary disturbance of wildlife during demolition of structures and construction in TA-48. - Clearing of 12.6 acres (5 hectares) of ponderosa pine forest would cause loss or displacement of associated wildlife. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. - DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl. *RLWTF Upgrade Project* - Loss of up to 5.4 acres (2.2 hectares) of habitat if the evaporation tanks and pipeline are constructed. - Implementation of the evaporation tank option would reduce wetlands and riparian habitat in Mortandad Canyon and the abundance and diversity of Mexican spotted owl prey species, requiring Section 7 consultation with the U.S. Fish and Wildlife Service. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. *Waste Management Facilities Transition Project* - Short-term impacts on wildlife in the vicinity of TA-54 and the TRU Waste Facility site from new construction and demolition activities. - TRU Waste Facility construction could result in the loss of 2.5 to 7 acres (1.0 to 2.8 hectares) of ponderosa pine forest or open field.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
			- Construction at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. - A TRU Waste Facility could be built in portions of the Mexican spotted owl Area of Environmental Interest which would require Section 7 consultation with the U.S. Fish and Wildlife Service.
			Science Complex Project - Temporary displacement of wildlife due to construction-related activities. - Options 1 and 2 would remove 5 acres (2 hectares) of ponderosa pine forest. - Under Option 3, less than 5 acres (2 hectares) of grassland and forest would be cleared. - Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. *Remote Warehouse and Truck Inspection Station Project* - Temporary displacement of wildlife due to construction-related activities. - 4 acres (1.6 hectares) of ponderosa pine forest and pinyon-juniper woodland would be cleared. - Construction may affect, but is not likely to adversely affect, the bald eagle.
Human Health			
Offsite Population Dose (person-rem per year) Risk (LCFs per year)	 30 0.018	 6.1 [i] 0.0037	 Less than 36 [j, k] 0.022
MEI [l] Dose (millirem per year) Risk (LCFs per year)	 7.8 4.7×10^{-6}	 0.78 [i] 4.7×10^{-7}	 Less than 8.2 [j, k] 4.9×10^{-6}
Workers Dose (person-rem per year) Risk (LCFs per year)	 280 0.17	 257 0.15	 407 to 543 [m] 0.24 to 0.33 [m]

[i] After about 2009, TA-18 (Pajarito Site) would no longer be able to contribute to radiological air emissions, thereby reducing the MEI and population doses.

[j] Population dose and MEI dose include 6.2 person-rem and 0.42 millirem respectively, attributable to the assumed removal of all MDAs (LCF risk of 3.7×10^{-3} and 2.5×10^{-7}, respectively). This dose could be smaller depending on the MDAs being remediated, whether an MDA is capped rather than removed, the number of MDAs being remediated at one time, and other factors.

[k] After about 2009, TA-18 (Pajarito Site) and TA-21 would not contribute to radiological air emissions, thereby reducing the MEI and population doses.

[l] Under the No Action Alternative and the Expanded Operations Alternative, the LANL site-wide MEI would be located near LANSCE. Under the Reduced Operations Alternative, the LANL site-wide MEI would be located near the firing sites at TA-36.

[m] The range for the Expanded Operations Alternative reflects the contribution from the two MDA Remediation Project options. The lower value is for the Capping Option, the higher value is for the Removal Option. The annual average worker doses contributed by the MDA Remediation Project alone would range from about 1 (MDA capping) to 137 (MDA removal) person-rem per year (0.0006 to 0.082 LCF per year).

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Cultural Resources			
	Land Conveyance and Transfer - Potential damage to cultural resources and impacts on protection of and accessibility to Native American sacred sites from conveyance or transfer of cultural resources out of the responsibility and protection of DOE. Potential damage on conveyed or transferred parcels due to future development. *Trails Management Program* - Enhanced protection of cultural resources. Potentially adverse effects from demolition and remodeling of historic buildings in High Explosive Processing and Testing Facilities. Documentation would be required to resolve adverse effect.	Same as No Action Alternative.	Same as No Action Alternative plus: *Waste Management Facilities Transition Project* Removal of domes would have a positive impact on views from traditional cultural properties. Potential impact to cultural resources from construction of the TRU Waste Facility. Also, this facility could be visible from lands of the Pueblo of San Ildefonso, depending on its location. *MDA Remediation Project* No direct impacts are expected for either option of the MDA Remediation Project, although the potential for indirect impacts from temporary remediation support activities in the vicinities of the MDAs and PRSs would require review and protective measures taken as needed. To varying degrees, impacts on archaeological sites or historic structures eligible or potentially eligible for listing on the National Register of Historic Places could result from the following projects. These resources would be protected as appropriate and documentation would be developed as required to resolve adverse effects. - *Security-Driven Transportation Modifications,* - *Physical Science Research Complex,* - *Replacement Office Buildings,* - *Radiological Sciences Institute (including the Institute for Nuclear Nonproliferation Science and Technology),* - *RLWTF Upgrade,* - *LANSCE Refurbishment,* - *Waste Management Facilities Transition,* - *TA-55 Radiography Facility,* - *Science Complex* - *Remote Warehouse and Truck Inspection Station.* - *TA-18 Closure Project* - *TA-21 Structure DD&D*

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Socioeconomics			
	LANL Employment		
	2005 levels of employment assumed to remain steady at 13,504 employees.	A decrease of 500 employees from 2005 levels would be expected to result in the loss of 530 indirect jobs in the region (total 1,030 jobs lost).	An employment increase of 2.2 percent per year from 2007 to 2011 would result in an additional 600 to 1,890 employees working at LANL and creation of another 640 to 2,000 indirect jobs. This growth rate is consistent with the projected regional growth rate.
	Housing		
	No new housing units needed specific to changes in LANL employment level.	Additional housing units could become available in the tri-county area as a result of the projected decrease in LANL's employment level. These could be expected to offset the need for additional housing units in the region because the population would still be expected to grow, although at a slower rate (about 1.5 percent versus 2.3 percent).	Additional housing units would be required in the tri-county area due to the projected increase in LANL's employment level along with the projected increase in the region's population. More LANL employees could be expected over time to reside in Rio Arriba, Santa Fe, or other surrounding counties, compared to Los Alamos County, where a shortage of available housing would likely continue. The number of housing units needed would depend on the number of workers relocating from outside the area. Overall, the number of units needed would likely be small compared to overall needs in the tri-county area.
	Construction		
	Completion of previously approved construction projects is expected to draw workers already in the region who historically work from job-to-job.	Same as the No Action Alternative for construction projects.	An increase in the number of construction projects would be expected to draw workers already in the region who historically work from job-to-job.
	Local Government Finance		
	Annual gross receipts tax yields would be expected to remain at current levels in real terms.	Annual gross receipts tax yields directly and indirectly associated with LANL employment could decrease by about 1.1 percent.	Annual gross receipts tax yields directly and indirectly associated with LANL employment are projected to increase by between 1.3 and 3.9 percent from 2007 through 2011 over 2005 levels in real terms.
	Services		
	The demand for services such as police, fire, and hospital beds would be expected to remain at current levels in proportion to LANL employment. Regional population is projected to increase even if LANL employment remains flat, so there would be an increase in the demand for regional services but the increased demand would not be driven by LANL employment growth.	Demand for services would be expected to decrease in proportion to the number of out-of-work LANL-related employees leaving the region. However, regional population would still be projected to increase even if LANL employment was to decrease by the small levels envisioned in this alternative compared to the No Action Alternative. Demand for services would likely increase as well.	Demand for services would be expected to increase in proportion to the number of additional LANL-related jobs added to the region. The associated number of additional school age children would be between 440 and 1,400 in the tri-county area, resulting in an estimated increase in needed public school funding from the State of $3.2 million in 2007 to $11 million in 2011. Most of the additional services would be required in Rio Arriba, Santa Fe, and other surrounding counties.

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative (Preferred Alternative)***
Site Infrastructure			
LANL Site and Other Los Alamos County Users Total Per Alternative (annual)	Electricity requirements: 645,000 megawatt-hours total (495,000 megawatt-hours for LANL); 49 percent of system capacity.	Electricity Requirements: 516,000 megawatt-hours total (366,000 megawatt-hours for LANL); 39 percent of system capacity.	Electricity Requirements: 827,000 megawatt-hours total (677,000 megawatt-hours for LANL); 63 percent of system capacity.
	Electric Peak Load: 111 megawatts total (91.2 megawatts for LANL); 74 percent of system capacity.	Electric Peak Load: 80.6 megawatts total (60.4 megawatts for LANL); 54 percent of system capacity.	Electric Peak Load: 144 megawatts total (124 megawatts for LANL); 96 percent of system capacity.
	Natural Gas Demand: 2,215,000 decatherms total (1,197,000 decatherms for LANL); 27 percent of system contract capacity supply.	Natural Gas Demand: 2,181,000 decatherms total (1,163,000 decatherms for LANL); 27 percent of system contract supply capacity.	Natural Gas Demand: 2,331,000 decatherms total (1,313,000 decatherms for LANL); 29 percent of system contract supply capacity.
	Water Demand: 1,621 million gallons total (380 million gallons for LANL); 90 percent of system available water rights.	Water Demand: 1,544 million gallons total (303 million gallons for LANL); 85 percent of system available water rights.	Water Demand: 1,763 million gallons total (522 million gallons for LANL); 98 percent of system available water rights.
	Project Effects: - Ongoing electrical power system upgrades would have a positive incremental impact onsite electrical energy and peak load capacity. - Potential for increased natural gas consumption from increased capacity at the TA-3 Co-Generation Complex. Note: Values are rounded.	*Project Effects:* Same as the No Action Alternative.	*Project Effects:* - Increases in electrical energy, peak load, and water demands over the No Action Alternative due to increased operational levels at the Metropolis Center and LANSCE (see above).
MDA Remediation (total over 10 years)	No change in utility demands.	Same as No Action Alternative.	Annual average of up to 70 million gallons of liquid fuels and 58 million gallons of water for remediation activities.

Waste Type	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative (Preferred Alternative)*		
			Total Including MDA Remediation Project	*Total Excluding MDA Remediation Project*	*MDA Remediation [n] Project Only*
Waste Management (10-Year Total)					
Transuranic Waste					
Contact-handled [o] (cubic yards)	3,500 to 5,900	3,500 to 5,900	5,300 to 33,000	5,200 to 11,000	68 to 22,000
Remote-handled [p] (cubic yards)	–	–	11 to 61	11	0 to 50
Low-Level Radioactive Waste [p, q]					
Bulk low-level radioactive waste (cubic yards)	39,000	39,000	196,000 to 884,000	186,000	11,000 to 698,000
Packaged low-level radioactive waste (cubic yards)	33,000 to 128,000	33,000 to 110,000	80,000 to 183,000	80,000 to 183,000	–
High activity low-level [p] radioactive waste (cubic yards)	–	–	0 to 347,000	–	0 to 347,000
Remote-handled low-level [p] radioactive waste (cubic yards)	–	–	480 to 1,700	480	0 to 1,200
Mixed low-level radioactive waste (cubic yards)	1,800 to 2,800	1,800 to 2,800	3,900 to 183,000	3,200 to 4,400	710 to 178,000
Construction/Demolition Debris [r] (cubic yards)	198,000	197,000	642,000 to 722,000	595,000	47,000 to 126,000
Chemical waste [s] (pounds)	19,000,000 to 37,000,000	19,000,000 to 36,000,000	64,000,000 to 129,000,000	22,000,000 to 39,000,000	42,000,000 to 90,000,000
Liquid Radioactive Wastes					
Liquid transuranic waste (gallons)	300,000	300,000	500,000	500,000	(t)
Liquid low-level radioactive waste (at TA-50) (gallons)	40,000,000	40,000,000	50,000,000	50,000,000	(t)
Liquid low-level radioactive waste (at TA-53) (gallons)	1,400,000	50,000 [u]	1,400,000	1,400,000	(t)

[n] Waste volumes are the incremental increase over remediation waste projections from the No Action Alternative.
[o] Operations waste volumes are assumed to be contact-handled transuranic waste and packaged low-level radioactive waste; small volumes of remote-handled or high-activity waste may be generated.
[p] These waste types are generated during retrieval of waste from MDAs under the Expanded Operations Alternative. Nominal volumes generated under other alternatives are accounted for in other waste categories.
[q] The subcategories of low-level radioactive waste do not necessarily meet precise definitions, but are used to assist in the analysis of transportation and disposal options and impacts.

- Bulk low-level radioactive waste = wastes that can be transported in large volumes in soft-sided containers.
- Packaged low-level radioactive waste = typical low-level radioactive waste packaged in drums or boxes.
- High activity low-level radioactive waste = waste exceeding 10 CFR 61.55 Class A concentrations (greater than 10 nanocuries per gram of transuranic nuclides) and therefore not accepted at certain facilities.
- Remote-handled low-level radioactive waste = waste with a dose rate exceeding 200 millirem per hour at the surface of the container.

[r] Demolition waste includes uncontaminated wastes such as steel, brick, concrete, pipes and vegetative matter from land clearing.
[s] Chemical waste includes wastes regulated under the Resource Conservation and Recovery Act, Toxic Substances Control Act, or state hazardous waste regulations. The large increase under the Expanded Operations Alternative is primarily due to high volumes of waste associated with MDA remediation.
[t] MDA remediation is projected to generate roughly 10,000 to 24,000 gallons (38,000 to 91,000 liters) of industrial, hazardous, low-level, and mixed low-level liquid wastes.
[u] Under the Reduced Operations Alternative, operations at the LANSCE facility would cease. Approximately 5,000 gallons (20,000 liters) of radioactive liquid waste per year from TA-50 would continue to be treated at TA-53.

Note: Because values have been rounded to the nearest hundred, thousand, or million, totals may not equal the sum of individual contributions.
To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359; gallons to liters, multiply by 3.78533.

	No Action Alternative	Reduced Operation Alternative	*Expanded Operations Alternative (Preferred Alternative)*				
			Total Including MDA Remediation Project		*Excluding MDA Remediation Project*	*MDA Remediation Project Only*	
			Capping	*Removal*		*Capping*	*Removal*
Transportation (for 10-Year Period 2007-2016)							
Incident Free							
Public Radiation Exposure *Dose (person-rem) / Risk (LCFs):*							
Total	58.4/0.035	53.1/0.032	89.1/0.053	286.8/0.17	88.6/0.053	0.49/0.0003	198.2/0.12
LANL to Pojoaque	1.8/0.0011	1.7/0.0010	2.8/0.0017	8.1/0.0049	2.8/0.0017	0.01/0.000006	5.3/0.0032
Pojoaque to Santa Fe	3.3/0.0020	3.1/0.0019	4.6/0.0028	13.3/0.0080	4.6/0.0028	0.02/0.00001	8.7/0.0052
Worker Radiation Exposure: (transport drivers) *Dose (person-rem) / Risk (LCFs):*	163.8/0.098	147.2/0.088	255.9/0.15	910.3/0.55	254.0/0.15	1.9/0.0012	656.4/0.40
Transportation Accidents							
Population: - *Radiological Risk (LCFs)*	0.00017	0.00015	0.00025	0.0016	0.00024	0.00001	0.0013
- *Nonradiological Traffic Fatalities* [v]	0 (0.37)	0 (0.34)	1 (0.95)	3 (3.23)	1 (0.90)	0 (0.02)	2 (2.3)

[v] Nonradiological traffic fatalities include all traffic accidents involving both radioactive and nonradioactive materials and waste shipments. Values presented are the nearest whole number.

	No Action Alternative	*Reduced Operation Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Local Traffic			
Average Daily Traffic at Entry Points	42,300	40,600	up to 49,800
Environmental Justice			
	No disproportionately high and adverse impacts on minority or low-income populations. Radiological doses to minority and low-income populations would be lower than those to sectors of the population that are not members of these groups. Human health impacts from exposure through special pathways (including subsistence consumption of fish and wildlife) would not present disproportionately high and adverse impacts to minority or low-income populations.	Same as No Action Alternative.	While there would be small, but not significant, increases in radiological and chemical risks to the public (0.004 LCFs), increased levels of operations and implementation of proposed projects are not expected to have any disproportionately high and adverse impacts on minority or low-income populations. Radiological doses to minority and low-income populations would be lower than those to sectors of the population that are not members of these groups.

	No Action Alternative	*Reduced Operation Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Facility Accidents (highest risk and MDA removal accidents presented)			
Wildfire – Radiological (Waste Storage Domes at TA-54 – assumed frequency 1 in 20 years)			
Offsite Population			
Dose (person-rem)	91,000	Same as No Action Alternative.	Same as No Action Alternative.
Risk (LCFs per year)	2.7		
MEI			
Dose (rem)	1,900 [w]		
Risk (LCFs per year)	0.05 [x]		
Noninvolved Worker			
Dose (rem)	8,700 [w]		
Risk (LCF per year)	0.05 [x]		
Wildfire – Chemical (Releases formaldehyde at TA-43 – assumed frequency 1 in 20 years)			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit)	25 parts per million	Same as No Action Alternative	Same as No Action Alternative.
- ERPG-3 distance	97 yards		
- Distance to the site boundary	13 yards		
Site-Wide Seismic Event – Radiological (PC-3 seismic event – assumed frequency 1 in 1,250 years) [z]			
Offsite Population			
Total Dose (person-rem)	36,000	Same as No Action Alternative	Same as No Action Alternative
Risk (LCF per year)	0.014		
MEI			
Maximum Dose (rem)	460 [w]		
Risk (LCF per year)	0.00045		
Noninvolved Worker [aa]			
Maximum Dose (rem)	2,000 [w]		
Risk (LCF per year)	0.0008		
Site-Wide Seismic Event – Chemical (PC-3 seismic event releases formaldehyde at TA-43 – assumed frequency 1 in 1,250 years) [z]			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit)	25 parts per million	Same as No Action Alternative	Same as No Action Alternative.
- ERPG-3 distance	120 yards		
- Distance to the site boundary	13 yards		
Facility Accident (RANT lightning strike fire – assumed frequency 1 in 8 years)			
Offsite Population			
Dose (person-rem)	11,000	Same as No Action Alternative	Same as No Action Alternative
Risk (LCF per year)	0.8		
MEI			
Dose (rem)	410 [w]		
Risk (LCF per year)	0.06		
Noninvolved Worker [bb]			
Dose (rem)	1,900 [w]		
Risk (LCF per year)	0.12 [x]		

	No Action Alternative	*Reduced Operation Alternative*	*Expanded Operations Alternative (Preferred Alternative)*
Facility Chemical Release (Selenium hexafluoride at TA-54 – assumed frequency 1 in 240 years)			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit) - ERPG-3 distance - Distance to the site boundary	5 parts per million 962 yards 537 yards	Same as No Action Alternative	Same as No Action Alternative.
MDA G Removal Accident – Radiological (explosion – assumed frequency 1 in 100 years)			
Offsite Population	Not applicable	Not applicable	
Dose (person-rem)			770
Risk (LCF per year)			0.005
MEI			
Dose (rem)			55
Risk (LCF per year)			0.0007
Noninvolved Worker			
Dose (rem)			410
Risk (LCF per year)			0.005
MDA B Removal Accident (sulfur dioxide – frequency not assumed)			
- Concentrations above which life-threatening health effects could result (ERPG-3 [y] limit) - ERPG-3 distance - Distance to the site boundary	Not applicable	Not applicable	15 parts per million 37 yards 49 yards

[w] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[x] The risk to any individual would not exceed the risk of the accident scenario.

[y] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005b).

[z] Based on the 2007 update of the probabilistic seismic hazard analysis (LANL 2007a).

[aa] The maximum risk (considering consequence and probability) to the noninvolved worker comes from the PC-2 seismic event which has a frequency of 1 in 700 (LANL 2007).

[bb] The maximum risk (considering consequence and probability) to the noninvolved worker comes from the Waste Characterization, Reduction, and Repackaging Facility lightning strike fire which has a frequency of 1 in 7.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MDA = material disposal area; LANSCE = Los Alamos Neutron Science Center; NPDES = National Pollutant Discharge Elimination System; RLWTF = Radioactive Liquid Waste Treatment Facility; CMRR = Chemistry and Metallurgy Research Replacement Facility; LCF = latent cancer fatality; MEI = maximally exposed individual; ERPG = Emergency Response Planning Guideline; PC = performance category; RANT = Radioassay and Nondestructive Testing; ROI = region of influence.

Note: To convert gallons to liters, multiply by 3.7854; cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

3.6.2 Summary of Cumulative Impacts

In accordance with Council on Environmental Quality regulations, a cumulative impact analysis includes "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). The cumulative impact analysis for this SWEIS includes (1) an examination of cumulative impacts presented in the *1999 SWEIS*; (2) impacts since the *1999 SWEIS* was issued (presented in this SWEIS in Chapter 5); and (3) a review of the environmental impacts of past, present, and reasonably foreseeable actions for other Federal and non-Federal agencies in the region.

Reasonably foreseeable actions that are likely to occur at LANL are described in Section 3.3 under the Expanded Operations Alternative. Additional DOE or NNSA actions that could impact LANL include the possible consolidation of nuclear operations related to production of radioisotope power systems (DOE/EIS-0373D) (DOE 2005c); proposed operation of a Biosafety Level 3 facility; a proposed advanced fuel cycle facility for research and development associated with the Global Nuclear Energy Partnership (GNEP) initiative; the potential implementation of Complex Transformation; and a potential disposal facility for Greater-Than-Class C waste.

Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems – As proposed in the *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems* (DOE/EIS-0373D) (*Consolidation EIS*) (DOE 2005c), consolidation of DOE plutonium-238 activities at the Idaho National Laboratory would reduce plutonium-238 operations at LANL. But regardless of the decision on the *Consolidation EIS,* some plutonium-238 operations would continue at LANL. Therefore, very small changes in the impacts from plutonium-238 activities at LANL would occur.

If current plutonium-238 operations were to continue at the LANL Plutonium Facility Complex, as described under the *Consolidation EIS* No Action Alternative, manufacturing of up to 80 pits per year could still be accomplished within the LANL Plutonium Facility Complex. This would be accommodated by consolidating a number of plutonium processing and support activities (such as analytical chemistry and materials characterization at the Chemistry and Metallurgy Research Replacement Facility). The impacts of the 80-pit-per-year production rate and plutonium-238 processing (at levels far above the level of plutonium-238 processing identified in the *Consolidation EIS*) have been evaluated in both the LANL *1999 SWEIS* and this new SWEIS. Therefore, there would be no additional cumulative effects from these activities.

Biosafety Level 3 Facility – NNSA is preparing an *Environmental Impact Statement for the Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0388D) to analyze the potential environmental impacts of operating a Biosafety Level 3 Facility. Operation of the facility would be consistent with the land use designation of Research & Development for Experimental Science. The facility is visually compatible with surrounding structures; therefore, there would be no impacts to visual resources. There would be no impacts to geology and soils and water resources from operations. Air emissions from the facility's laboratories are HEPA-filtered, resulting in very minor air quality effects. Noise impacts would be restricted to noise from heating, ventilation, and air conditioning system operations, consistent with other buildings in the area. Facility operations would have no effect upon ecological resources in the area. There would be no effect on prehistoric, historic, traditional, or paleontological resources. Facility personnel would come primarily from the existing LANL workforce, leading to no socioeconomic impacts. Operations would be well within LANL infrastructure capability to provide utilities such as electricity, water, and natural gas. There would be no discernable effects on local traffic conditions. There have been no reported cases of illnesses in the United States due to the release of diagnostic specimens during transport (Cummings 2007).

There would be a low potential risk of illness to site workers or visitors and no public human health effect from routine operations involving biohazardous material. Accident conditions would result in minimal or no impact to the public primarily because there would be severely limited opportunity for transport of an infectious dose of a biohazardous material to the public. Biohazardous material in open cultures would be handled only in biosafety cabinets where a spill would be contained. In addition, biohazardous material would be handled in a liquid or solid culture container that would release very few organisms to the air if dropped or spilled. This means that one of the most critical risk factors, public exposure to an infectious dose from a biohazardous material, is greatly minimized, and therefore, the potential risk of disease would be very low. The EIS will address slope stability at the Biosafety Level 3 Facility based on the recent update to the LANL probabilistic seismic hazard analysis (Cummings 2007, LANL 2007a).

Advanced Fuel Cycle Facility – On January 4, 2007, DOE issued an NOI (72 FR 331) to prepare a Programmatic EIS for the GNEP initiative. GNEP would encourage expansion of domestic and international nuclear energy production while reducing nuclear proliferation risks, and reduce the volume, thermal output, and radiotoxicity of spent nuclear fuel before disposal in a geologic repository. LANL is one of the DOE sites being considered for an advanced fuel cycle facility. The advanced fuel cycle facility would be a large shielded facility (approximately 1 million square feet [92,900 square meters] (DOE 2008). Potential cumulative impacts at LANL associated with the proposed advanced fuel cycle facility are based on preliminary data and could change prior to the public release of the Draft *GNEP PEIS*.

Complex Transformation – On January 11, 2008, NNSA announced the availability of the Draft *Complex Transformation SPEIS* (73 FR 2023), which evaluates NNSA's proposal for a smaller, more efficient nuclear weapons complex that would be better able and more suited to respond to future national security challenges. The Preferred Alternative in the Draft *Complex Transformation SPEIS* is to pursue distributed centers of excellence. LANL would be the center of excellence for plutonium manufacturing and research and development, with a production capacity of up to 80 pits per year. This alternative would be based on the use of the existing and planned infrastructure already described in the SWEIS Expanded Operations Alternative (DOE 2007b). Among other alternatives for LANL that are evaluated in the *Complex Transformation SPEIS*, the one that would have the largest potential cumulative impacts is the consolidated nuclear production center. The SWEIS cumulative impacts analysis addresses the impacts of construction and operation of a consolidated nuclear production center at LANL.

Disposal of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC EIS). On July 23, 2007, DOE issued an NOI to prepare an *Environmental Impact Statement for the Disposal of*

Greater-Than-Class-C Low-Level Radioactive Waste (GTCC EIS) (72 FR 40135). The *GTCC EIS* will address the disposal of low-level radioactive waste generated by activities licensed by the Nuclear Regulatory Commission or an Agreement State that contain radionuclides in concentrations exceeding 10 CFR 61 Class C limits, as well as DOE waste having similar characteristics. LANL is being considered as one of eight candidate DOE disposal sites for Greater-Than-Class C waste, along with a generic commercial disposal facility option in arid and humid environments. In addition, DOE is evaluating several disposal technologies in the *GTCC EIS* including geologic repositories, intermediate depth boreholes, and enhanced near-surface disposal facilities. The alternatives in the *GTCC EIS* could result in changes to facilities or operations at LANL, but because the changes have yet to be developed, quantitative data are not available for the cumulative impacts analysis.

Reasonably foreseeable actions for the region surrounding LANL were also reviewed for the cumulative impacts analysis. Interviews were conducted with personnel in planning departments in the surrounding counties, as well as from the regional Bureau of Land Management and Santa Fe National Forest offices, to collect information on activities that might affect cumulative impacts. Available documentation was reviewed for activities that could contribute to cumulative impacts.

Each resource area in this SWEIS was reviewed for potential cumulative impacts; the analyses are summarized in the following paragraphs. The level of detail provided for each resource area is commensurate with the extent of the potential cumulative impacts. Some resources were not provided with a detailed analysis based on minimal or very localized impacts from LANL operations and a judgment that, cumulatively, there would be no appreciable impacts on these resources.

The following paragraphs summarize cumulative impacts for LANL and the surrounding region of influence. The maximum cumulative impacts for all resource areas would occur if a decision was made to implement the SWEIS Expanded Operations Alternative in its totality.

Land Use, Visual Environment, Ecological Resources, and Cultural Resources

Impacts on land use, visual environment, ecological resources, and cultural resources from LANL operations have been discussed previously. Additional impacts could arise from the conveyance and transfer of land as required under Public Law 105-119. Up to 826 acres (334 hectares) of land could be developed after transfer or conveyance. For example, Los Alamos County has indicated there are proposals to develop approximately 1,000 new residences on land adjacent to LANL and to develop land for light industry, retail, and residential development along the Los Alamos Canyon rim across from the airport. This could change the current land use and increase cumulative impacts on visual, ecological, and cultural resources. In addition, the *Complex Transformation SPEIS* consolidated nuclear production center facilities, if constructed at LANL, could result in disturbance of up to 545 acres (221 hectares) of land. The total land area required for the GNEP advanced fuel cycle facility would be approximately 373 acres (151 hectares) with 144 acres (58 hectares) inside a property protection fence, including approximately 62 acres (25 hectares) within a perimeter intrusion, detection, and assessment system (DOE 2008).

Impacts associated with construction of the consolidated nuclear production center or the GNEP advanced fuel cycle facility at LANL would include the loss of habitat and of less mobile wildlife, such as reptiles and small mammals. Best management practices and implementation measures set forth in the LANL *Threatened and Endangered Species Habitat Management Plan* would be used to minimize the potential for any adverse effects to plant and animal communities and on threatened and endanger or special interest species. After construction, temporary structures would be removed and the sites reclaimed.

Proposed sites for the *Complex Transformation SPEIS* consolidated nuclear production center in TA-16 or TA-55 and the GNEP advanced fuel cycle facility in TA-36 that involve undisturbed lands are likely to contain archaeological resources due to the high density of these resources in the region. Identification, evaluation, determination of impact, and implementation of mitigative measures would be conducted in consultation with the New Mexico State Historical Preservation Office (SHPO), interested Native American tribes, and in accordance with *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*.

Geology and Soils

For geology and soils, the primary impacts are due to proposed closure of the MDAs under the Expanded Operations Alternative in compliance with the Consent Order. If the waste at the MDAs is contained in place (MDA Capping Option), the final covers would require up to 2.5 million cubic yards (1.9 million cubic meters) of bulk materials including crushed tuff, rock, gravel, topsoil, and other materials for surface grading and erosion control. Construction of the consolidated nuclear production center or the GNEP advanced fuel cycle facility would also require the use of bulk geologic materials. These materials would be obtained from LANL resources and from quarries and mines in the surrounding counties. While the quantity of materials would be large, there would be sufficient resources in the region to meet the demand.

Water Resources

Reasonably foreseeable activities in the region could affect surface water and groundwater in combination with past and present activities, as well as those proposed at LANL in this SWEIS. Mitigation measures implemented by Federal agencies during fire and vegetation management projects and modification of water control structures installed after the Cerro Grande Fire would minimize impacts on surface water quality and quantity. Use of facilities to evaporate treated effluent from the Radioactive Liquid Waste Treatment Facility would improve surface water resources in Mortandad Canyon. Additional groundwater depletion projected as a result of potential new residential development within Los Alamos County could be somewhat offset by reduced depletion of the regional aquifer following implementation of the city of Santa Fe’s water diversion project and reduced pumping of the Buckman Well Field. Monitoring of the quality and quantity of the regional aquifer would be needed to evaluate the rate and direction of contaminant movements and to track the amount of water available for use. The North Railroad Avenue groundwater contamination plume located over 12 miles (19 kilometers) from the LANL boundary is undergoing remediation, and is not expected to migrate into groundwater and surface water impacted by past or present LANL operations.

Air Quality

Under the Expanded Operations Alternative, construction, excavation, and remediation activities could result in temporary increases in air pollutant concentrations at the site boundary and along publicly accessible roads. These impacts would be similar to those that would occur during construction of a housing project or a commercial complex. Emissions of fugitive dust from these activities would be controlled with water sprays and other engineering and management practices as appropriate. The maximum ground level concentrations offsite and along publicly accessible roads would be below ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide for certain projects that could occur near the site boundary. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements. The impacts on the public would be minor.

The projected increase in LANL employees and vicinity populations would cause an increase in vehicles and an associated increase in vehicle emissions along the routes used to access the site. However, cumulative concentrations of all criteria pollutants are expected to remain compliant with Federal and State ambient air quality standards.

The 24-hour standard for nitrogen dioxide and total suspended particulates could be exceeded if the Complex Transformation consolidated nuclear production center operated at LANL along with implementation of the Expanded Operations Alternative. Based on these potential exceedances, more detailed site-specific analyses would need to be performed if LANL were selected as the site for the consolidated nuclear production center. Preliminary data available for the GNEP advanced fuel cycle facility do not include emissions.

The contribution to cumulative air quality impacts from offsite construction and operation activities was also evaluated. The maximum impacts from construction activities (including fugitive dust) for oil and gas development in the region are evaluated in the *Farmington Proposed Resource Management Plan and Final EIS* and were shown to occur very close to the source, with concentrations decreasing rapidly with distance (BLM 2003b). Therefore, it is expected that offsite air emissions from disturbance and construction would not contribute substantially to cumulative impacts at LANL.

Impacts of inert pollutants (pollutants other than ozone and its precursors) generally were found to be limited to a few miles downwind from the source. For emissions from the oil and natural gas well fields, the distance where the nitrogen dioxide concentrations dropped below their significance levels was 15.6 to 24.9 miles (25 to 40 kilometers). Therefore, it is expected that emissions from the operation of offsite facilities would not contribute substantially to cumulative impacts at LANL.

In contrast, the maximum effects of volatile organic compounds and nitrogen oxide emissions on ozone levels usually occurs several hours after these compounds are emitted and many miles from their sources (BLM 2003b). A number of mitigation measures for activities occurring in the region are designed to reduce the cumulative air quality impacts from gas and oil wells and pipelines. One of the more successful mitigation measures requires that new and replacement wellhead compressors limit their nitrogen oxide emissions to less than 10 grams per horsepower-hour, and each pipeline compressor station limit its total nitrogen oxide emissions to less than 1.5 grams per horsepower-hour. This measure is intended to substantially reduce the level and extent of emissions that form ozone throughout the region and to reduce visibility impacts on Class I Areas such as Bandelier National Monument.

Human Health

For human health, the dose to the general public from all anticipated airborne emissions at LANL (Expanded Operations Alternative) could be as much as 36 person-rem per year. The dose to the offsite MEI from all anticipated airborne emissions at LANL could be as much as 8.2 millirem per year. The Clean Air Act regulations limit airborne radiation doses to 10 millirem per year for any individual member of the public. No additional LCFs would be expected at these dose levels. If the consolidated nuclear production center facilities were sited at LANL, the offsite radiological impacts would be essentially unchanged due to closure of facilities whose functions would be included in the new center. Preliminary data available for the GNEP advanced fuel cycle facility do not include estimates of offsite dose impacts.

Collective worker doses would increase if the MDA Removal Option was implemented. Collective worker dose would increase from about 280 person-rem per year under the No Action Alternative to an average of up to about 540 person-rem per year due to the number of workers involved. At the maximum dose, the annual risk of a LCF in the worker population would be about 0.3 (or for each 3 years of operation, 1 chance of an LCF in the worker population). Worker dose would decrease by about 140 person-rem annually after the MDA remediation work was complete. Worker doses would be expected to increase from operation of the consolidated nuclear production center facilities at LANL. The net increase in collective worker doses would be approximately 105 person-rem per year. The increased annual risk of an LCF in the worker population would be 0.06 (or for each 17 years of operation, an additional LCF might be expected in the worker population). Preliminary data for the GNEP advanced fuel cycle facility do not include a worker population dose estimate. Individual worker doses would be maintained as low as reasonably achievable (ALARA) and within applicable regulatory limits.

Environmental surveillance results for radioisotopes and chemicals, monitoring of LANL radiological emissions and radiation dose data, and cancer mortality and incidence rates in New Mexico and all counties surrounding LANL are presented in this SWEIS. These data, along with the final LANL Public Health Assessment, issued on August 31, 2006, by the U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, show that "there is no evidence of contamination from LANL that might be expected to result in ill health to the community" and "[o]verall, cancer rates in the Los Alamos area are similar to cancer rates found in other communities" (CDC 2006). Additionally, there is currently a Center for Disease Control and Prevention dose reconstruction project at LANL in the initial information gathering phase (CDC 2006). Therefore, this information is not available to include in the cumulative impacts analysis.

Socioeconomics

By 2011, LANL operations under the No Action Alternative could account for approximately 20 percent of employment in the tri-county area (Los Alamos, Rio Arriba, and Santa Fe

Counties) and an even higher percentage of wages due to the large difference in average wages for LANL employees versus the county averages. Under the Expanded Operations Alternative, direct employment at LANL could increase by another 14 percent by 2011. Of the 1,890 direct and 2,000 indirect jobs thus created, about 1,600 and 1,700 jobs, respectively, would be held by those in the tri-county area. This would increase the estimated percentage of the population employed in the tri-county area as a result of LANL operations activities to 22 percent.

If the maximum number of jobs estimated for operation of the Los Alamos Research Park and the conveyance and transfer of land were also created by 2011, there could be additional socioeconomic impacts in the region of influence. Cumulatively, the Expanded Operations Alternative and these activities could result in nearly 21,000 direct and 22,000 indirect jobs in the region. This scenario would increase the estimated percentage of the population employed by LANL-related activities or actions to 31 percent of the region of influence.

Increases in employment related to the proposed *Complex Transformation SPEIS* consolidated nuclear production center facilities would add approximately 1,500 direct and 1,600 indirect jobs for a total of 3,100 additional employees living in the tri-county region of influence. The addition of the GNEP advanced fuel cycle facility could add about 1,100 direct jobs in the tri-county region of influence, generating approximately 1,200 indirect jobs for a total 2,300 additional employees living in the tri-county region of influence. Combined with the other initiatives discussed above and LANL's continuing operations under the Expanded Operations Alternative, this scenario could increase the estimated percentage of the population employed by LANL-related activities to 33 percent of the region of influence.

The rate of population growth in the region would likely exceed current rates, placing additional strain on regional infrastructure and social services. For example, additional demand would be placed on regional water and electrical systems, roads would be more heavily traveled, additional housing would need to be constructed, and there may be demands for additional schools and hospitals. There would also be beneficial gains in terms of average wages and benefits flowing into the local economy because many of these jobs should be relatively higher paying jobs (for example, research jobs), and the unemployment rate would likely fall.

Infrastructure

Under the SWEIS Expanded Operations Alternative, the cumulative peak electrical load would approach, but not exceed, the system capacity; and the water use would approach, but not exceed, the system available water rights. Planned upgrades to the electrical system should enhance peak load capacity and ensure that electric energy is available for future operations. For water use, Los Alamos County is currently pursuing additional water rights to supply its water customers, including LANL. LANL water requirements have been decreasing compared to the demand in 1999, and are far below projections included in the *1999 SWEIS*. In the near term, no infrastructure capacity constraints are expected, and LANL demands on infrastructure resources are below projected levels and within site capacities. Potential shortfalls in available capacity would need to be addressed if increased site requirements are larger than those analyzed in this SWEIS.

If the proposed Complex Transformation consolidated nuclear production center, the GNEP advanced fuel cycle facility, or both were located at LANL, the system capacities for electricity and water could be exceeded and additional resources might need to be identified to satisfy the projected demand. It is likely that significant modifications would be required and LANL would need to obtain greater water resources, or significantly reduce its potable water use through mitigative measures. Overall LANL work assignments might have to be revamped, reduced, or eliminated so that existing potable water supplies would be adequate to support the assigned LANL work load.

Waste Management

Cumulative generation of all waste types is expected to be substantial, largely due to future remediation of MDAs and DD&D of facilities. Although this would be the case under all alternatives, the quantities of wastes projected under the Expanded Operations Alternative would be significantly larger than those projected under the other alternatives. Sufficient disposal capacity, both on- and offsite, for all waste types would be available except possibly under the Expanded Operations Alternative. Up to 1.4 million cubic yards (1.1 million cubic meters) of low-level radioactive waste and 33,000 cubic yards (25,000 cubic meters) of transuranic waste are projected. About two-thirds of the transuranic waste volume is associated with postulated complete removal of all waste from the MDAs – including transuranic waste buried before 1970. Final waste volumes from MDA remediation may be smaller because waste generation is dependent on future regulatory decisions by the New Mexico Environment Department and on waste volume reduction techniques such as sorting. Additional resources, including new storage and handling facilities, could be required to augment existing and proposed waste management capabilities.

Onsite disposal capacity for low-level radioactive wastes may be sufficient, depending on the actual volumes generated by remediation; disposal capacity can be supplemented by offsite facilities if needed. It is assumed that the transuranic waste would be disposed of at WIPP. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste and all of the transuranic waste buried before 1970 across the complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs would be based on the needs of the entire DOE complex. Any transuranic waste that may be generated at LANL without a disposal pathway would be safely stored until disposal capacity becomes available.

Operation of the proposed Complex Transformation consolidated nuclear production center would result in additional radioactive waste being generated. Up to 1,160 cubic yards (890 cubic meters) of transuranic waste, 12,000 cubic yards (9,000 cubic meters) of low-level radioactive waste, and 72 cubic yards (55 cubic meters) of mixed low-level radioactive waste would be generated annually. Operations would also generate up to 8,900 gallons (33,800 liters) of liquid low-level waste and up to 3,600 gallons (13,700 liters) of mixed low-level liquid waste annually. These wastes would be treated and packaged for disposal in accordance with their characteristics and applicable requirements in existing facilities or new facilities. Low-level waste would be disposed of onsite, mixed low-level waste would be disposed of at a permitted offsite facility, and transuranic waste would be disposed of at WIPP.

The volumes of low-level radioactive waste (up to 3,450 cubic yards [2,640 cubic meters]) and mixed low-level radioactive waste (up to 4.4 cubic yards [3.4 cubic meters]) projected to be generated annually by the GNEP advanced fuel cycle facility (DOE 2008) would be managed within the current waste management program. In addition, the project could generate up to 928 cubic yards (710 cubic meters) of nondefense transuranic waste annually (DOE 2008), which is not eligible for disposal at WIPP. Transuranic waste without a disposal pathway would be safely stored until a disposal facility became available. The project could also generate 34 cubic yards (26 cubic meters) of high-level radioactive waste annually (DOE 2008). Facilities to safely manage high-level radioactive waste until it could be sent to a geologic repository would have to be provided by the project since no high-level radioactive waste is currently managed at LANL.

Transportation

The total cumulative worker dose from 130 years of radioactive materials shipments (general transportation, historical DOE shipments, and reasonably foreseeable actions as estimated in the *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, (DOE/EIS-0250F-S1D) (DOE 2007a), as well as shipments associated with the LANL SWEIS alternatives, would be a maximum of 382,400 person-rem, which could result in 229 LCFs. The total cumulative dose to the general public would be a maximum of 343,900 person-rem, which could result in 206 excess LCFs. The total estimated traffic fatalities associated with accidents involving radioactive material and waste transports would be a maximum of 119.

Implementing the Expanded Operation Alternative would result in no more than three additional traffic fatalities and zero worker or public cancer deaths (LCFs); therefore, they would not contribute substantially to cumulative impacts. For perspective, in 2004, there were 522 traffic fatalities in New Mexico, 58 of which occurred in the three counties neighboring LANL (Los Alamos, Rio Arriba, and Santa Fe Counties) (see Chapter 4, Table 4–56).

Daily traffic could increase on county roads by up to 18 percent (averaged across all LANL entrances) due to (1) increased development of both housing and light industry, as a result of the conveyance and transfer of lands; (2) increased truck shipments under the Expanded Operations Alternative; (3) projected increases in the LANL workforce under the Expanded Operations Alternative; and (4) increased employment at the Los Alamos Research Park. Development of land transferred under the *Land Conveyance and Transfer EIS* (DOE/EIS-0293) (DOE 1999d) could increase traffic in the vicinity of the airport and TA-21 based on current Los Alamos County plans to develop light industry, retail, and residential units on these tracts. This action, combined with the increased traffic associated with DD&D activities at TA-21, could cause excessive traffic loads on NM 502.

The major radiological transportation actions involving Category I/II special nuclear material related to the proposal to consolidate activities at LANL would be transportation of pits currently stored at Pantex and highly enriched uranium currently stored at Y-12 to LANL. After these one-time shipments were completed, there would be no annual shipment of pits and highly enriched uranium from these sites. The estimated radiological health impacts of the one-time transportation of pits and highly enriched uranium to LANL would not result in any additional

LCFs in the general public. Non-radiological impacts would be expected to result in zero fatalities as a result of accidents. Workers handling the movement of pits and highly enriched uranium would receive a collective dose of approximately 5,500 person-rem, resulting in an estimated 3.3 LCFs. It should be noted that in accordance with DOE regulations, the maximum annual dose to a radiation worker would be administratively controlled to 2 rem per year; therefore, an individual worker would not be expected to develop a lifetime latent fatal cancer from exposures during these activities.

The major transportation actions involving radioactive materials related to the *GNEP PEIS* advanced fuel cycle facility at LANL would involve the receipt of shipments of spent reactor fuel, shipments of transmutation fuel, shipments of spent fast reactor fuel, and radioactive waste shipments associated with operation of the advanced fuel cycle facility (DOE 2008).

The addition of proposed facilities and an increased number of workers for the consolidated nuclear production center in TA-16 would likely result in increased traffic along NM 4 from White Rock to West Jemez Road and on West Jemez Rd to the center of the site. The consolidation of facilities in TA-16 would somewhat alleviate current concerns related to increased traffic along Pajarito Road under the Expanded Operations Alternative, because there could be a corresponding decrease in traffic along Pajarito Road from NM 4 to TA-55 if the activities at the Plutonium Facilities Complex were relocated to TA-16. Conversely, the GNEP advanced fuel cycle facility is proposed to be built in TA-36 which would lead to increased traffic along Pajarito Road from NM 4 to the center of LANL, if approved.

Environmental Justice

No disproportionately high adverse human and environmental effects to minority or low-income populations would be expected as a result of implementing any of the three alternatives considered in this SWEIS, constructing and operating the *Complex Transformation SPEIS* consolidated nuclear production center or the GNEP advanced fuel cycle facility. Employment at LANL and in the surrounding region would be expected to increase, thus creating additional employment opportunities for local individuals. As additional funding flows into the regional economy, increased opportunities for low-income and minority populations should be realized. Also, the conveyance and transfer of land to the Department of the Interior that has occurred benefits people inhabiting the Pueblo of San Ildefonso. A consultation process is in place to address possible impacts to traditional cultural properties from LANL activities.

3.6.3 Summaries of Potential Consequences from Project-Specific Analyses

Appendices G, H, I, and J of this SWEIS contain evaluations of the environmental impacts of projects proposed for implementation under the Expanded Operations Alternative. They include projects to replace or refurbish existing structures and their related capabilities, DD&D of old structures and remediation of environmental contamination, modifications to site infrastructure, and expansion of site capabilities. This section summarizes the potential consequences of implementing each of the proposed projects.

The sliding-scale approach is used in this SWEIS to evaluate environmental consequences. This approach implements the Council on Environmental Quality instruction to "focus on significant environmental issues" (40 CFR 1502.1) and to discuss impacts "in proportion to their significance" (40 CFR 1502.2[b]). For some of the project-specific analyses it was determined that there would be no or only minor impacts for some resource areas. Consequently, these resource areas are not analyzed in detail. In the following tables, these resource areas are identified as having "no or negligible impacts."

General temporary construction-related impacts would be expected to occur for most of the projects summarized in this section during construction and DD&D activities. After project completion, these impacts would cease and the area would return to normal. These impacts are not discussed in detail in the project summaries:

- Physical disturbances to areas under or in the vicinity of construction and DD&D projects would disrupt land use, affect the visual environment, and disturb the soils and geology, the latter primarily from excavation activities.
- Water resources, primarily surface water quality, could be temporarily affected by runoff and increased sediment loads from construction and DD&D sites. Stormwater Pollution Prevention Plans describing best management practices would be required and would mitigate most of these impacts. A Construction General Permit, a U.S. Army Corps of Engineers Section 404 Dredge and Fill Permit, and a Section 401 New Mexico Water Quality Certification would be obtained, if needed, for projects that may affect surface water.
- Air quality impacts would be increased by emissions of criteria air pollutants, primarily carbon monoxide and nitrogen oxides from vehicles and heavy equipment, as well as particulate matter from soil disturbance.
- Noise levels could rise from the increased number of personal vehicles, trucks hauling materials and waste to and from construction sites, and heavy equipment involved in the activities. Most noise would be localized, but if a project were near a LANL site boundary, offsite populations could be disturbed.
- Loss of habitat from land disturbance and increased noise and light are potentially adverse ecological impacts from construction and DD&D activities. Impacts could be minimized by avoiding working during nesting seasons for sensitive species, using special lighting, protecting areas of concern, and working only during certain times of the day or year.
- Construction workers would be subject to accidents typical of any construction site. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities). To prevent serious exposures and injuries, all site construction contractors would be required to submit and adhere to a Construction Safety and Health Plan and undergo site-specific hazard training. Appropriate personal protection measures would be a routine part of construction activities, including use of personal protection equipment such as coveralls, respirators, gloves, hard hats, steel-toed boots, eye shields, and earplugs or covers. Workers also would be protected by other engineered and administrative controls.
- Increased consumption of fuels, water, and electricity would occur during construction and DD&D.

- Implementing the projects addressed in this section may result in impacts to potential release sites covered under the Consent Order. As needed, these potential impacts would be addressed through the accelerated cleanup process described in Section VII.F of the Consent Order.

Summary of Impacts for the Physical Science Research Complex Project

The Physical Science Research Complex would be a complex of four buildings in TA-3 with approximately 350,000 square feet (32,500 square meters) of floor space, approximately 30 percent of which would be laboratory space (primarily laser). This complex would be available to consolidate staff currently located in TA-3 and other LANL locations in newer, more efficient and modern space. A number of structures would be demolished to make room for the Physical Science Research Complex, and a number of buildings vacated by staff moving to the new facility would also undergo DD&D. A building potentially eligible for listing on the National Register of Historic Places could be impacted, as well as the Administration Building which has been determined to be eligible. Proposed activities would require documentation to resolve adverse effects. Only minor impacts would be expected from construction and operation of this facility. There would be some improvement in the overall appearance of areas in which aging buildings and temporary structures would be demolished. **Table 3–20** summarizes the potential impacts of implementing this project.

Table 3–20 Summary of Impacts for the Physical Science Research Complex Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – Demolition of vacated structures would improve the overall appearance of TA-3, TA-35, and TA-53.
Geology and Soils	Temporary construction- and DD&D-related impacts. Approximately 499,000 cubic yards of rock and soil would be disturbed during construction.
Water Resources	No or negligible impact.
Air Quality and Noise	*Air Quality* – Temporary construction- and DD&D-related impacts. Little or no change in emissions from operations. *Noise* – Temporary construction- and DD&D-related impacts.
Ecological Resources	No or negligible impact.
Human Health	Temporary construction-related impacts and accident potential for workers. Potential worker exposure to radiological contamination and asbestos during DD&D. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. Positive impact on relocated staff from improved working conditions.
Cultural Resources	Possible impact on a building potentially eligible for listing on the National Register of Historic Places and the Administration Building, which has been determined to be eligible. Proposed activities would require documentation to resolve adverse effects.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity; requirements would be similar to or less than the facilities being replaced.
Waste Management	*Construction* – 1,600 cubic yards of construction debris. *DD&D* – 17,000 cubic yards of low-level radioactive waste; 177,000 cubic yards of solid waste including demolition debris; and 314,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes and demolition wastes (some radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

There would be no major environmental impacts from construction, operation, and DD&D of existing buildings for the Replacement Office Buildings Project. Most construction would be in a developed portion of TA-3; however, a portion of the project area would require use of about 13 acres (5.3 hectares) of currently undeveloped land. Protection of cultural resources and potential accommodation for the Mexican spotted owl during construction could be required. **Table 3–21** summarizes the potential impacts of implementing this project.

Table 3–21 Summary of Impacts for the Replacement Office Buildings Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – Consistent with future land use plans; about 13 acres of undeveloped land would be disturbed. *Visual Environment* – New buildings and parking lot could be visible from West Jemez Road and Pajarito Road.
Geology and Soils	Temporary construction- and DD&D-related impacts. Approximately 369,000 cubic yards of rock and soil would be disturbed during construction.
Water Resources	Temporary construction- and DD&D-related impacts.
Air Quality and Noise	*Air Quality* – Temporary construction-and DD&D-related impacts. No change in emissions from operations. *Noise* – Temporary construction- and DD&D-related impacts.
Ecological Resources	Temporary construction-related impacts. Loss of 13 acres of habitat. Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle.
Human Health	Temporary construction- and DD&D-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment.
Cultural Resources	Possible impact on a historic trail potentially eligible for listing on the National Register of Historic Places. Proposed activities could require documentation to resolve adverse effects.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity; requirements would be similar to or less than the facilities being replaced.
Waste Management	*Construction* – 1,700 cubic yards of construction waste. *DD&D* – 31 cubic yards of low-level radioactive waste and 6,900 cubic yards of demolition debris.
Transportation	No or negligible impact.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

Summary of Impacts for the Radiological Sciences Institute Project, Including Phase I – the Institute for Nuclear Nonproliferation Science and Technology

The proposed project would involve the DD&D of 52 obsolete structures scattered over 6 TAs, and the construction of the Radiological Sciences Institute in TA-48, which would include as many as 13 new facilities. Phase I would include construction of five buildings associated with the Institute for Nuclear Nonproliferation Science and Technology. This facility would include Security Category I and II laboratories and vaults, other laboratory space, a secure radiochemistry laboratory, and associated offices and support facilities.

DD&D activities and transportation would result in the largest potential impacts. DD&D activities are expected to generate large quantities of debris, including some radioactively-contaminated debris. With the exception of low-level radioactive waste, most DD&D waste would be transported to appropriate offsite facilities. Transportation impacts would include temporary disruption of traffic on Pajarito Road during construction; increased local traffic during operations; and movement of large amounts of DD&D waste. **Table 3–22** summarizes the potential impacts of implementing this project.

Table 3–22 Summary of Impacts for the Radiological Sciences Institute Project, Including Phase I – the Institute for Nuclear Nonproliferation Science and Technology

Resource Area	*Impact Summary*
Land Resources	*Land Use* – Some currently designated Reserve and Experimental Science areas would be redesignated in the future as Nuclear Materials Research and Development; 12.6 acres of undeveloped land would be disturbed. *Visual Environment* – Minor impact from new development in TA-48 west of existing buildings.
Geology and Soils	Temporary construction-related impacts. Approximately 802,000 cubic yards of rock and soil would be disturbed during construction. Excavation of welded tuff could necessitate blasting. Negligible impacts anticipated from DD&D activities.
Water Resources	Temporary construction-related impacts. DD&D of older contaminated structures could reduce the potential for future surface water and groundwater contamination.
Air Quality and Noise	*Air Quality* – Temporary construction- and DD&D-related nonradiological impacts and potential for release of radionuclides in contaminated soils in the vicinity of the proposed building location. Little or no change in emissions from operations. *Noise* – Temporary construction- and DD&D-related impacts could include blasting.
Ecological Resources	Temporary construction-related impacts. Loss of 12.6 acres of habitat. Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl.
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. No additional LCFs in general population or to the MEI from radiological doses from facility construction or operation and associated DD&D.
Cultural Resources	Possible impact on two archaeological sites determined to be eligible for the National Register of Historic Places and on potentially eligible historic buildings, including the Radiochemistry Building. Documentation to resolve adverse effects on the archaeological sites would be required before beginning construction of the Radiological Sciences Institute and could be required before demolition of any of the potentially important historic structures.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity, requirements would be similar to or less than the facilities being replaced.
Waste Management	*Construction* – 2,800 cubic yards of construction debris and associated solid waste. *DD&D* – 1,100 cubic yards of transuranic waste; 96,000 cubic yards of low-level radioactive waste; 1,000 cubic yards of mixed low-level radioactive waste; 77,000 cubic yards of demolition debris; and 988,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes, and demolition wastes (some of which would be radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	Postulated facility accident with the highest impacts would result in an LCF risk of 1 in 12,000 for a noninvolved worker and 1 in 77,000 for the MEI; there would be no excess LCFs expected in the exposed population.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality; MEI = maximally exposed individual.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359; acres to hectares, multiply by 0.40469.

Summary of Impacts for Radioactive Liquid Waste Treatment Facility Upgrade Project

This project has been proposed to improve the operation and reliability of the Radioactive Liquid Waste Treatment Facility in TA-50. Three options have been proposed to upgrade the facility, each involving DD&D of part of the existing facility. Under Option 1, a new building for treating liquid low-level radioactive and transuranic wastes would be constructed west of the existing facility in a parking area, along with a central utilities building. The East Annex would be demolished. Under Option 2, the Radioactive Liquid Waste Treatment Facility treatment capabilities would be housed in two or more separate structures to the west and north of the existing facility (for example, one or more structures for low-level radioactive liquid waste and one or more structures for transuranic liquid waste). The East Annex, the North Annex, and a transformer located on the north side of the existing facility would be demolished to accommodate the new construction. Option 3 is identical to Option 2, except that the existing facility would be renovated for reuse; the most DD&D would be required under this option. An auxiliary action of installing a pipeline and constructing evaporation tanks to treat effluent could occur with any of the options, including the No Action Option (not upgrading the facility).

Potential impacts from each of the action options would be similar. Demolition of the East Annex and the transuranic influent storage tanks would likely produce considerable low-level radioactive waste and some transuranic waste. There is also the potential for releasing radioactive or other hazardous constituents from contaminated soils and contaminated structural materials, but proper procedures would be followed to minimize their release. **Table 3–23** summarizes the potential impacts of implementing this project.

Implementing the auxiliary action to construct evaporation tanks and a pipeline would result in a change in the land use category and the loss of habitat of up to 5.4 acres (2.2 hectares) of currently undeveloped land. Tank construction would cause a break in the forest cover that would be noticeable from areas west of LANL. Use of the evaporation tanks would improve surface water quality by eliminating a discharge that could contribute to movement of existing environmental contamination.

Table 3–23 Summary of Impacts for the Radioactive Liquid Waste Treatment Facility Upgrade Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – If the option to construct evaporation tanks and pipeline were implemented, the land use designation of up to 5.4 acres of land for the area of the tanks would change from Reserve to Waste Management. *Visual Environment* – The new treatment buildings would not result in a change to the overall visual character of the area within TA-50, but the area proposed for construction of the evaporation tanks is currently undeveloped and wooded, and a break in the forest cover would be noticeable from areas west of LANL.
Geology and Soils	Temporary construction- and DD&D-related impacts. Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. Permanent removal of contaminated soil to accommodate new facilities. Up to 164,000 cubic yards of rock and soil could be disturbed, assuming construction of the evaporation tanks and pipeline.
Water Resources	Potential positive impact on effluent water quality and quantity due to more stringent discharge requirements and improved processing.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. Potential for increased radioactive emissions during DD&D. Minimal impact expected from operation. *Noise* – Minor construction equipment and traffic noise impact to workers.
Ecological Resources	Temporary construction- and DD&D-related impact. Loss of up to 5.4 acres of habitat if the evaporation tanks and a pipeline are built. May affect, but is not likely to adversely affect, the Mexican Spotted Owl and bald eagle.
Human Health	Temporary construction-related impacts and accident potential for workers. Potential worker exposure to radiological contamination during DD&D. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. During operations, worker health and safety would be improved because of improved reliability and design and less maintenance on new systems. RLWTF emissions do not have a distinguishable effect on the projected dose to the public.
Cultural Resources	Possible impact on several historic properties, including the RLWTF, potentially eligible for listing on the National Register of Historic Places. Proposed activities could require documentation or excavation to resolve adverse effects.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Utility requirements are expected to increase but to stay within LANL utility capacity.
Waste Management	*Construction* – Up to 1,150 cubic yards of construction debris. *DD&D* – Up to 230 cubic yards of transuranic waste; 10,300 cubic yards of low-level radioactive waste; 150 cubic yards of mixed low-level radioactive waste; 1,800 cubic yards of demolition debris; and 212,000 pounds of chemical waste.
Transportation	Temporary disruption of local traffic during construction and DD&D. Transportation of construction materials and wastes and demolition wastes (some of which would be radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality; RLWTF = Radioactive Liquid Waste Treatment Facility.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.7854; pounds to kilograms, multiply by 0.45359; acres to hectares, multiply by 0.40469.

Summary of Impacts for Los Alamos Neutron Science Center Refurbishment Project

The LANSCE Refurbishment Project would include renovations and improvements to the existing facility in TA-53 to increase its reliability and extend its operating life. Impacts from implementation would be minimal. There could be minimal indirect effects on utility usage and air emissions from increased usage of the facilities after the project was complete. **Table 3–24** summarizes the potential impacts of LANSCE Refurbishment Project activities.

Table 3–24 Summary of Impacts for the Los Alamos Neutron Science Center Refurbishment Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	No or negligible impact.
Water Resources	Project implementation may result in a small increase in nonradiological cooling water discharge from increased facility usage.
Air Quality and Noise	*Air Quality* – Negligible to minor impacts during refurbishment. Operations may result in increased nonradiological air emissions from increased facility usage. *Noise* – Potential temporary increase in onsite noise levels during refurbishment.
Ecological Resources	No or negligible impact.
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and use of personal protective equipment. Operations impacts may increase as a result of increased accelerator usage. The maximum dose to the MEI as a result of emissions, however, would be limited to 7.5 millirem per year.
Cultural Resources	Possible impact on several historic buildings potentially eligible for listing on the National Register of Historic Places and the LANSCE accelerator building, which has been determined to be eligible. Documentation to resolve adverse effects would be required before making modifications to the accelerator building and could be required before modifications or demolition of any of the other potentially important historic structures.
Socioeconomics and Infrastructure	*Socioeconomics* – No impacts identified. *Infrastructure* – Negligible utility requirements during refurbishment. Project implementation could result in increased utility demands from increased facility usage. Peak load demand could approach current capacity but ongoing improvements to LANL's electric power infrastructure should alleviate this concern.
Waste Management	Small quantities of low-level radioactive waste, mixed low-level radioactive waste, chemical waste, and nonhazardous solid waste would be generated during refurbishment.
Transportation	No or negligible impact.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

MEI = maximally exposed individual; LANSCE = Los Alamos Neutron Science Center.

Summary of Impacts for the Radiography Facility Project

The proposed Radiography Facility would be constructed at TA-55 to eliminate the need for transporting nuclear items to different locations at LANL during the examination process. Minor impacts from construction would be expected. Radiography operations would use engineering and administrative controls to ensure workers would not be exposed to high radiation fields. Implementation of the project would reduce the number of onsite trips for nuclear components, resulting in fewer road closures and improved traffic flow. **Table 3–25** summarizes the potential impacts of the proposed TA-55 Radiography Facility Project.

Table 3–25 Summary of Impacts for the Technical Area 55 Radiography Facility Project

Resource Area	Impact Summary
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	Temporary construction-related impacts. Up to 8,000 cubic yards of soil and rock would be disturbed.
Water Resources	No or negligible impact.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. *Noise* – Temporary construction-related impacts.
Ecological Resources	No or negligible impact.
Human Health	*Construction* – Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. *Operations* – Operations would involve high radiation fields. Worker health would be protected by facility design, radiation control procedures, and personal protective equipment.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No more than negligible impact on LANL utility capacity.
Waste Management	*Construction* – Up to 24 cubic yards of solid waste would be generated during construction of the new building.
Transportation	Implementation of project would reduce onsite nuclear material transport.
Environmental Justice	No or negligible impact.
Facility Accidents	Accident impacts are bounded by those analyzed for the TA-55 Plutonium Facility Complex.

TA = technical area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Summary of Impacts for Plutonium Facility Complex Refurbishment Project

The TA-55 Plutonium Facility Complex Refurbishment Project would upgrade the electrical, mechanical, safety, and other selected facility systems to improve overall reliability to ensure continued operations. The project would be implemented in phases as a series of subprojects. All work would be performed inside the existing TA-55 complex. Several subprojects could have positive impacts on the environment, including replacement of the chiller, which would result in fewer emissions of ozone-depleting substances; implementation of the Steam System Subproject, which would reduce emissions of criteria pollutants; several subprojects that would improve the safety basis of the complex; and improvement in stack mixing and emissions monitoring resulting from implementation of the Stack Upgrade and Replacement Subproject. Implementation of the project would result in small amounts of radioactive and chemical waste that would be accommodated by the LANL waste management infrastructure. **Table 3–26** summarizes the potential impacts for the Plutonium Facility Complex Refurbishment Project.

Table 3–26 Summary of Impacts for the Plutonium Facility Complex Refurbishment Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* – Temporary construction-related impacts of previously disturbed areas. *Visual Environment* – No impacts identified.
Geology and Soils	Temporary construction-related impacts.
Water Resources	No impacts identified.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. Potential reduction in air emissions from upgrades and installation of new equipment. *Noise* – Temporary construction-related impacts confined to LANL site in and near TA-55, except for a very small potential increase in traffic noise.
Ecological Resources	No or negligible impact.
Human Health	Temporary construction-related impacts and accident potential for workers. Potential worker exposure to radiological contamination during refurbishment activities. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment. No radiological risks to members of the public identified from construction or normal operations.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No impacts identified. *Infrastructure* – No more than negligible impact on LANL utility capacity.
Waste Management	*Construction and DD&D* – 340 cubic yards of transuranic waste; 1,300 cubic yards of low-level radioactive waste; 220 cubic yards of mixed low-level radioactive waste; 2,700 cubic yards of demolition debris; and 2,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes and demolition wastes (some of which would be radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	A number of the higher-priority subprojects involve upgrades that would substantially improve the safety basis of the Plutonium Facility Complex.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.4536.

Summary of Impacts for the Science Complex Project

The proposed Science Complex, a state-of-the-art multidisciplinary facility used for light laboratory and offices, would consist of two buildings and one supporting parking structure. The Science Complex would be constructed at one of three proposed sites: in TA-62, west of the Research Park area; in the Research Park in the northwest portion TA-3; or in the southeast portion of TA-3.

Construction of the Science Complex at the TA-62 site or the Research Park site would disturb about 5 acres (2 hectares) of undeveloped land. Each of the locations would require some modification of site infrastructure such as extending natural gas pipelines. The Research Park option would likely require rerouting of additional utilities currently located in or near the project area. **Table 3–27** summarizes the potential impacts of Science Complex Project activities.

Table 3–27 Summary of Impacts for the Science Complex Project

Resource Area	Impact Summary		
	Northwest TA-62 Option	**Research Park Option**	**South TA-3 Option**
Land Resources	*Land Use* – 5 acres of undeveloped land would be permanently disturbed; the land use plans for 15.6 acres would be changed. *Visual Environment* – Views from neighboring properties and roadways would be altered by construction of the proposed structures and from night lighting. Forested buffer between LANL and Los Alamos Canyon would be lost.	*Land Use* – Impacts similar to Northwest TA-62 Site. *Visual Environment* – Impacts similar to Northwest TA-62 Site.	*Land Use* – Negligible impacts identified. *Visual Environment* – No impacts identified.
Geology and Soils	Temporary construction-related impacts. Approximately 840,000 cubic yards of soil and rock would be disturbed.		
Water Resources	Temporary construction-related impacts.		
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. *Noise* – Temporary construction-related impacts. Minor increased noise levels from operation.		
Ecological Resources	Temporary construction-related impacts; loss of up to 5 acres of habitat. Under the TA-62 option, construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle.		
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment.		
Cultural Resources	Possible impact on two archaeological sites determined to be eligible for the National Register of Historic Places. Proposed activities would require documentation to resolve adverse effects.	No impacts identified.	No impacts identified.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Addition of a natural gas line and tie-in to sanitary sewage system would be required. No more than negligible impact on LANL utility capacity.	*Socioeconomics* – No or negligible impact. *Infrastructure* – Would likely require rerouting of many utilities currently located on the site and extension of a sewer trunk line.	*Socioeconomics* – No or negligible impact. *Infrastructure* – Addition of a natural gas line and tie-in to sanitary sewage system would be required.
Waste Management	*Construction* – Approximately 3,300 cubic yards of construction debris would be generated.		
Transportation	Once complete, impacts would include an estimated 5,790 vehicle trips on the average weekday (2,895 vehicles entering and exiting in a 24-hour period).	Impacts similar to Northwest TA-62 Site.	Impacts would be greater than those for the Northwest TA-62 site due to the site location within the planned Security Perimeter Road and higher traffic flows on Diamond Drive relative to those on West Jemez Road. Construction traffic impacts would also be greater due to travel on Diamond Drive.
Environmental Justice	No or negligible impact.		
Facility Accidents	Risk of an LCF for a Science Complex occupant from a CMR Building accident: 1 chance in 560,000 per year.	Risk of an LCF for a Science Complex occupant from a CMR Building accident: 1 chance in 240,000 per year.	Risk of an LCF for a Science Complex occupant from a CMR Building accident: 1 chance in 60,000 per year.

TA = technical area; LCF = latent cancer fatality; CMR = Chemistry and Metallurgy Research.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

Summary of Impacts for Remote Warehouse and Truck Inspection Station Project

The Remote Warehouse and Truck Inspection Station Project would relocate shipment receiving, warehousing, and distribution functions from TA-3 to a site in TA-72. In addition, the Truck Inspection Station would be relocated from its current location on the northwest corner of NM 4 and East Jemez Road to the new location. Impacts resulting from this project would be minor, although the proposed facilities would be constructed in a relatively undeveloped area with desirable aesthetic qualities. Some screening of the proposed facilities would be possible using selective tree cutting and strategic placement of the facilities, but the view would be permanently altered to one that is typical of a more developed area. Nearby sensitive archaeological sites and National Historic Landmarks would be protected from construction and operation activities and increased visitation by installing fencing around the perimeter of the Remote Warehouse and Truck Inspection Station. **Table 3–28** summarizes the potential impacts for this project.

Table 3–28 Summary of Impacts for the Remote Warehouse and Truck Inspection Station Project

Resource Area	*Impact Summary*
Land Resources	*Land Use* –Land use designation would change from Reserve to Physical/Technical Support; 4 acres of undeveloped land would be disturbed. *Visual Environmental* – Views would change from primarily natural landscape to include developed area. Lighting could be visible from Tsankawi Unit of Bandelier National Monument.
Geology and Soils	Temporary construction-related impacts. Approximately 90,000 cubic yards of soil and rock would be disturbed during construction.
Water Resources	Temporary construction-related impacts.
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. *Noise* – Temporary construction-related impacts. Possible noticeable noise along East Jemez Road during operations.
Ecological Resources	Temporary construction-related impacts; loss of 4 acres of habitat. Construction may affect, but is not likely to adversely affect, the bald eagle.
Human Health	Temporary construction-related impacts and accident potential for workers. Impacts would be mitigated through safe work practices, procedures, and personal protective equipment.
Cultural Resources	Possible impact on three nearby archaeological sites potentially eligible for listing on the National Register of Historic Places and two National Historic Landmarks. Proposed activities could require documentation to resolve adverse effects. Fencing around perimeter of project site would aid in protecting these sensitive sites.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Addition of a natural gas line and means of sanitary sewage treatment, conveyance, or disposal would be required. No more than negligible impact on LANL utility capacity.
Waste Management	Approximately 610 cubic yards of construction debris would be generated.
Transportation	Changes to geometry of East Jemez Road. Potential reduction of traffic in and around TA-3.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

Summary of Impacts for TA-18 Closure Project, Including Remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition

This proposed project would relocate the Security Category III and IV capabilities and materials remaining in TA-18, and would conduct DD&D of the buildings and structures at TA-18. The removal of buildings and structures at TA-18 (Pajarito Site) would provide positive local visual impacts, as would the eventual return of the area to its natural state, which would blend with other undisturbed portions of LANL. Buildings of historic importance and other cultural sites are located in TA-18. These cultural resources would be protected during DD&D activities as required. **Table 3–29** summarizes the potential impacts of these activities.

Table 3–29 Summary of Impacts for the Technical Area 18 Closure Project, Including Remaining Operations Relocation and Structure Decontamination, Decommissioning, and Demolition

Resource Area	*Impact Summary*
Land Resources	*Land Use* – DD&D could result in an overall change in the land use designation from Nuclear Materials Research and Development to Reserve. *Visual Environmental* – Potentially positive impact from removal of old buildings.
Geology and Soils	Temporary DD&D-related impacts.
Water Resources	DD&D would remove facilities from a floodplain, thereby enhancing protection of surface water quality.
Air Quality and Noise	*Air Quality* – Temporary DD&D-related impacts. *Noise* – Temporary DD&D-related impacts.
Ecological Resources	Temporary DD&D-related impacts. DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl and southwestern willow flycatcher. Restoration of the site could create a more natural habitat and benefit wildlife.
Human Health	The primary source of potential impacts on workers and members of the public would be associated with the release of radiological contaminants during DD&D. Potential impacts would be much less than during past operations and would be mitigated using confinement and filtration methods.
Cultural Resources	Three archaeological resources sites found at TA-18 (a rock shelter, a cavate complex, and the Ashley Pond cabin) have been determined to be eligible for listing on the National Register of Historic Places, and there are other eligible and potentially eligible buildings within the TA. Proposed activities would require documentation to resolve adverse effects, and these buildings would be protected during DD&D activities as required. Several historic properties at TA-18 have been identified for permanent retention, including the Pond Cabin, the Slotin Accident Building (TA-18-1), and other properties that represent the history of the TA and LANL.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No or negligible impact.
Waste Management	Waste generated from the disposition of the buildings and structures is estimated to be 4,700 cubic yards of low-level radioactive waste; 5 cubic yards of mixed low-level radioactive waste; 17,000 cubic yards of demolition debris; and 75,000 pounds of chemical waste.
Transportation	Transportation of wastes would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for the TA-21 Structure Decontamination, Decommissioning, and Demolition Project

All or a portion of the buildings and structures at TA-21 would undergo DD&D under this project. Two options are proposed: the Complete DD&D Option would remove essentially all structures within TA-21; the Compliance Support Option would remove only those structures necessary to support remediation activities.

Onsite and offsite visual impacts would be improved by removal of some or all of the buildings and structures at TA-21. DD&D activities would affect buildings and structures potentially eligible for listing on the National Register of Historic Places, so documentation to resolve adverse effects could be required. Implementation of this project at the same time that TA-21 MDA remediation is underway would result in local traffic impacts along DP Road and in the Los Alamos townsite. **Table 3–30** summarizes the potential impacts of these activities.

Table 3–30 Summary of Impacts for Technical Area 21 Structure Decontamination, Decommissioning, and Demolition Project

Resource Area	***Impact Summary***	
	Complete DD&D Option	***Compliance Support Option***
Land Resources	*Land Use* – The remainder of the western portion of the area would be available for conveyance to Los Alamos County. The eastern part of the TA would remain a part of LANL for the foreseeable future. *Visual Resources* – Temporary DD&D-related impacts. Long-term impacts would be positive with the removal of old industrial buildings.	*Land Use* – Currently unconveyed portions of TA-21 would remain under DOE control. Land use designations would remain unchanged. *Visual Environment* – Temporary construction- and DD&D-related impacts. Over the long-term, the view of the TA from NM 502 and from higher elevations to the west would still include portions of the current mix of 50-year-old structures.
Geology and Soils	Temporary DD&D-related impacts.	Temporary DD&D-related impacts.
Water Resources	Improvement in overall water resources from discontinuing processes and associated water use and eliminating two outfalls.	Little or no impact on water resources.
Air Quality and Noise	*Air Quality* – Temporary DD&D impacts. Operational emissions would be relocated or cease. *Noise* – Temporary DD&D-related impacts.	*Air Quality* – Nonradioactive air pollutant emissions from the three natural gas-fired boilers in Building 21-0357 and the vehicle exhaust and emissions from activities in the maintenance facilities would remain. *Noise* – Temporary DD&D-related impacts.
Ecological Resources	Temporary DD&D-related impacts. Activities may affect, but are not likely to adversely affect, the Mexican spotted owl.	
Human Health	East Gate MEI would receive 2×10^{-4} millirem over the life of the project.	
Cultural Resources	DD&D of buildings and structures at TA-21 would have direct effects on 15 NRHP-eligible historic buildings and structures (and 1 potentially eligible building) associated with the Manhattan Project and Cold War years at LANL.	
Socioeconomics and Infrastructure	*Socioeconomics* – Temporary modest increase in employment due to DD&D activities. *Infrastructure* – No or negligible impact.	
Waste Management	DD&D would generate 1 cubic yard of transuranic waste; 34,000 cubic yards of low-level radioactive waste, 65 cubic yards of mixed low-level radioactive waste; 47,000 cubic yards of solid waste; and 420,000 pounds of chemical waste.	The volume of solid waste and debris generated under this Option would be about 29,000 cubic yards less than that under the Complete DD&D Option.
Transportation	Transportation of construction materials and wastes and demolition wastes (some radioactive) would not be expected to result in any fatalities or excess LCFs. Local traffic impacts associated with DD&D activities would be exacerbated by MDA remediation occurring at the same time.	
Environmental Justice	No or negligible impact.	
Facility Accidents	No or negligible impact.	

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MEI = maximally exposed individual; NRHP = National Register for Historic Places; LCF = latent cancer fatality; MDA = material disposal area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for Waste Management Facilities Transition Project

This project involves DD&D of certain aboveground facilities in TA-54, Areas G and L, to facilitate closure of those areas; construction of additional waste management facilities; removal of waste stored underground in pits and shafts in Area G; and preparation and shipment of this waste for disposal. New waste management facilities would include a retrieval facility to assist in removal of high-activity remote-handled transuranic waste from certain shafts, new low-level radioactive waste facilities in TA-54, and a new TRU Waste Facility in the Pajarito Road Corridor to store and process transuranic waste.

The waste storage domes in Area G would be removed as part of this project, which would have a beneficial impact on both near and distant views. Because these domes are visible from the lands of the Pueblo of San Ildefonso, their removal would improve the views from that vantage point. Construction at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Construction of the TRU Waste Facility, which could require up to 7 acres (2.8 hectares), could occur within Mexican spotted owl Areas of Environment Interest which would require consultation with the U.S. Fish and Wildlife Service. (The location of the TRU Waste Facility has not been finalized, so land resource, ecological, and cultural resource impacts could vary.) Eventual removal of stored wastes in Area G would reduce the dose to the facility-specific MEI. Worker doses could also decrease after 2015, once waste management activities in Area G are completed. **Table 3–31** summarizes the potential impacts of these activities.

Summary of Impacts for Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions[7]

The environmental impacts that could result from implementation of the Consent Order depend on decisions yet to be made by the New Mexico Environment Department. To bound the range of possible consequences of implementing different corrective measures, two action options have been evaluated: (1) a Capping Option, in which specific MDAs are stabilized in-place, and (2) a Removal Option, in which the waste and contamination within the MDAs are removed. These options are for analytical purposes only and do not necessarily represent the corrective measures that NNSA would propose to the New Mexico Environment Department. Remediation of other potential release sites would also occur at LANL. The impacts of remediating other potential release sites would be small relative to those for MDA remediation.

The Removal Option would result in larger near-term impacts than the Capping Option. Both options would involve major ground-disturbing activities that would require use of heavy equipment and hauling of materials and wastes. Temporary construction impacts such as increases in noise levels and emissions of criteria pollutants and particulate matter would be expected. Because these activities would be widespread and would continue over a number of years, MDA remediation activities would have a larger impact than other proposed projects. Under the Removal Option, large quantities of wastes would be generated including low-level radioactive waste and transuranic waste buried at LANL before 1970. Onsite disposal capacity

Table 3–31 Summary of Impacts for the Waste Management Facilities Transition Project

Resource Area	Impact Summary
Land Resources	*Land Use* – Temporary construction-related impacts. The TRU Waste Facility could require up to 7 acres (2.8 hectares) of undeveloped land and could result in a change in land use designation, depending on its location. *Visual Environment* – Positive impact due to removal of the domes in TA-54. The TRU Waste Facility could be visible from San Ildefonso Pueblo lands, depending on its location.
Geology and Soils	Temporary construction- and DD&D-related impacts would occur in previously disturbed areas; impacts would be minor. Up to 169,000 cubic yards of soil and rock would be disturbed.
Water Resources	Minor impacts to surface water and groundwater. New facilities would use mitigative techniques to minimize impacts of spills.
Air Quality and Noise	*Air Quality* – Temporary construction impacts. Operational emissions would be mitigated using engineering controls, such as filtration systems, and monitored. Emissions from new facilities would not exceed those currently measured at the Decontamination and Volume Reduction System. Point source and area emissions in Area G would decrease by the end of 2015. *Noise* – Temporary construction-related impacts.
Ecological Resources	Temporary construction-related impacts at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Construction of the TRU Waste Facility could disturb up to 7 acres (2.8 hectares) of ponderosa pine forest and open field. Consultation with the U.S. Fish and Wildlife Service could be required since construction could take place within Mexican spotted owl Areas of Environmental Interest.
Human Health	Minimal radiological impacts to offsite population. Reduced impacts to the MEI. Removal of transuranic waste would reduce area sources of occupational radiological exposure in Area G, potentially decreasing worker exposures after 2015.
Cultural Resources	Removal of the domes at TA-54 would reduce visual impacts on nearby traditional cultural properties. Potential impact to cultural resources could occur from construction of the TRU Waste Facility, depending on its location.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Infrastructure demands would not exceed current LANL site capabilities.
Waste Management	Construction waste would include 500 cubic yards of construction debris. DD&D waste would include 30,000 cubic yards of low-level radioactive waste; 8 cubic yards of mixed low-level radioactive waste; 54,000 cubic yards of solid waste including demolition debris; and 566,000 pounds of chemical waste.
Transportation	Transportation of construction materials and wastes and demolition wastes (some radioactive) would not be expected to result in any fatalities or excess LCFs.
Environmental Justice	No or negligible impact.
Facility Accidents	The postulated facility accident having the highest impacts would result in an LCF risk of 1 in 900 for a noninvolved worker, 1 in 12,000 for the MEI, and 1 in 500 to the exposed population.

TA = technical area; DD&D = decontamination, decommissioning, and demolition; MEI = maximally exposed individual; LCF = latent cancer fatality.
Note: To convert cubic yards to cubic meters, multiply by 0.76456, pounds to kilograms, multiply by 0.45359.

for low-level radioactive wastes may be sufficient, depending on the actual volumes generated by remediation; disposal capacity can be supplemented by offsite facilities if needed. WIPP's disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste plus all transuranic waste buried before 1970 across the DOE complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs, if generated, would be based on the needs of the entire DOE complex. Any transuranic waste

[7] NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.

generated at LANL without a disposal pathway would be safely stored until disposal capacity becomes available.

The Removal Option would result in over 100,000 shipments of radioactive and nonradioactive wastes that could require transport to offsite disposal facilities. These shipments could lead to two to three traffic fatalities over a 10-year period from nonradiological (truck collision) accidents. In addition, both the Capping or Removal Option would require the use of large quantities of soil, rock, and other bulk materials that would be obtained from LANL or local sources including the borrow pit in TA-61. Transporting this material to the MDAs could increase traffic congestion on LANL and local roads. Acquisition of large quantities of material from the TA-61 borrow pit could result in local visual impacts and some elimination of wildlife habitat.

Operational accidents postulated for the Removal Option could result in radiological or chemical exposures and risks to noninvolved workers, the MEI, and the population within a 50-mile (80-kilometer) radius. Although sulfur dioxide is not known to be present in MDA B, an accident was postulated in which a quantity of the gas would be released. This postulated accident could result in concentrations of sulfur dioxide in excess of the Emergency Response Planning Guideline (ERPG)-3 out to 111 feet (34 meters) (DOE 2005e). The MDA B MEI distance is 148 feet (45 meters). The ERPG-2 distance would be approximately 270 feet (80 meters). **Table 3–32** summarizes the potential impacts of the options for remediation, cleanup, and Consent Order actions.

Table 3–32 Summary of Impacts for Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions

Resource Area	***Capping Option***	***Removal Option***
Land Resources	*Land Use* – Temporary commitment of land may be required to support remediation. Future use of the MDAs would remain restricted because capping would stabilize rather than remove existing contamination. *Visual Environment* – Temporary adverse impacts would result from capping activities. Borrow pit in TA-61 would become more visible.	*Land Use* – Temporary commitment of land may be required to support remediation. Decontamination would provide expanded opportunities for future use of some lands. *Visual Environment* – Temporary adverse impacts would result from removal activities. Borrow pit in TA-61 would become more visible.
Geology and Soils	Up to 2.5 million cubic yards of soil and rock would be required for capping; most material would be available from LANL sources. Covers for the MDAs would be contoured and provided with run-on and run-off control measures. Contamination within the subsurface of the MDAs and in the immediate vicinities would be fixed in-place except for contaminated gases or vapors.	Up to 2.2 million cubic yards of soil and rock would be required for fill and cover material; most would be available from LANL sources. Complete removal of the MDAs would eliminate the susceptibility of buried materials to erosional or other geological processes. Existing soil contamination in the vicinity of the MDAs would be greatly reduced, and contaminated soil or gas would be largely eliminated.
Water Resources	Few, if any impacts to surface water or groundwater from site investigations. Final MDA covers would minimize surface water run-on, runoff, erosion, and could protect surface and groundwater resources.	Few, if any, impacts to surface or groundwater from site investigations. There would be much less contamination in soils and sediments that could present a risk to water quality.

Resource Area	***Capping Option***	***Removal Option***
Air Quality and Noise	*Air Quality* – Minor to moderate impacts from releases of airborne pollutants caused by heavy equipment used in remediation and trucks hauling materials. Increased potential for particulate matter release from TA-61 borrow pit. *Noise* – Minor to moderate increase in traffic noise associated with remediation.	*Air Quality* – Larger releases of airborne pollutants than Capping Option from additional vehicles and heavy equipment. Comparable particulate matter release. The potential for long-term release of volatile organic compounds from the MDAs would be greatly reduced, if not eliminated. *Noise* – Temporary increase in noise in vicinity of remediation. Minor to moderate increase in traffic noise associated with remediation.
Ecological Resources	Temporary localized, construction-type impacts during site investigations and remediation. In a few cases, remediation activities may affect, but are not likely to adversely affect, the Mexican spotted owl, bald eagle, and southwestern willow flycatcher. Possible loss of habitat at the TA-61 borrow pit, including undeveloped buffer and core habitat for the Mexican spotted owl. Expansion of the borrow pit would require consultation with the U.S. Fish and Wildlife Service.	
Human Health	Radiological and nonradiological risks to workers would be minor. There would be no risk to the public during MDA capping, while future risks would be reduced.	Radiological and nonradiological risks to workers would be increased. There would be small risk to the public during MDA removal, while future risks would be greatly reduced.
Cultural Resources	No archaeological resources are located within any of the MDAs. Few or no risks to cultural resources at potential release sites. All work would be coordinated with LANL personnel responsible for preservation of cultural resources.	
Socioeconomics and Infrastructure	*Socioeconomics* – Marginal increases in employment, personal income, and other economic measures. *Infrastructure* – Marginal increases in utility usage.	*Socioeconomics* –Increases anticipated in employment, personal income, and other economic measures. *Infrastructure* – Increases in utility infrastructure demands.
Waste Management	280 cubic yards of transuranic waste; 20,000 cubic yards of low-level radioactive waste; 1,800 cubic yards of mixed low-level radioactive waste; 47,000 cubic yards of solid waste; and 50 million pounds of chemical waste. Sufficient capacity would exist at LANL to dispose of the low-level radioactive waste.	22,000 cubic yards of transuranic waste; 1,000,000 cubic yards of low-level radioactive waste; 180,000 cubic yards of mixed low-level radioactive waste; 130,000 cubic yards of solid waste; and 97 million pounds of chemical waste. This volume of low-level radioactive waste may require use of some offsite disposal capacity.
Transportation	Increase in shipments of waste and bulk materials on onsite and offsite roads would not be expected to result in any LCFs among workers or the public from radiation exposure during waste transport, nor traffic fatalities from accidents.	Large increase in shipments of waste and bulk materials on onsite and offsite roads would not be expected to result in any LCFs among workers or the public from radiation exposure during waste transport, but could result in traffic fatalities.
Environmental Justice	No disproportionately high and adverse impacts on minority or low-income populations.	
Facility Accidents	Low risks of accidents involving radioactive or hazardous materials.	Postulated facility accident with the highest radiological impacts would result in an LCF risk of 1 in 210 for a noninvolved worker; 1 in 1,500 for the MEI; and 1 in 220 for the population within a 50-mile radius. Postulated facility accident with the highest chemical impacts would result in concentrations of sulfur dioxide exceeding ERPG-3 out to 111 feet; ERPG-2 out to 270 feet.

MDA = material disposal area; TA = technical area; LCF = latent cancer fatality; MEI = maximally exposed individual.
ERPG = Emergency Response Planning Guideline.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; feet to meters, multiply by 0.3048; miles to kilometers, multiply by 1.6093; pounds to kilograms, multiply by 0.45359.

Summary of Impacts for Security-Driven Transportation Modifications Project

This proposed project would restrict privately owned vehicles (according to their security level) along portions of Pajarito Corridor West between TA-48 and TA-63. The project would involve constructing new roadways, parking lots, pedestrian and vehicle bridges across Ten Site Canyon, and security check points. Auxiliary actions are also being considered that would construct bridges across Mortandad and Sandia Canyons. **Table 3–33** summarizes the potential impacts of these activities.

Table 3–33 Summary of Impacts for the Security-Driven Transportation Modifications Project

Resource Area	*Impact Summary*	
	Proposed Action	***Auxiliary Actions***
Land Resources	*Land Use* – Development of portions of the Pajarito Corridor West would be within current land use plans. *Visual Environment* – Temporary construction impacts. Permanent, pronounced changes to views from parking lots and pedestrian and vehicle bridges across Ten Site Canyon.	*Land Use* – The route for Auxiliary Action A would represent a change in land use but would be within the scope of the LANL Comprehensive Site Plan. The route for Auxiliary Action B would be partially within current land use plans. *Visual Environment* – Permanent, pronounced changes to views from proposed bridges over Mortandad and Sandia Canyons.
Geology and Soils	Temporary construction-related impacts. Approximately 238,000 cubic yards of soil and rock would be disturbed during construction. Up to 26,000 cubic yards of soil and rock would be disturbed if both auxiliary actions are implemented.	
Water Resources	Temporary construction-related impacts.	
Air Quality and Noise	*Air Quality* – Temporary construction-related impacts. Minor increase in vehicle emissions during operation. *Noise* – Temporary construction-related impacts. Minor increase in traffic noise in vicinity of new roads and bus routes during operation.	*Air Quality* – Temporary construction-related impacts. Minor increase in vehicle emissions during operation. *Noise* – Temporary construction-related impacts. Minor increase in traffic noise in vicinity of new roads and bus routes during operation.
Ecological Resources	Temporary construction-related impacts. Up to 30 acres of habitat loss from parking lot and bridge construction. Construction of a span bridge across Ten Site Canyon would be unlikely to cause adverse affects to the Mexican spotted owl.	Temporary construction-related impacts. Proposed Auxiliary Action A construction falls within Areas of Environmental Interest core and buffer zones for the Mexican spotted owl, and would disturb up to 25.4 acres of habitat. Proposed Auxiliary Action B construction falls within Areas of Environmental Interest buffer zone for the Mexican spotted owl, and would disturb 67.1 acres of habitat. Potentially adverse impacts on owls from traffic noise and light. Implementation of either Auxiliary Action would necessitate consultation with the U.S. Fish and Wildlife Service.
Human Health	No or negligible impact.	
Cultural Resources	Proposed bridges could adversely affect views of Ten Site Canyon from nearby Traditional Cultural Properties.	Further detailed analysis would be required once the exact bridge locations are determined to ensure protection of prehistoric and historic sites located to the east and west of the proposed bridge corridor. Proposed bridges could adversely affect views of Mortandad and Sandia Canyons from nearby Traditional Cultural Properties.
Socioeconomics and Infrastructure	*Socioeconomics* – No impacts identified. *Infrastructure* – Temporary construction-related impacts. Some existing utilities might require relocation or rerouting.	
Waste Management	Approximately 1,260 cubic yards of construction debris.	Approximately 160 cubic yards under Auxiliary Action A, and 110 cubic yards under Auxiliary Action B, of construction debris.
Transportation	Some temporary and intermittent disruption of traffic during construction of new roads and bridges. Traffic patterns would be permanently altered, but impacts would be minor.	
Environmental Justice	No or negligible impact.	

Note: To convert cubic yards to cubic meters, multiply by 0.76456; acres to hectares, multiply by 0.40469.

The most consequential impacts from implementing this project would be on the visual environment and the Mexican spotted owl. The removal of open and forested land under the Proposed Action would add to the overall developed appearance of the Pajarito Corridor West as viewed from nearby and higher elevations to the west. The construction of both vehicle and pedestrian bridges across Ten Site Canyon under the Proposed Action, and Mortandad and Sandia Canyons under the auxiliary actions, would be major changes to the landscape. While careful site selection and bridge design would help mitigate visual impacts, the bridges would nevertheless alter the natural appearance of the canyons as viewed from both nearby and distant locations. The proposed bridges could adversely affect views of the three canyons from nearby traditional cultural properties. Bridges constructed across Mortandad and Sandia Canyons would pass through Areas of Environmental Interest for the Mexican spotted owl. Habitat would be lost as a result of the proposed and auxiliary actions, and the light and noise from traffic could create adverse effects. The U.S. Fish and Wildlife Service has determined that, provided reasonable and prudent measures are taken, construction of a span bridge over Ten Site Canyon would be unlikely to cause adverse affects to the Mexican spotted owl. Additional consultation with the U.S. Fish and Wildlife Service would be needed for the proposed action if a land rather than span bridge was to be used, and for the auxiliary actions once the exact locations and designs of the optional bridges over Mortandad and Sandia Canyons are better known.

Summary of Impacts for Nicholas C. Metropolis Center for Modeling and Simulation Increase in Level of Operations

This project would expand the computing capabilities of the Metropolis Center to support a 100-teraflops capability at a minimum, and could approach 1,000 teraflops (1 petaflops). This action would add mechanical and electrical equipment, including chillers, cooling towers, and air-conditioning units. **Table 3–34** summarizes the potential impacts of these activities.

The level to which operations could increase would be limited by the amount of electricity (15 megawatts) and water (51 million gallons [193 million liters] per year) needed to support the increased capabilities. Because each new generation of computing capability machinery continues to be designed with increased computational speed and enhanced efficiency in cooling water and electrical requirements, it is anticipated that higher computing capabilities could be achieved within these limitations. Planned improvements to the Sanitary Effluent Recycling Facility should increase its effectiveness in supplying the Metropolis Center with cooling water. Accordingly, the Metropolis Center's reliance on groundwater is expected to diminish substantially.

Table 3–34 Summary of Impacts for Nicholas C. Metropolis Center for Modeling and Simulation Increase in Level of Operations

Resource Area	*Impact Summary*
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	No or negligible impact.
Water Resources	Discussed in infrastructure.
Air Quality and Noise	No or negligible impact.
Ecological Resources	No or negligible impact.
Human Health	No or negligible impact.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – Water usage would expand to 51 million gallons per year, which would not exceed available water supply capacities. Electrical demand would increase to 15 megawatts, which would not exceed available electrical supply capacities.
Waste Management	No or negligible impact.
Transportation	No or negligible impact
Environmental Justice	No or negligible impact.
Facility Accidents	No or negligible impact.

Note: To convert gallons to liters, multiply by 3.7854.

Summary of Impacts for Increase in Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project

This proposed project would expand the types and quantities of sealed sources that could be managed at LANL by the Off-Site Source Recovery Project. The proposed project would continue the current approach of providing safe storage of sealed sources at LANL when other reasonable options for disposition, such as reuse or commercial disposal, are not available. The only impacts resulting from these activities would result from exposure to the radioactive sources during normal operations and postulated accidents. Under normal conditions, the sealed sources would be completely contained and would contribute only to external radiation exposure. Proper shielding and radiation control procedures would minimize worker exposure. Noninvolved workers and the public would not be expected to receive any measurable dose during normal operations.

For purposes of analysis, potential bounding accident scenarios were assessed for an aircraft crash with fire at Area G at TA-54, as well as a seismic event with fire at Wing 9 of the Chemistry and Metallurgy Research Building. Consequences of the Wing 9 event also were calculated for a release emanating from TA-48 because the Radiological Sciences Institute that would be built in TA-48 would provide a replacement for the Chemistry and Metallurgy Research Building Wing 9 hot cell. None of these accidents would result in a fatal dose to the noninvolved worker, the MEI, or the population within a 50-mile (80-kilometer) radius. The highest LCF risk to the population would result from an accident at Wing 9 of the Chemistry and Metallurgy Research Building with consequences calculated at TA-3. This postulated accident could result in an increase in LCF risk of approximately 1 chance in 6 million for the noninvolved worker, 1 chance in 70 million for the MEI, and 1 chance in 600 for the population within a 50-mile (80-kilometer) radius.

Potential mitigation measures could include placing sealed sources at locations where they would not be susceptible to damage from an aircraft crash, fire, or seismic event (kept underground); or instituting lower limits for maximum allowable source radioisotope activity in shipping containers, the TA-54 dome, and Wing 9 of the Chemistry and Metallurgy Research Building. **Table 3–35** summarizes the potential impacts from increasing the scope of the Off-Site Source Recovery Project at LANL.

Table 3–35 Summary of Impacts for Increase in Type and Quantity of Sealed Sources Managed at Los Alamos National Laboratory by the Off-Site Source Recovery Project

Resource Area	***Impact Summary***
Land Resources	*Land Use* – No or negligible impact. *Visual Environment* – No or negligible impact.
Geology and Soils	No or negligible impact.
Water Resources	No or negligible impact.
Air Quality and Noise	*Air Quality* – No or negligible impact. *Noise* – Temporary construction-related impacts from construction and burial activities.
Ecological Resources	No or negligible impact.
Human Health	Involved worker doses would be maintained below their regulatory and administrative limits through use of shielding, safe work practices, procedures, and personal protective equipment. Noninvolved workers and the public would not be expected to receive any measurable doses during normal operations.
Cultural Resources	No or negligible impact.
Socioeconomics and Infrastructure	*Socioeconomics* – No or negligible impact. *Infrastructure* – No impacts identified.
Waste Management	No impacts identified.
Transportation	No or negligible impact.
Environmental Justice	No or negligible impact.
Facility Accidents	Postulated accidents could result in an increase in LCF risk to the noninvolved worker, the MEI, and population within 50-mile radius. Highest LCF risk to population would be from a CMR Building Wing 9 accident.

LCF = latent cancer fatality; MEI = maximally exposed individual; CMR = Chemistry and Metallurgy Research.
Note: To convert miles to kilometers, multiply by 1.6093.

CHAPTER 4
AFFECTED ENVIRONMENT

4.0 AFFECTED ENVIRONMENT

This chapter describes the environmental setting and existing conditions associated with Los Alamos National Laboratory (LANL) and the U.S. Department of Energy's (DOE) operations at the site. This chapter also provides baseline descriptions for use in evaluating the environmental impacts of the reasonable alternatives identified in Chapter 3. Since existing conditions at the site were described in detail in the *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a), information presented in that document is incorporated here by reference. The present chapter summarizes each resource area for context, based on the *1999 SWEIS*, but emphasizes the differences that have occurred in the environmental setting since its publication. Resource areas addressed include land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, socioeconomics and infrastructure, waste management and pollution prevention, transportation, environmental justice, and environmental restoration.

LANL is located in north-central New Mexico, 60 miles (97 kilometers) north-northeast of Albuquerque, 25 miles (40 kilometers) northwest of Santa Fe, and 20 miles (32 kilometers) southwest of Española in Los Alamos and Santa Fe Counties (see **Figure 4–1**). LANL and the surrounding region are characterized by forested areas with mountains, canyons, and valleys, as well as diverse cultures and ecosystems. The area is dominated by the Jemez Mountains to the west and the Sangre de Cristo Mountains to the east. These two mountain ranges are divided north to south by the Rio Grande. LANL is located on the Pajarito Plateau, which is cut by 13 steeply sloped and deeply eroded canyons that have formed isolated finger-like mesas running west to east. Most structures at LANL are located on these mesas (DOE 1999a).

DOE evaluated the environmental impacts within defined regions of influence for each resource area. The regions of influence are specific to the type of effect evaluated, and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions were assessed for an area within an 80-kilometer (50-mile) radius of the proposed facilities. Economic effects were evaluated within a socioeconomic region of influence that include the county in which the site is located and nearby counties in which substantial portions of the site's workforce reside. Brief descriptions of the regions of influence are given in **Table 4–1**.

This chapter presents information about the LANL environment to serve as a baseline against which impacts can be compared. Depending on the resource area being discussed, data are presented in different ways. For resource areas with annually quantifiable metrics (such as effluent discharges or radiological doses) data for a number of years are shown, generally for the years since the issuance of the *1999 SWEIS* through 2005. For other resource areas (such as land use, noise, ecology, and cultural resources), the data are current as of the end of 2005 unless otherwise noted.

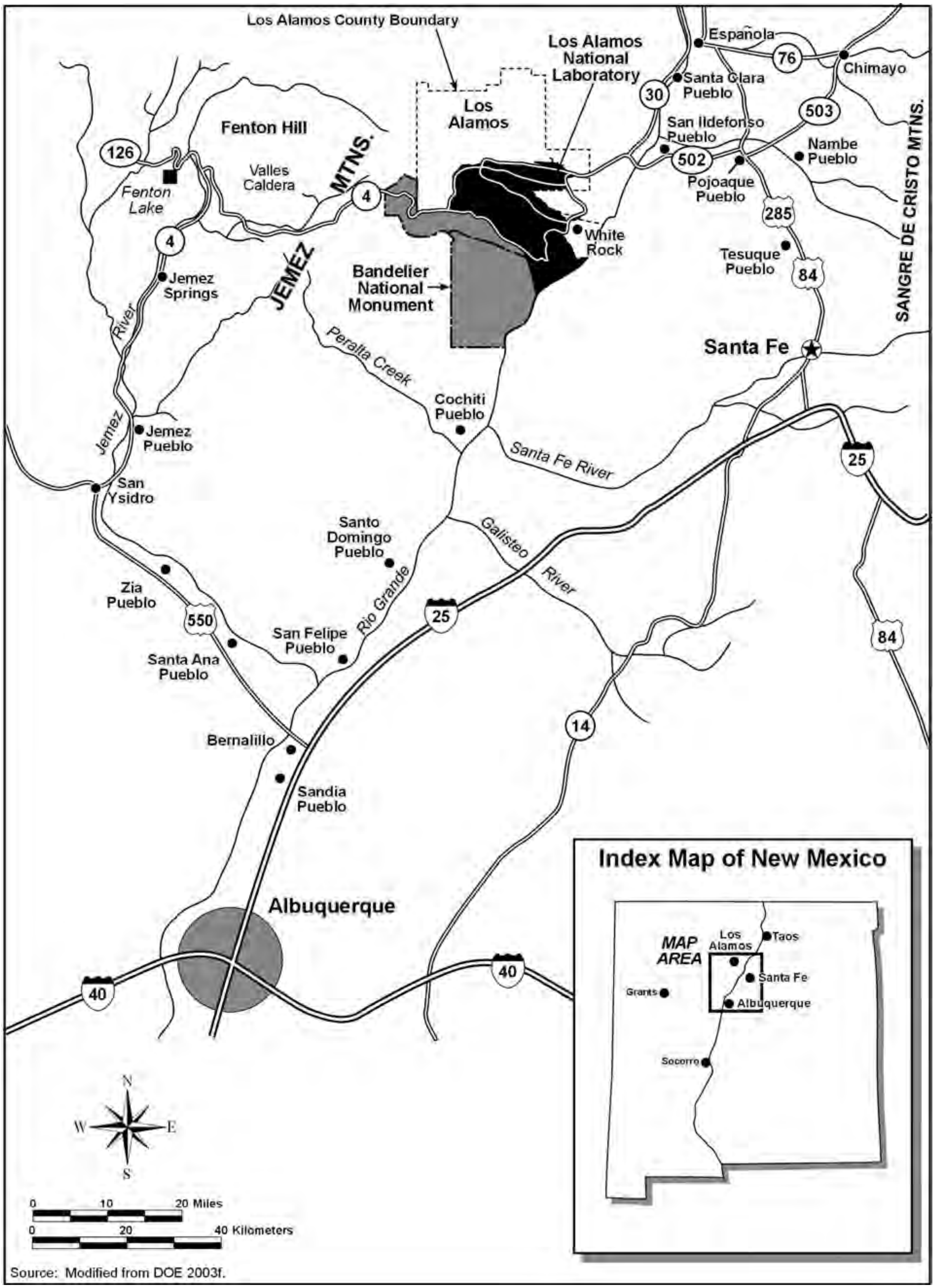


Figure 4–1 Location of Los Alamos National Laboratory

Table 4–1 General Regions of Influence for the Affected Environment

Environmental Resources	*Region of Influence*
Land Resources	The site and the areas immediately adjacent to the site
Geology and Soils	Geologic and soil resources within the site and nearby offsite areas
Water Resources	Surface water bodies and groundwater located onsite, on adjacent properties, and extending to northern New Mexico and southern Colorado
Air Quality and Noise	The site, nearby offsite areas within local air quality control regions, where significant air quality impacts may occur (air quality); the site, nearby offsite areas and access routes to the site (noise)
Ecological Resources	The site and adjacent areas
Human Health	The site and offsite areas within 50 miles of the site where worker and general population radiation, and hazardous chemical exposures may occur
Cultural Resources	The area within the site and adjacent to the site boundary
Socioeconomics and Infrastructure	The counties where approximately 90 percent of site employees reside (socioeconomics); the site (infrastructure)
Waste Management and Pollution Prevention	The site
Transportation	Local area and transportation corridors to offsite locations
Environmental Justice	The minority and low-income populations within 50 miles of the site
Environmental Restoration	The site

Note: To convert miles to kilometers, multiply by 1.6093.

4.1 Land Resources

Land resources include land use and visual resources. Land use is defined as the way land is developed and used in terms of the kinds of anthropogenic activities that occur (such as agriculture, residential areas, industrial areas) (EPA 2006a). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources such as geological, atmospheric, ecological, and cultural resources. Visual resources are natural and manmade features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape (BLM 1986).

4.1.1 Land Use

Land use in the LANL region is linked to the economy of northern New Mexico, which depends heavily on tourism, recreation, agriculture, and Federal and state government employment for its economic base. Area communities generally are small and primarily support urban uses including residential, commercial, light industrial, and recreational facilities. The region also includes Native American communities; lands of the Pueblo of San Ildefonso share LANL's eastern border, and six other Pueblos are clustered nearby. Entities that serve as land stewards and determine land uses within the LANL region are depicted in **Figure 4–2**. These include DOE, the U.S. Forest Service, Native American pueblos, the U.S. National Park Service, the County of Los Alamos, private land-owners, the State of New Mexico, and the Bureau of Land Management.

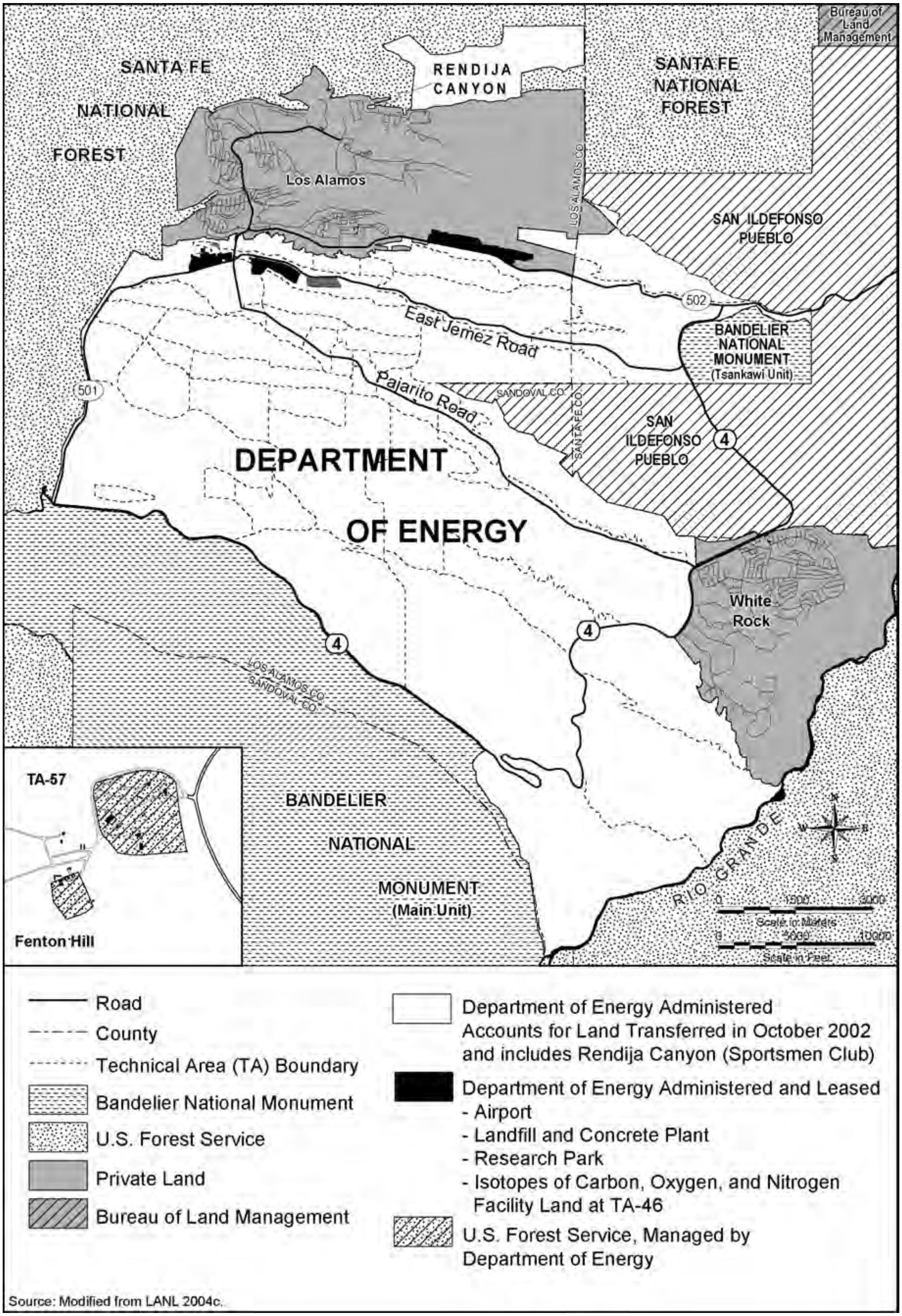


Figure 4–2 Land Management and Ownership

LANL is divided into 48 technical areas (TAs) (not including TA-0, which comprises leased space within the Los Alamos townsite) covering 25,600 acres (10,360 hectares) with locations and spacing that reflect the site's historical development patterns, regional topography, and functional relationships (see **Figure 4–3**). In 1943, development of LANL began with the construction of a little more than 93,000 gross square feet (8,640 gross square meters) of space. At the end of 2005, LANL had approximately 8,600,000 gross square feet (800,000 gross square meters) of space. While the number of structures changes with time (due to frequent addition or removal of temporary structures and miscellaneous buildings), the current breakdown of structures is 952 permanent structures; 373 temporary structures (such as trailers, transportables, and transportainers); and 897 miscellaneous structures (such as sheds and utility structures) (LANL 2006a).

Only about 2,400,000 gross square feet (223,000 gross square meters) of space in 409 buildings are designed to house personnel in an office environment. In addition to onsite office space, 450,000 gross square feet (42,000 gross square meters) of space are leased within the Los Alamos townsite and White Rock community to provide workspace for an additional 1,683 people (LANL 2006a).

Overall, 43 percent of the structures at LANL (not including leased or rented space) are more than 40 years old, and 52 percent are more than 30 years old. A recent condition assessment survey determined the conditions of the facilities are: 23 percent in excellent condition; 17 percent in good; 11 percent in adequate; 17 percent in fair; 18 percent in poor; and 11 percent in failing condition. Condition assessment requirements cover a wide range of criteria and standards (such as safety, severity, and seismic) (LANL 2006a). This represents an improvement in both building age and condition since the *1999 SWEIS* was published.

Although developed areas play a vital role at LANL, they make up only a small part of the site. Most of the site is undeveloped to provide security, safety, and expansion possibilities for future mission-support requirements. There are no agricultural activities present on the LANL site, nor are there any prime farmlands in the vicinity. In 1977, DOE designated LANL as a National Environmental Research Park; in 1999, the White Rock Canyon Reserve was dedicated. The Reserve is about 1,000 acres (405 hectares) in size and is located on the southeast perimeter of LANL. It is managed jointly by DOE and the National Park Service for its significant ecological and cultural resources and research potential (DOE 2003d).

LANL is separated into the following internal land use categories: service and support, experimental science, high explosives research and development, high explosives testing, nuclear materials research and development, physical and technical support, public and corporate interface, reserve, theoretical and computational science, and waste management (see **Figure 4–4**) (LANL 2003h). Previously, a hazard-based system based on the most hazardous activity in each TA was used to characterize land use. Six land use categories were delineated under this system (DOE 1999a).

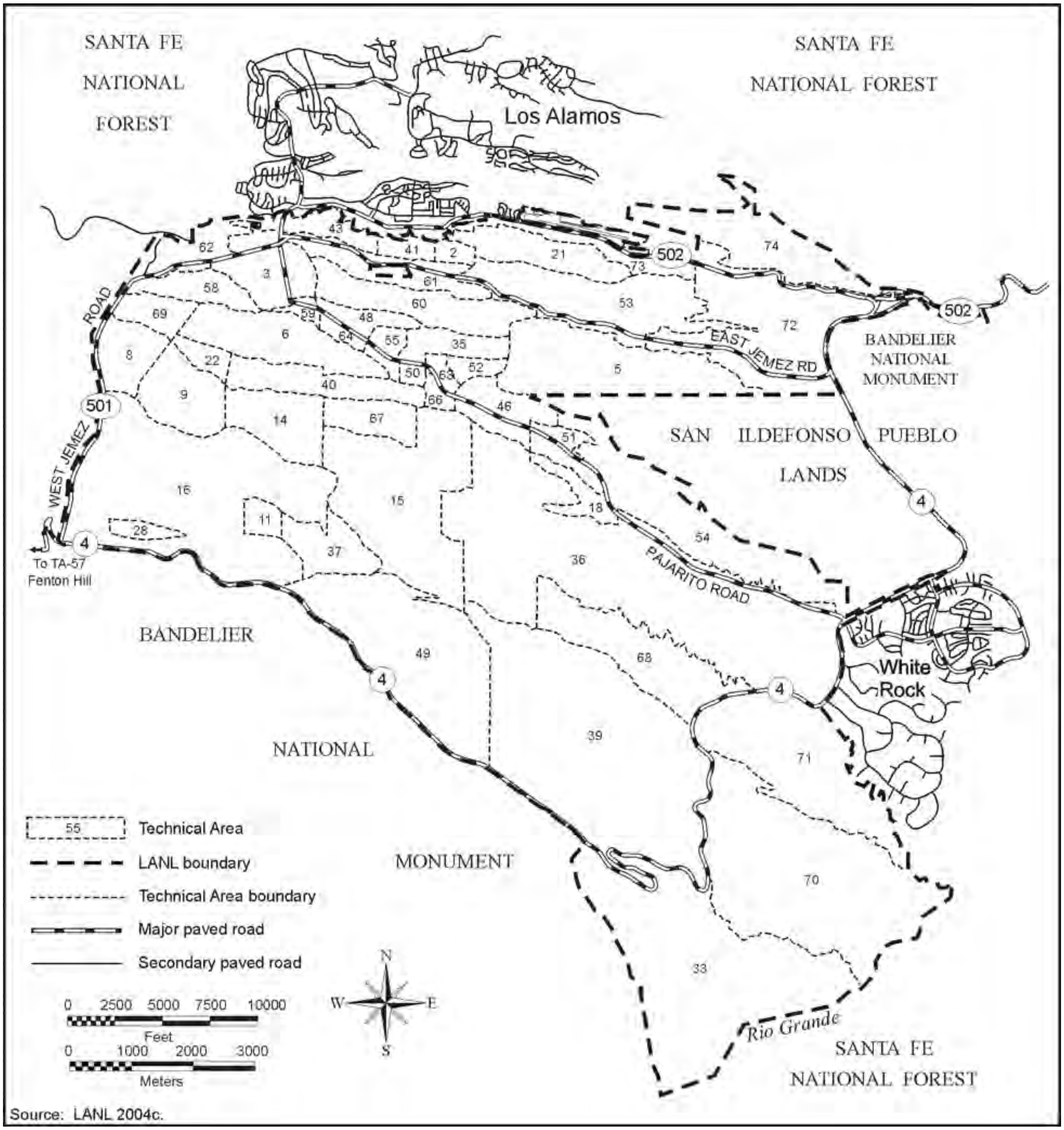
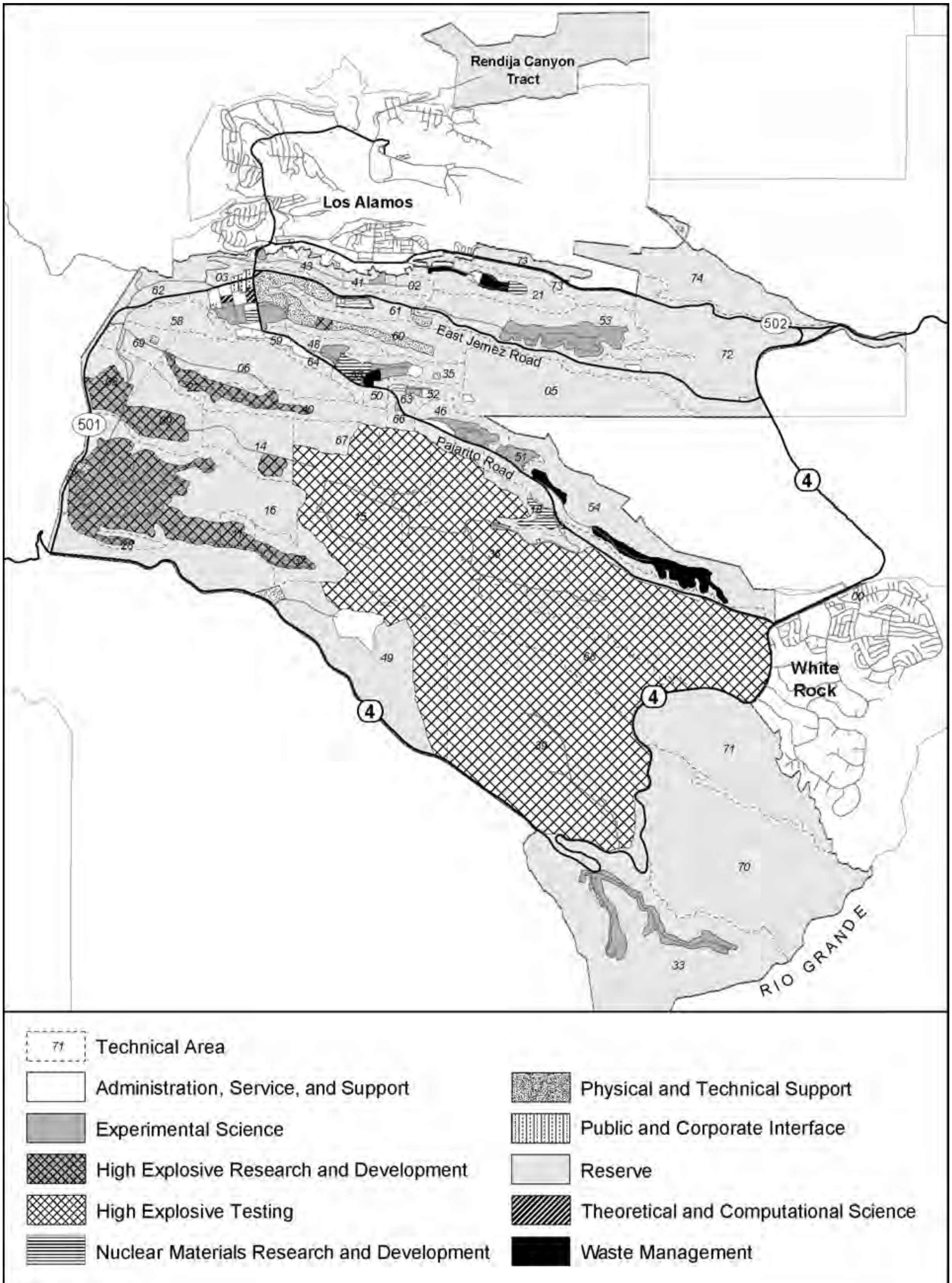


Figure 4–3 Technical Areas of Los Alamos National Laboratory



Source: LANL 2006a.

Figure 4–4 Los Alamos National Laboratory Site-Wide Land Use

The 10 land use categories noted above describe the activities at LANL and are defined below.

- *Administration, Service, and Support*—Administrative functions, nonprogrammatic technical expertise, support, and services for LANL management and employees.
- *Experimental Science*—Applied research and development activities tied to major programs.
- *High Explosives Research and Development*—Research and development of new explosive materials. This land is isolated for security and safety.
- *High Explosives Testing*—Large, isolated, exclusive-use areas required to maintain safety and environmental compliance during testing of newly developed explosive materials and new uses for existing materials. This land also includes exclusion and buffer areas.
- *Nuclear Materials Research and Development*—Isolated, secured areas for conducting research and development involving nuclear materials. This land use includes security and radiation hazard buffer zones. It does not include waste disposal sites.
- *Physical and Technical Support*—Includes roads, parking lots, and associated maintenance facilities; infrastructure such as communications and utilities; facility maintenance shops; and maintenance equipment storage. This land use generally is free from chemical, radiological, or explosives hazards.
- *Public and Corporate Interface*—Provides link with the general public and other outside entities conducting business at LANL, including technology transfer activities.
- *Reserve*—Areas that are not otherwise included in one of the previous categories. It may include environmental core and buffer areas, vacant land, and proposed land transfer areas.
- *Theoretical and Computational Science*—Interdisciplinary activities involving mathematical and computational research and related support activities.
- *Waste Management*—Provides for activities related to the handling, treatment, and disposal of all generated waste products, including solid, liquid, and hazardous materials (chemical, radiological, and explosive).

The U.S. Forest Service is responsible for the Santa Fe National Forest, which encompasses 1,567,181 acres (634,708 hectares) in the Sangre de Cristo Mountains to the east and Jemez Mountains to the west of LANL. The Santa Fe National Forest is managed for multiple-use activities such as logging, cattle grazing, hiking, fishing, hunting, camping, and skiing. The Dome Wilderness Area is located within the National Forest near Bandelier National Monument and provides habitat for a number of federally protected and state protected species (DOE 1999a).

The lands of the Pueblo of San Ildefonso are located immediately east of LANL (see Figure 4–2). Being neighbors of LANL, the Pueblo has a continuing interest in the site and its impact on Pueblo lands (see text box). The Pueblo owns or has use of 30,242 acres (12,239 hectares) of land, including approximately 2,106 acres (852 hectares) recently transferred from DOE (as described later in this subsection). Pueblo land use is a mixture of residential, gardening and farming, cattle grazing, hunting, fishing, food and medicinal plant gathering, and firewood production, along with general cultural and resource preservation. Most of the inhabitants of San Ildefonso live along New Mexico 30 (NM 30) in Santa Fe County, about 2.75 miles (4.43 kilometers) northeast of the LANL boundary. The Pueblo of San Ildefonso has not adopted a formal land use plan (DOE 1999a).

Pueblo of San Ildefonso Monitoring

The Pueblo of San Ildefonso, through various grants and in cooperation with DOE and the LANL operating contractor, conducts a program of environmental monitoring and assessment of associated risks. Under this program, the Pueblo environmental staff obtains environmental samples and monitors Pueblo of San Ildefonso lands. Environmental sampling and monitoring activities are conducted for air, water (both groundwater and surface water), sediment, biota, and radiation exposure. In addition, the Pueblo environmental staff tracks sampling sites on Pueblo of San Ildefonso lands that are used by Federal and state agencies, assists with maintaining these sites and collecting samples, and incorporates the sampling results from these external groups into their database. Monitoring activities are reported to DOE on a quarterly basis.

The National Park Service is responsible for Bandelier National Monument, which was established in 1916 and consists of two units: the Main Unit (32,937 acres [13,329 hectares]) located immediately south of LANL, and the Tsankawi Unit (790 acres [320 hectares]) located to the northeast of LANL. Only a small portion of the Main Unit has been developed for visitors; in fact, about 70 percent of this unit has been designated a Wilderness Area. The Tsankawi Unit is undeveloped. The number of visitors to the Monument peaked at 410,143 in 1997, but visitation declined to about 292,000 in 2002 (LANL 2006a).

Also located in the Los Alamos area is the Valles Caldera National Preserve, which was created in 2001 when the Federal Government purchased the 89,000-acre (36,017-hectare) Baca Ranch. It is located inside a volcanic caldera in the Jemez Mountain 20 miles (32.2 kilometers) west of Los Alamos. Studded with eruptive domes and featuring Redondo Peak (11,254 feet [3,430 meters]), this old ranch property is now being developed to explore a new way of managing public lands (Valles Caldera Trust 2005).

In 2004, Los Alamos County completed a preliminary draft of the *Los Alamos County Comprehensive Plan* (LAC 2004a). This action was part of the process to update its 1987 Plan (previously addressed in the *1999 SWEIS*). The county consists of approximately 69,860 acres (28,272 hectares), most of which is owned by the Federal Government. Only about 8,753 acres (3,542 hectares), including land that was conveyed from DOE (as described later in the subsection), are under county jurisdiction; much of this land is located within the Los Alamos townsite and White Rock. Among the nine land use types designated in the Plan, "Federal" applies to land owned by the Federal Government, primarily the U.S. Forest Service and DOE. Although the county government has no jurisdiction over these lands, it continues to seek the cooperation of each Federal entity to achieve the goals set forth in the *Los Alamos County Comprehensive Plan*. When Federal land changes ownership, the new owner is required to submit a proposed amendment to the general plan and an application for a zoning change before the land can be developed (LAC 2004a). In 1999, Los Alamos County leased 41.5 acres (16.8 hectares) of TA-3 from LANL for development of a research park; to date, about 5 acres (2 hectares) has been developed (LANL 2003h, 2006a).

On the evening of May 4, 2000, employees of the National Park Service ignited a prescribed burn in a forested area approximately 3.5 miles (2.2 kilometers) west of LANL. The area of the burn was within the boundaries of Bandelier National Monument along a mountain slope of the Cerro Grande (DOE 2000f). The next day, the fire was declared a wildfire. By the time it was fully contained on June 8, the fire had consumed approximately 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) of LANL land (Balice, Bennett, and Wright 2004) (see **Figure 4–5**). Direct effects of the fire on LANL land use included impacts on numerous site structures. Of the 332 structures affected by the fire, 236 were impacted, 68 were damaged, and 28 were destroyed (ruined beyond economic repair). Fire mitigation work such as flood retention facilities affected about 50 acres (20.2 hectares) of undeveloped land (LANL 2003h). Following the fire, the Cerro Grande Rehabilitation Project was created to facilitate and implement post-fire remediation activities. A *Wildfire Hazard Reduction Project Plan* (LANL 2001b) was developed to identify and prioritize projects and to provide guidelines for project implementation. This Plan called for treatment, including thinning of existing stands, of up to 10,000 acres (4,047 hectares) to reduce wildfire hazard. Between 2001 and 2005, 9,150 acres (3,703 hectares) were treated. In addition, 800 acres (324 hectares) were thinned between 1997 and 1999 (LANL 2006g).

As a result of the passage of Public Law 105-119, Section 632, 10 tracts (consisting of a number of subtracts) comprising 4,078.4 acres (1,650.5 hectares) have been designated for conveyance from DOE to the Incorporated County of Los Alamos or the New Mexico Department of Transportation, as well as for transfer to the Department of the Interior to be held in trust for the Pueblo of San Ildefonso. The change in ownership was to be completed in 2007. However, as part of the fiscal year 2007 Defense Authorization Act, DOE has been given an additional 5 years to complete the conveyance and transfer process. To date, 2,258.87 acres (914.14 hectares) have been turned over, including all tracts to the Department of the Interior for the Pueblo of San Ildefonso (LANL 2006l, 2006a). This turnover reduced the size of LANL to about 25,600 acres (10,360 hectares).

Table 4–2 provides the acreage of each subtract, its status, and the designated recipient. **Figure 4–6** shows the location of the 10 tracts to be turned over. As noted above, under the draft *Los Alamos County Comprehensive Plan* (LAC 2004a), conveyed land falling under county jurisdiction would require a general plan amendment and zoning change before development would be permitted. Some of the lands proposed for transfer are in Santa Fe County and would require a similar planning process to establish land uses.

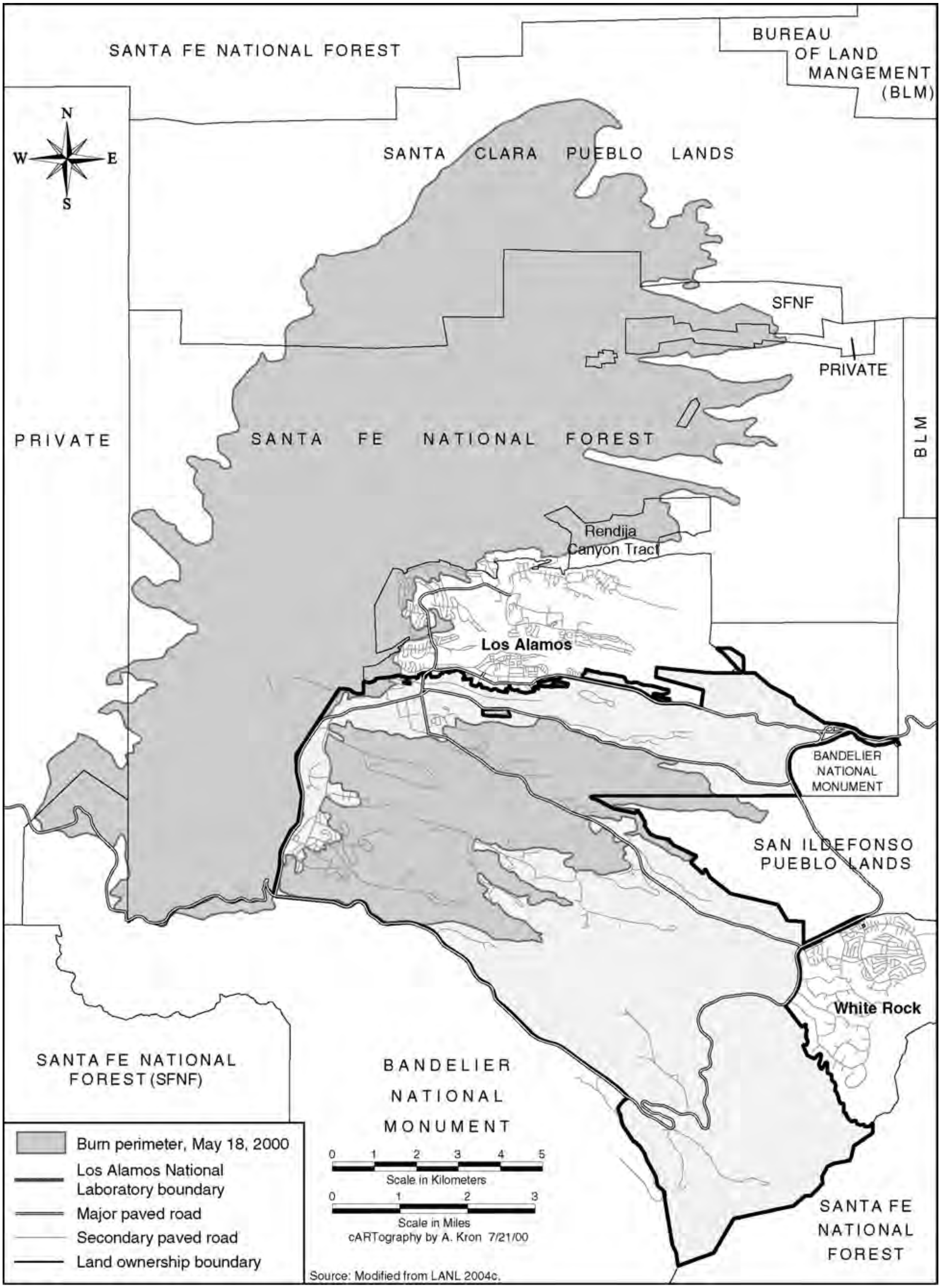


Figure 4–5 Cerro Grande Fire, Total Area Burned

Table 4–2 Lands Conveyed to Los Alamos County and Transferred to the Department of Interior to be Held in Trust for the Pueblo of San Ildefonso

Tract/Subtract		Size (acres)	Status	Recipient
Description	Designator			
Manhattan Monument	A-1	0.04	Conveyed	Los Alamos County
Site 22	A-2	0.17	Conveyed	Los Alamos County
Airport				
Airport-1 (East)	A-3	9.43	Conveyed	Los Alamos County
Airport-2 (North)	A-4	91.35	To be conveyed	Los Alamos County
Airport-3 (South)	A-5			
Unit 1	A-5-1	34.64	Conveyed	Los Alamos County
Unit 2	A-5-2	52.87	To be conveyed	Los Alamos County
Airport-4 (West)	A-6	4.18	Conveyed	Los Alamos County
Airport-5 (Central)	A-7	5.83	Conveyed	Los Alamos County
DP Road				
DP Road-1 (South)	A-8	25.01	To be conveyed	Los Alamos County
DP Road-2 (North)	A-9	4.25	Conveyed	Los Alamos County
DP Road-3 (East)	A-10	13.01	To be conveyed	Los Alamos County
DP Road-4 (West)	A-11	3.09	To be conveyed	Los Alamos County
Los Alamos Area Office				
Los Alamos Area Office-1 (East)	A-12	4.51	Conveyed	Los Alamos County
Los Alamos Area Office-2 (West)	A-13	8.81	To be conveyed	Los Alamos County
Rendija (A-14)	A-14	888.06	To be conveyed	Los Alamos County
Technical Area 21				
TA-21-1 (West)	A-15			
Unit 1	A-15-1	7.54	Conveyed	Los Alamos County
Unit 2	A-15-2	1.18	To be conveyed	Los Alamos County
Technical Area 74				
TA-74-1 (West)	A-17	5.52	Conveyed	Los Alamos County
TA-74-2 (South)	A-18	567.62	To be conveyed	Los Alamos County
TA-74-3 (North)	B-2	2,088.19	Transferred	Pueblo of San Ildefonso
TA-74-4 (Middle; Little Otowi)	B-3	3.36	Transferred	Pueblo of San Ildefonso
White Rock				
White Rock	C-1	15.39	To be conveyed	New Mexico Department of Transportation
White Rock-1	A-19	76.28	Conveyed	Los Alamos County
White Rock-2	B-1	14.93	Transferred	Pueblo of San Ildefonso
White Rock "Y"				
White Rock "Y"-1	C-2	104.0	To be conveyed	New Mexico Department of Transportation
White Rock "Y"-3	C-3	30.90	To be conveyed	New Mexico Department of Transportation
White Rock "Y"-4	C-4	18.24	To be conveyed	New Mexico Department of Transportation

Note: To convert acres to hectares, multiply by 0.40469.
Source: LANL 2006l.

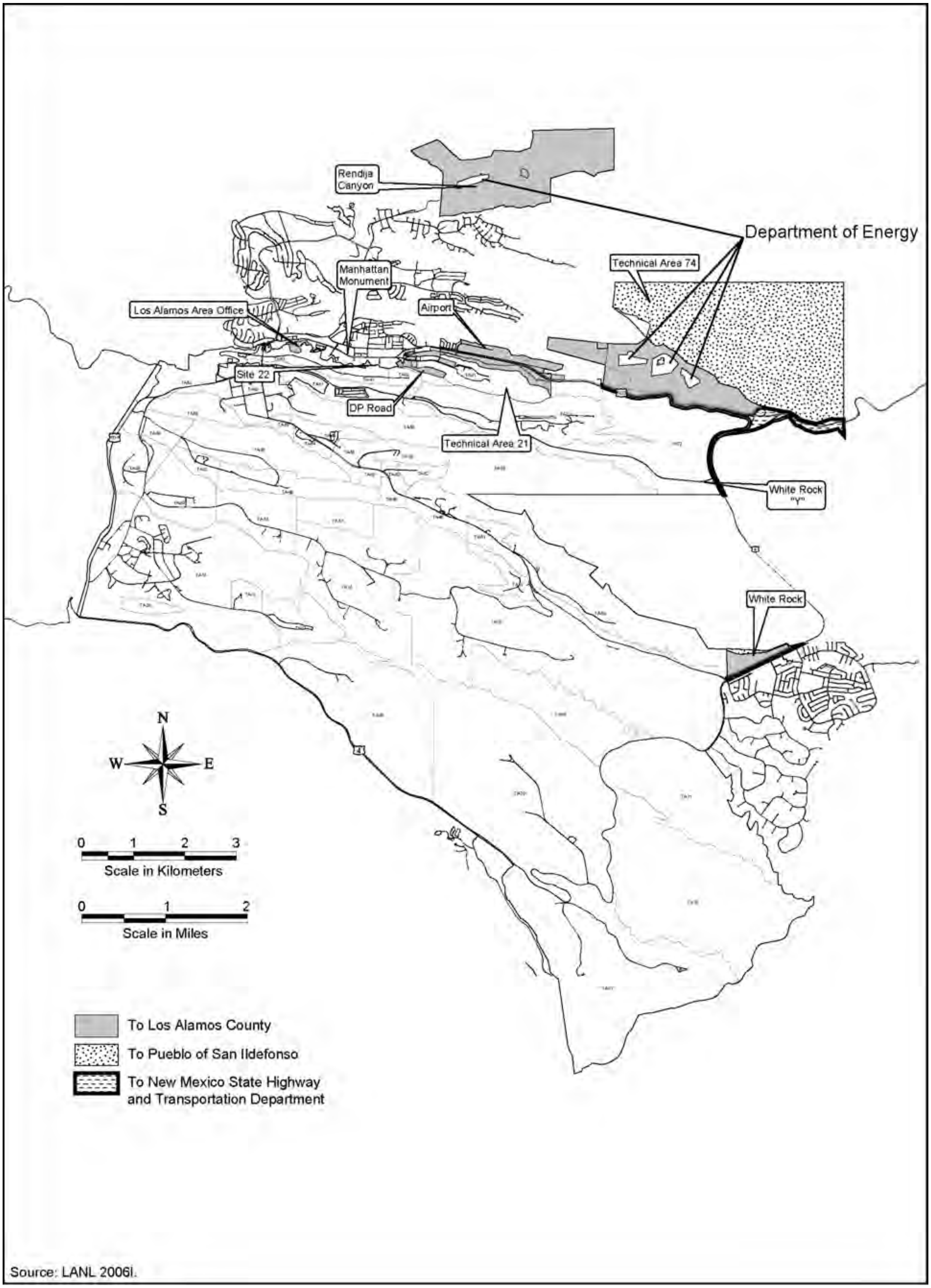


Figure 4–6 Overview of Land Conveyance and Transfer

4.1.2 Visual Environment

The natural setting of the Los Alamos area is panoramic and scenic. The mountain landscape, unusual geology, varied plant communities, burned over areas, and archaeological heritage of the area create a diverse visual environment. The topography of northern New Mexico is rugged, especially in the vicinity of LANL. Mesa tops are cut by deep canyons, creating sharp angles in the land form. In some cases, slopes are nearly vertical. Often, little vegetation grows on these steep slopes, exposing the geology, with contrasting horizontal strata varying from bright reddish orange to almost white in color.

A variety of vegetation occurs in the region, the density and height of which may change over time and can affect the visibility of an area within the LANL viewshed. Generally, portions of LANL located along mesa tops at lower elevations toward the eastern site boundary are covered with grasslands, mixed shrubs, or short trees, with sparsely distributed taller trees, allowing greater visibility from within the viewshed. In contrast, portions of LANL located at upper elevations toward the western boundary are more densely covered by tall mixed conifer forests that reduce the visibility of these areas (DOE 1999a).

The most obvious modern alteration of the natural landscape is development. Many buildings at LANL were built as temporary structures and present an austere, utilitarian appearance. Viewed from a distance at lower elevations, LANL is primarily distinguishable among the trees in the daytime by views of its water storage towers, emission stacks, the white-colored domes at TA-54, and occasional glimpses of older buildings. The new National Security Sciences Building is eight stories in height and is highly visible. The Los Alamos townsite appears mostly residential in character. The water storage towers are visible against the forested backdrop of the Jemez Mountains. At elevations above LANL, along the upper reaches of the Pajarito Plateau rim, the view of LANL is primarily of scattered buildings among heavily forested areas and the multi-storied buildings within TA-3. Similarly, the residential character of the Los Alamos townsite is predominately visible from higher elevation viewpoints (DOE 1999a, LANL 2004c).

At night, the lights of LANL, the Los Alamos townsite, and White Rock are directly visible from various locations across the viewshed as far away as the towns of Española and Santa Fe. Because there is little nighttime activity at LANL, there are relatively few security light sources compared to the nearby communities; thus, at a distance, the distinction between LANL and the two communities is lost to the casual observer (DOE 1999a).

To decrease the impact of development, new structures generally have been designed and built in a more unified and modern style. Further, recent construction has been sensitive to the effects of taller, more visible structures on the visual environment. For example, radio towers and the Emergency Operations Center water tower, have been painted to blend with the background (LANL 2003h, DOE 2001).

Bandelier National Monument is an important area from which LANL may be viewed. Separate units of the Monument border LANL to the south (Main Unit) and northeast (Tsankawi Unit) (see Figure 4–2). Views from the Main Unit along NM 4 are of a generally natural landscape, although there are instances where LANL structures are visible. These include miscellaneous buildings and infrastructure located in TA-33, several facilities and infrastructure associated with

TA-49, and TA-16 facilities located east of NM 501 near where it meets NM 4. Visible near Bandelier's main entrance are a water tower and a National Radioastronomy Observatory Very Long Range Array telescope, both located within TA-33. Panoramic views of LANL and the Los Alamos townsite are available from higher elevations of the western portion of the Main Unit. Views from the Tsankawi Unit include the temporary truck inspection station and some of the taller structures found within LANL and the Los Alamos townsite.

Views from various locations in Los Alamos County and its immediate surroundings were altered by the Cerro Grande Fire of 2000. Although the visual environment is still diverse, interesting, and panoramic, both summer and winter vistas were severely affected by the fire. For example, rocky outcrops forming the mountains are now more visible through the burned forest areas than in the past, and the eastern slopes of the Jemez Mountains present a mosaic of burned and unburned areas. While many LANL facilities generally are screened from view, some developed areas that were previously screened by vegetation are now more visible to passing traffic (DOE 2000f, LANL 2004c).

Since 1997, wildfire prevention activities, such as forest thinning, have been implemented on the LANL site on an accelerated schedule. Between 1997 and 2005, 9,950 acres (4,027 hectares) of forests and woodlands were thinned resulting in a more open, park-like forest. This has, in turn, increased the visibility of some facilities. Additionally, an outbreak of bark beetles beginning in 2001 killed thousands of trees, further opening the forest and making LANL facilities more visible (LANL 2004c, 2006a).

To date, 2,259 acres (914 hectares) of land have been turned over to Los Alamos County and the Department of the Interior to be held in trust for the Pueblo of San Ildefonso (LANL 2004c). This turnover, however, has not changed the visual setting of either the LANL site or the surrounding area because development has not yet occurred on any of this land.

Following the events of September 11, 2001, a number of changes were initiated that limited or redirected public access to facilities at LANL. This has resulted in fewer opportunities for the public to view LANL facilities (LANL 2004c).

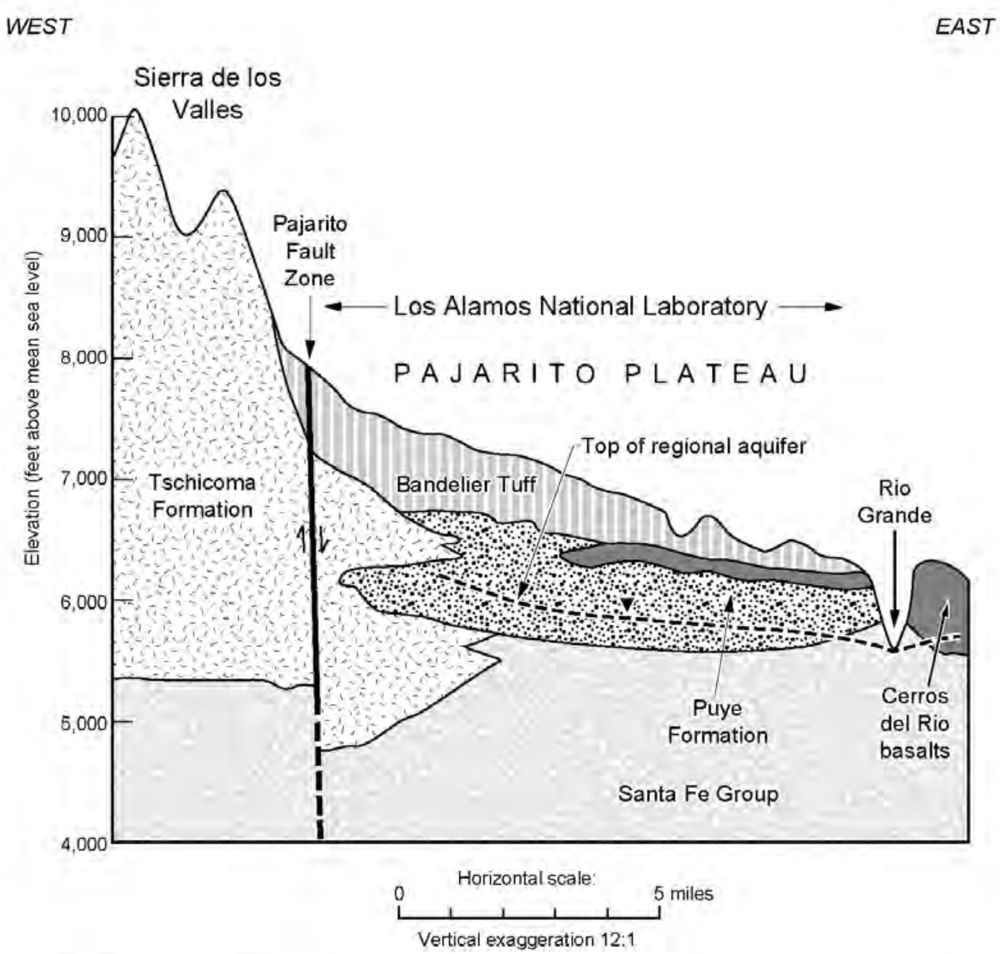
4.2 Geology and Soils

This section describes the geology, geologic conditions, soils, and mineral and geothermal resources present on the LANL site and in the surrounding area. In general, the information provided in Chapter 4, Section 4.2, of the *1999 SWEIS* is current; the most significant changes are updates to seismic conditions and the probabilistic seismic hazard analysis, as well as the effects of the 2000 Cerro Grande Fire on soil characteristics and erosion.

4.2.1 Geology

The geology of the LANL region is the result of complex faulting, sedimentation, volcanism, and erosion over the past 20 to 25 million years (DOE 1999a). LANL lies on the Pajarito Plateau, which is formed of volcanic tuffs (welded volcanic ash) deposited by past volcanic eruptions from the Jemez Mountains to the west (see **Figure 4–7**). The Jemez Mountains are a broad highland built up over the last 13 million years through volcanic activity. Late in the volcanic period, cataclysmic eruptions from calderas in the central part of the Jemez Mountains deposited the thick blankets of tuff that form the Pajarito Plateau (Broxton and Vaniman 2004). Volcanic activity culminated with the eruption of the rhyolitic Bandelier Tuff from 1.6 to 1.22 million years ago. During emplacement, intense heat and hot volcanic gases welded portions of these tuffs into the hard, resistant deposits that make up the upper surface of the plateau. Most of the bedrock on LANL property is composed of the salmon-colored Bandelier Tuff (DOE 1999a). The surface of the Pajarito Plateau is divided into numerous narrow, finger-like mesas separated by deep east-to-west-oriented canyons that drain to the Rio Grande. The canyons were formed by streams flowing eastward across the plateau from the Jemez Mountains to the Rio Grande.

Since the *1999 SWEIS* was issued, some specific geological information has been updated. The Cerro Toledo "Interval" of the Bandelier Tuff unit consists of volcaniclastic sediments and tephras reaching a thickness of 400 feet (122 meters) (LANL 2004c), an increase from the previously reported maximum thickness of 130 feet (40 meters) (DOE 1999a).



Notes:
1. The thickness of geologic units has been exaggerated on this figure to illustrate unit relationships and topography.
2. Offset of the Tschicoma formation on the Pajarito Fault zone is schematic due to the variation along the trace of the fault.
3. To convert feet to meters, multiply by 0.3048.

Source: LANL 2005h.

Figure 4–7 Generalized Cross-Section of the Los Alamos National Laboratory Area

4.2.2 Geologic Conditions

This subsection describes the geologic conditions that could affect the stability of buildings and infrastructure at LANL. It includes stratigraphy, volcanic activity, seismic activity (earthquakes), slope stability, surface subsidence, and soil liquefaction.

4.2.2.1 Stratigraphy

The upper sequence of rocks that underlie LANL are exposed in the 600- to 1,000-foot (183- to 305-meter)-deep, steep-sided canyons cut into the surface of the Pajarito Plateau. The exposed rocks range in age from middle Eocene sediments of the Santa Fe Group to Quaternary alluvium (LANL 1996a). The layers vary in hardness and resistance to erosion; the light-colored units tend to be softer and to form slopes on canyon walls, while darker-colored units tend to be harder and to form vertical cliffs. The following discussion briefly describes the geologic formations in relation to LANL.

The Santa Fe Group is the deepest sedimentary sequence beneath the site (see Figure 4–7). It was deposited in the Española basin, a Rio Grande rift basin that underlies the LANL area. The group ranges from early Eocene to late Pliocene in age; the uppermost sediments are late Miocene beneath the western and central Pajarito Plateau and grade upward into the late Pliocene to the east. The deposits consist of a series of light pink to buff-colored fluvial (stream deposited) siltstones and silty sandstones with a few lenses of conglomerate and clay. In some sections, the sediments are interbedded with basalt flows (NPS 2005a). To the east, these flows represent the Cerros del Rio Basalts (Broxton and Vaniman 2004).

The Puye Formation overlies the Santa Fe Group beneath the western and central Pajarito Plateau and thins beneath the eastern plateau (see Figure 4–7). It consists of coalescing alluvial fans that were shed eastward from the domes and flows of the Sierra de los Valles; as a result the formation overlaps and postdates the Tshicoma Formation. The sediments are late Miocene to late Pliocene in age and generally consist of interbedded gray-colored fluvial sandstones and gravels. The upper part of the Puye Formation is interlayered with lava flows. To the east, the flows represent the Cerros del Rio Basalts (see Figure 4–7), a series of basaltic and related lava flows separated by generally thin beds of sedimentary deposits of the Santa Fe Group and Puye Formation (Broxton and Vaniman 2004).

The Bandelier Tuff is the uppermost stratigraphic unit on the Pajarito Plateau. It forms the foundation for most LANL facilities as well as the canyon walls along LANL streams (LANL 1996a). The Bandelier is a late Pliocene to Quaternary volcanic deposit formed primarily by eruption of the Valles and Toledo calderas, which occurred 1.6 and 1.22 million years ago, respectively (DOE 1999a). These eruptions produced widespread, voluminous ash flow sheets composed of pumice, tuffs, and some interlayered sediments.

During and shortly after tuff deposition, extreme heat indurated (hardened by heating) some of the layers, forming welded tuff deposits. These welded tuffs and other volcanic deposits (including basalt flows) were fractured due to cooling and non-seismic processes. The size, extent, density, and orientation (vertical, horizontal, or inclined) of the fractures varies between successive layers and both vertically and laterally within individual layers. The induration and fracturing of the volcanic deposits on the LANL site are an important control on canyon wall formation, slope stability, subsurface fluid flow, seismic stability, and the engineering properties of the rocks.

The layers that form the Bandelier Tuff and the cliff-forming units are illustrated in **Figure 4–8**. Most LANL facility foundations are either on or within the Tshirege Member (upper member) of the Bandelier Tuff. The Tshirege Member consists of a series of generally thick, welded tuff sheets deposited by multiple volcanic flows. It contains several units, all of which are recognizable due to differences in physical and weathering properties. From the bottom to the top of the Member, the subunits are described as follows (LANL 1999a):

- The Tsankawi Pumice Bed is the basal pumice fallout deposit of the Member. This pumice bed is typically 20 to 30 inches (50 to 70 centimeters) thick on the LANL site. It is composed of angular to subangular volcanic rock particles up to 2.4 inches (6 centimeters) in diameter.

- Qbt 1g is the lowermost unit of the Member. It is a porous, nonwelded, poorly sorted, ash flow deposit. It is poorly indurated, but forms steep cliffs because a resistant bench near the top of the unit forms a protective cap over the softer underlying tuff. Qbt 1g underlies most of the mesas and is exposed in canyon walls on the Pajarito Plateau.

- Qbt 1v is a series of cliff- and slope-forming outcrops composed of porous, nonwelded, devitrified ash flow deposit. The base of the unit is a thin, horizontal zone of preferential weathering marking the abrupt transition from vitric tuffs below to devitrified tuffs above. The lower part of Qb1 1v is an orange-brown colored colonnade tuff (Qbt 1v-c) that forms a distinctive low cliff characterized by columnar jointing. The colonnade tuff is overlain by a white-colored band of slope-forming tuffs. Qbt 1v is exposed in canyon walls and is present beneath portions of canyon floors.

- Qbt 2 is a medium-brown, vertical cliff-forming ash flow deposit. It is devitrified, relatively highly welded, and forms the steep, narrow canyon walls in the central and eastern portions of the Pajarito Plateau. It underlies canyon flows in the central and western portions of the plateau. Qbt 2 forms a resistant caprock on mesa tops in the eastern portion of the Pajarito Plateau.

- Qbt 3 is a nonwelded to partly welded, devitrified ash flow deposit. The basal part of Qbt 3 is a soft, nonwelded tuff that forms a broad, gently sloping bench on top of Qbt 2 in canyon wall exposures and on the broad canyon floors in the central part of the Pajarito Plateau. The upper part of Qbt 3 is a partly welded tuff that forms the caprock of mesas in the central part of the Pajarito Plateau, such as at TA-50. This unit is more densely welded to the west and locally contains apparent horizontal bedding or fracturing.

- Qbt 4 is a partially to densely welded ash flow deposit characterized by small, sparse pumices and numerous intercalated surge deposits. The unit is exposed on mesa tops on the western part of the Pajarito Plateau such as at TA-3. Some of the most densely welded areas occur on the western margin of LANL.

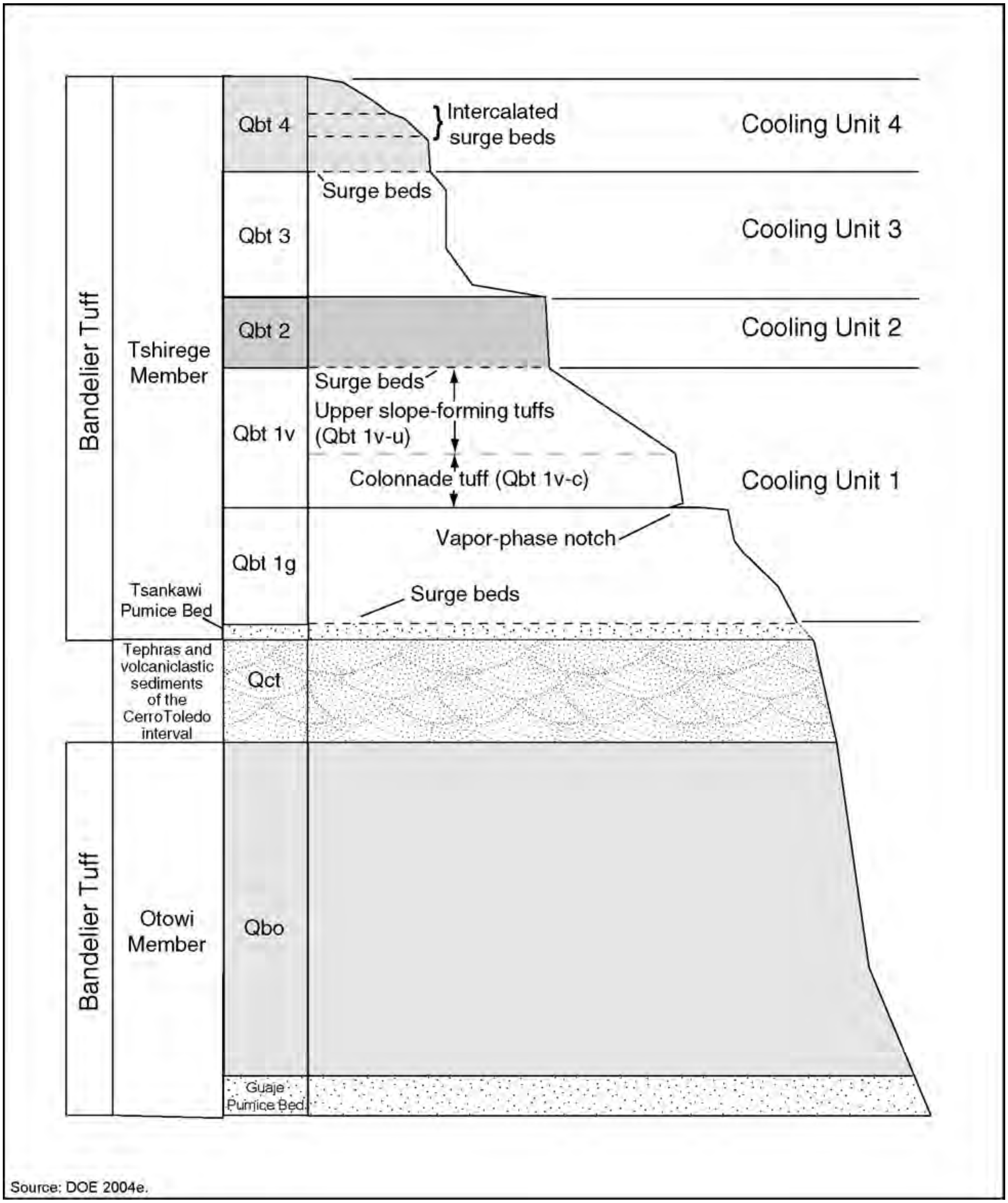


Figure 4–8 Stratigraphy of the Bandelier Tuff

In general, subunits of the Tshirege Member dip gently southeastward on the Pajarito Plateau. This dip is likely the primary initial dip, which mainly results from the burial of a southeast-dipping paleotopographic surface and thinning of units away from the volcanic source to the west.

Volcanic deposits postdating the eruption of the Bandelier Tuff are similar in character to the earlier unit. These deposits are intermittently present on the LANL site, with greater frequency of occurrence to the west.

Unconsolidated sediments form surficial, localized deposits across LANL. These deposits include colluvium and Quaternary alluvium. Colluvium, an accumulation of materials from rock falls and other gravity-driven processes, occurs at the base of slopes. Quaternary alluvium consists of recent stream deposits and occurs in and along LANL's canyons and watersheds as narrow bands of canyon-bottom sediments. Both materials consist of unconsolidated gravels, sands, and clays; however, colluvium is generally coarser-grained and less consolidated. Sediment is discussed in more detail in Section 4.3.1.5.

Overall, the complex interfingering and interlayering of strata beneath LANL results in variable properties that affect canyon wall formation, slope stability, subsurface fluid flow, seismic stability, and the engineering properties of the rocks. In general, poorly indurated and densely fractured layers tend to form canyon slopes that are susceptible to failure during erosion or seismic events and require remediation prior to installing engineered structures on the mesa surfaces, in the canyons, or crossing canyon walls. In such cases, the direction and density of the fractures is a critical engineering parameter. Beneath the Pajarito Plateau, the complex stratigraphy is reflected in the presence of perched groundwater zones. Perched groundwater occurs above welded tuffs in the Bandelier Tuff and other volcanic strata, above tuffs that have been altered to clays, above nonfractured basalt flows of the Cerro del Rio Basalts, and above fine-grained sedimentary deposits (such as lacustrine clays) in the Puye Formation (Robinson, Broxton, and Vaniman 2004). The upper surface of the regional aquifer (the water table) lies within the lower portion of the Puye Formation (see Figure 4–7). The aquifer includes the full thickness of the Santa Fe Group except along the Rio Grande, where the water table drops below the overlying Puye Formation. Interbedded basalt flows may account for localized confining conditions observed in the aquifer (NPS 2005a). The paleotopography and general dip to the southeast of the pre-Tshirege surface may strongly influence the direction of possible groundwater flow and contaminant migration in subsurface units. The paleotopography of the surface underlying the Bandelier Tuff may influence the flow direction of potential perched water zones (LANL 1999a).

In addition, the direction and rate of subsurface flow may be affected by the presence and orientation of fractures in some rock layers. As discussed above, these fractures may be related to cooling and formation of the individual strata. In some areas, faults related to seismic activity also may influence groundwater flow. The impact of geologic setting and geologic units on the hydrogeology beneath LANL is detailed in Appendix E.

4.2.2.2 Volcanism

There have been no significant changes to the information in this section from the *1999 SWEIS*; however, the unusually low amount of seismic activity in the Jemez Mountains has been reinterpreted to indicate that seismic signals of magma movement are partially absorbed deep in the subsurface due to elevated temperatures and high heat flow (LANL 2004c). The significance of this to LANL is that magma movement indicates that the Jemez Mountains continue to be a zone of potential volcanic activity, although at no greater probability than identified in the *1999 SWEIS*.

4.2.2.3 Seismic Activity

A comprehensive update to the LANL seismic hazards analysis was completed in June 2007 (LANL 2007a); the analysis presents estimated ground-shaking hazards and the ground motions that may result. The geological and geotechnical aspects of the study, along with a summary of the seismic setting, are incorporated in the following description. The relevance of the revised understanding of seismic hazards to LANL facilities is discussed in Chapter 5, Section 5.12, of this SWEIS.

The 2007 seismic hazard study updates the 1995 LANL study that was used for the *1999 SWEIS*. The studies consider all earthquake faults within 10 miles (16 kilometers) that meet the definition of the term "capable fault" as used by the U.S. Nuclear Regulatory Commission to assess the seismic safety of nuclear power reactors (Title 10 *Code of Federal Regulations* [CFR] Part 100, Appendix A).

The primary changes in the 2007 seismic update are the use of more recent field study data and the application of the most current seismic analysis methods (LANL 2007a). The only new characterization data regarding the dynamic properties of the subsurface beneath LANL are those from investigations performed at the Chemistry and Metallurgy Research Replacement Facility. Recent geological studies have refined the understanding of fault geometry, slip characteristics, and the relationship of the faults in the LANL area. The methods used in the updated 2007 analysis follow the Senior Seismic Hazard Advisory Committee's guidelines for a Level 2 analysis in *Recommendations for Probabilistic Seismic Hazard Analysis – Guidance on Uncertainty and Use of Experts* (NUREG/CR-6327, 1997). The study was designed and performed under the following DOE standards:

- DOE Standard 1020-2002, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities;
- DOE Standard 1022-94, Natural Phenomena Hazards Site Characterization Criteria; and
- DOE Standard 1023-95, Natural Phenomena Hazard Assessment Criteria.

The seismic hazards analysis report (LANL 2007a) includes details on refinement of the seismic source model, ground motion attenuation relationships, dynamic properties of the subsurface (particularly the Bandelier Tuff) beneath LANL, as well as the probabilistic seismic hazard, horizontal and vertical hazards, and design basis earthquake for LANL.

The dominant contributor to seismic risk at LANL is the Pajarito Fault System. The main element of the system is the Pajarito Fault. Secondary elements include the Santa Clara Canyon Fault, the Rendija Canyon Fault, the Guaje Mountain Faults, and the Sawyer Canyon Fault. The general fault geometry in the system is reflected in **Figure 4–9** (LANL 2004c).

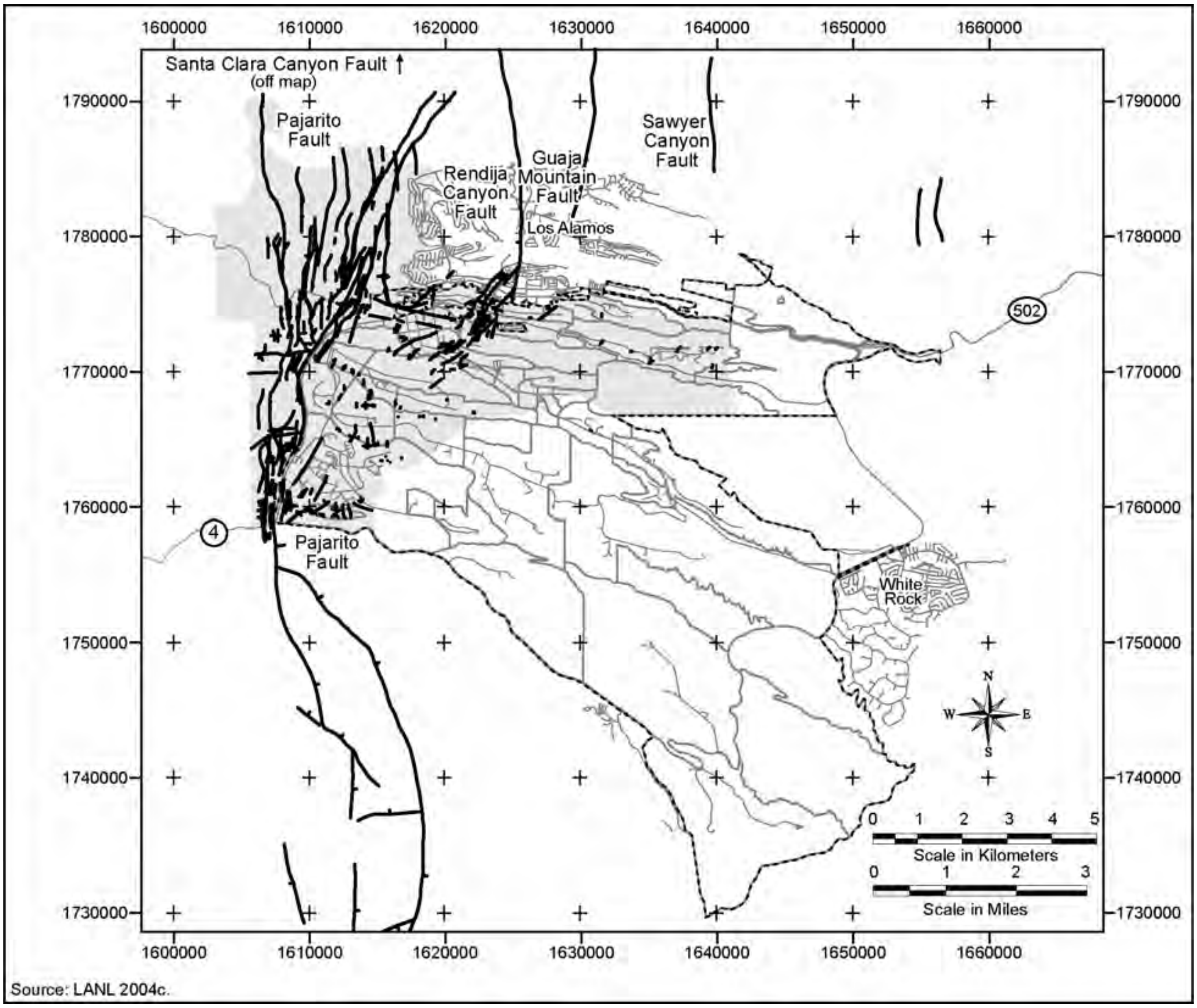


Figure 4–9 Mapped Faults in the Los Alamos National Laboratory Area

The descriptions of seismic settings and risk elements presented in the following sections are based on the 2007 seismic study (LANL 2007a) and data derived from trench and borehole studies, as well as other studies conducted on seismic hazards in the vicinity of LANL (LANL 2004c). These studies focused on the western third of LANL (the shaded area in Figure 4–9) because the principal faults, and thus the principal seismic risks at LANL, are located in that portion of the site.

Pajarito Fault

The Pajarito Fault is the main element of the Pajarito Fault System and contributes most of the seismic risk to LANL due to its proximity and level of seismic activity (LANL 2007a). It forms the main western margin of the Española Basin at LANL. The geometry of the Pajarito Fault varies appreciably along its north-south extent. Its shallow subsurface expression varies from a simple normal fault to broad zones of small faults to largely unfaulted monoclines. These features are all considered surface expressions of deep-seated normal faulting (LANL 2004c). Landslides along the main escarpment of the Pajarito Fault are cut by pronounced lineaments that are visible on aerial photographs and may express underlying faults, but this has not been confirmed.

The extent of movement along a fault may be approximated by the separation of stratigraphic layers on each side of the fault plane. Maximum stratigraphic separation on the Pajarito Fault occurs south-southwest of the LANL site, where down-to-the-east normal faulting shows up to 590 feet (180 meters) of stratigraphic separation on the Bandelier Tuff. Between Cañon de Valle and Pajarito Canyon, stratigraphic separation is approximately 475 feet (145 meters) on a series of faults over a lateral zone of about 3,300 feet (1,000 meters). In the vicinity of TA-16, deformation associated with the Pajarito Fault extends at least 5,000 feet (1,524 meters) to the east of the Pajarito Fault escarpment (LANL 2004c).

In the *1999 SWEIS*, the most recent faulting event along the Pajarito Fault was estimated to have occurred 45,000 years ago. More recent studies, including trench excavations and borehole stratigraphy and structure, indicated more recent movement (see **Table 4–3**) (LANL 2007a). Recent studies also indicated that movement on the Pajarito Fault may be linked to movement on the other fault segments in the Pajarito Fault System.

Table 4–3 Summary of Movement on Faults of the Pajarito Fault System

Name	*Approximate Length*	*Type*	*Most Recent Faulting Event*	*Maximum Earthquake Potential* [a]
Pajarito	26 miles	Normal, down-to-the-east [b]	1,400 to 2,200 years ago	7
Rendija Canyon	8 miles	Normal, down-to-the-west	Less than 8,000 years ago	6.5
Guaje Mountain	8 miles	Normal, down-to-the-west	3,400 to 6,500 years ago	6.5

[a] Richter magnitude.
[b] The fault plane dips to the east and the crustal block on the east side of the fault slips downward to the east when fault movement occurs. Down-to-the-west reverses this fault plane angle and sense of movement.
Note: To convert miles to kilometers, multiply by 1.6093.
Sources: DOE 1999a, LANL 2004c, LANL 2007a.

Five small earthquakes (magnitudes of 2 or less on the Richter scale) have been recorded in the Pajarito Fault since 1991. These small events, which produced effects felt at the surface, are thought to be associated with ongoing tectonic activity within the Pajarito Fault zone (LANL 2004c).

The west-central area of LANL, generally between TA-3 and TA-16, lies within a part of the Pajarito Fault made up of subsidiary or distributed ruptures. Deformation extends at least 5,000 feet (1,500 meters) to the east of the Pajarito Fault Escarpment. The general north-south trend of the Pajarito Fault structure is disrupted in TA-62, TA-58, and TA-3 by some east-west trending faults. These faults may be related to the Pajarito Fault, the Rendija Canyon Fault (see below), or may be independent structures. These are areas of generally higher potential for seismic surface rupture, relative to locations farther removed from the Pajarito Fault zone.

Santa Clara Canyon Fault

The Santa Clara Canyon Fault is a secondary element of the Pajarito Fault System. It is located to the north of the Pajarito Fault (beyond the northern extent of Figure 4–9) and generally continues the northeastern trend of the Pajarito Fault as it extends north beyond LANL (LANL 2007a). It is another fault element that defines the western margin of the Española Basin, but it has less influence on seismicity at LANL due to its distance from the site. Although it continues the western Española Basin margin, there is a gap of approximately 3 miles (5 kilometers) between the mapped traces of the two faults. As discussed below, this gap may be accommodated by movement on the Rendija Canyon and Guaje Mountain faults.

Rendija Canyon Fault

Studies of the Rendija Canyon Fault (LANL 2007a) indicate that it is a dominantly down-to-the-west normal fault located approximately 2 miles (3 kilometers) east of the Pajarito Fault (see Figure 4–9 and Table 4–3). South of the Los Alamos townsite, the Rendija Canyon Fault turns southwest and splays into a zone of deformation about 1 mile (1.5 kilometers) wide. Displacement on the fault is up to 130 feet (40 meters), and the displacement gradually decreases to the south as the zone of deformation broadens (LANL 2004c). The fault probably ends just south of Twomile Canyon where displacement is about 30 feet (10 meters). At the southern end of the fault zone, east-west trending faults run between the Rendija Canyon and Pajarito Fault zones, generally within TA-63, TA-58, and TA-3 (see Figure 4–9). The east-west oriented faults may relate to the Pajarito and Rendija Canyon structures (in space or time or both) or they may record an independent history of brittle deformation. Additional study may determine the relationship between movement along the north-south and east-west fault zones at LANL. As mentioned above, these areas are associated with a higher potential for seismic surface rupture, however, previous analysis shows that the risk is not significant.

Trench exposures across the Rendija Canyon Fault at Guaje Pines cemetery indicate that the most recent surface rupture occurred about 8,600 to 23,000 years ago (LANL 2007a). Geologic mapping shows that there is no faulting in the near-surface directly beneath TA-55 (LANL 2004c). The closest fault is about 1,500 feet (460 meters) west of the TA-55 Plutonium Facility. The Rendija Canyon Fault, therefore, does not continue from the Los Alamos townsite directly south to TA-55.

Within TA-3, there is no evidence of faulting in a 1.2 million-year-old member of the Bandelier Tuff (Tshirege Member) beneath the site of the Metropolis Center for Modeling and Simulation and the Nonproliferation International Security Center. A study at the Chemistry and Metallurgy Building identified two small, closely spaced, parallel reverse faults with a combined vertical separation of 8 feet (2.4 meters). Drilling at the National Security Sciences Building identified a small normal fault with less than 3 feet (1 meter) of displacement. The Rendija Canyon Fault does not extend farther west than Pajarito Road, but its eastern extent has yet to be conclusively defined (LANL 2004c).

Guaje Mountain Fault

The Guaje Mountain Fault is subparallel to the Pajarito Fault and Rendija Canyon Fault and is located approximately 1.2 miles (2 kilometers) east of the Rendija Canyon Fault (see Figure 4–9) (LANL 2004c). It is somewhat shorter than the Rendija Canyon Fault and the southern extent is not well documented. The fault exhibits about 115 feet (35 meters) of down-to-the-west displacement on the south side of Guaje Mountain, between Rendija and Guaje Canyons (Carter and Winter 1995) (see Table 4–3). The fault continues to have topographic expression as far south as Bayo Canyon. However, the displacement along the length of the fault and the southern extent are generally not well defined.

Geologic surface mapping and trenching at Pajarito Mesa demonstrated the absence of faulting in that area for at least the last 50,000 to 60,000 years. Small displacement faults traverse the mesa, but no southward continuation of the Guaje Mountain Fault was identified (LANL 2004c).

Based on available data, a series of seismic events have been identified on the Guaje Mountain Fault. These range in age from 3,400 to 300,000 years ago and have up to approximately 7 feet (2 meters) of displacement (LANL 2004c, 2007a).

Sawyer Canyon Fault

The Sawyer Canyon Fault is a short, west-dipping fault that is subparallel to and located east of the Rendija Canyon and Guaje Mountain Faults. Its effect on seismicity at LANL is relatively small because the surface trace is located at a distance from the site and the structure migrates away from LANL at depth. This fault is included in the 2007 seismic update to simplify modeling (LANL 2007a).

Other Areas of LANL

Surveying of Bandelier Tuff contacts at Mesita del Buey (TA-54) revealed 37 faults with vertical displacements of 2 to 26 inches (5 to 65 centimeters). These small faults appear to be secondary effects associated with large earthquakes in the main Pajarito Fault zone, or perhaps earthquakes on other faults in the region (LANL 2004c).

Geologic mapping and related field and laboratory investigations in the north-central to northeastern portion of LANL (TAs 53, 5, 21, 72, and 73) revealed only small faults that have little potential for seismic surface rupture. The study identified six small-displacement (less than 5 feet [1.5 meters] vertical displacement) faults or fault zones. These faults are considered subsidiary to the principal faults of the Pajarito Fault system (that is, the Pajarito, Rendija Canyon, and Guaje Mountain Faults) and likely experienced small amounts of movement during earthquakes on the principal faults (LANL 2004c).

Pajarito Fault System Event Chronology and Probabilistic Seismic Hazard Analysis

Recent work has shown that the Pajarito Fault system is a broad zone of distributed deformation, and that the primary Pajarito Fault itself probably breaks the surface along only part of its length in the vicinity of LANL (LANL 2004c). Most of the geologic structures that have been the targets of seismic studies are, in fact, faults subsidiary to the primary and secondary segments of the Pajarito Fault System (LANL 2007a). Establishing the precise seismic relationship, timing of events, and probability of seismic activity on each segment is made more difficult because the individual faults do not provide a complete record of paleoseismic events for the entire system. Results from paleoseismic investigations indicate that there have been at least two and possibly three surface-rupturing events on the Pajarito Fault System since 11,000 years ago. Reaching back to the Late Quaternary (110,000 years ago), a total of five to nine events have been identified, suggesting a longer recurrence interval than in the more recent past. The apparent difference in recurrence interval may be due to the loss of event markers earlier in the geologic record.

The following discussion represents the 2007 update of the understanding of seismic hazards at LANL (LANL 2007a). Overall, the Pajarito Fault System acts as a broad zone of faults that form an articulated monoclinal flexure and consists of several distinct fault segments. These include the Pajarito Fault (the primary segment), Santa Clara Canyon Fault, Rendija Canyon Fault, Guaje Mountain Fault, and Sawyer Canyon Fault (secondary segments). These faults show evidence of progressive linkage in the recent past and exhibit complex rupture patterns, including the recent surface-rupturing pattern described above. As the primary fault segment in the Pajarito Fault System, the Pajarito Fault is the primary source of seismic risk at LANL. Movement on the primary fault may be temporally related to movement on the secondary faults.

A combination of empirical and site-specific attenuation relationships were used in the probabilistic seismic hazard analysis. As in the 1995 analysis, the lack of region-specific attenuation relationships was mitigated by use of a stochastic ground motion modeling approach. This approach was used for four target areas, including the Chemistry and Metallurgy Research Replacement Facility, TA-3, TA-16, and TA-55. The Chemistry and Metallurgy Research Replacement Facility and technical areas were selected for use in the calculations because they all contain LANL facilities of interest and field data were available to support the calculations. In addition, an attenuation relationship was developed for dacite at LANL. (Dacite is a type of igneous rock of volcanic origin.) In this application, it was used as a modeling analog for the Bandelier Tuff. By combining the depth to the top of dacite beneath an area and the dacite attenuation relationship, the probabilistic seismic hazard analysis can be applied beyond the four target areas to other areas of interest across LANL.

The probabilistic hazard for peak ground acceleration at all of the sites is dominated by the Pajarito Fault System for all return periods, and the Pajarito Fault System is in turn the primary contributor to seismic hazard at LANL. Peak ground acceleration for the Uniform Hazard Response Spectra is presented in **Table 4–4**; results are calculated for a range of recurrence intervals. Similarly, the peak ground acceleration calculated for Seismic Design Criteria for the target areas are presented in **Table 4–5**.

The estimated probabilistic hazard has increased significantly, up to 83 percent, compared to the 1995 probabilistic seismic hazard analysis (**Table 4–6**) (LANL 2007a), due in large part to recognition of increased seismic activity along the Pajarito Fault System. The 1995 probabilistic seismic hazard analysis was used to set the seismic hazard and design basis earthquake in the *1999 SWEIS* (DOE 1999a) and in this SWEIS, as well as to determine the design criteria for facilities at LANL. The 2007 probabilistic seismic hazard analysis updates these parameters and will require review and revision of the seismic hazard and the design basis earthquake for use in designing and establishing operating limits for LANL facilities. Earthquake hazard analyses for LANL facilities are discussed in Chapter 5, Section 5.12, of this SWEIS.

Table 4–4 Los Alamos National Laboratory Mean Peak Ground Acceleration Values (g) from the Uniform Hazard Response Spectra

Return Period (years)	CMRR		TA-3		TA-16		TA-55		Site-Wide		Dacite	
	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.
1,000	0.27	0.32	0.27	0.32	0.25	0.31	0.27	0.32	0.27	0.32	0.13	0.12
2,500	0.52	0.60	0.52	0.59	0.47	0.57	0.52	0.60	0.52	0.60	0.27	0.27
10,000	1.03	1.21	1.03	1.10	0.93	1.05	1.03	1.21	1.03	1.21	0.65	0.65
25,000	1.47	1.79	1.45	1.57	1.33	1.50	1.47	1.79	1.47	1.79	1.01	0.97
100,000	2.30	3.01	2.29	2.79	2.11	2.57	2.30	3.01	2.30	3.01	1.69	1.65

g = acceleration equal to gravity, Horiz. = horizontal, Vert. = vertical.
Source: LANL 2007a.

Table 4–5 Los Alamos National Laboratory Peak Ground Acceleration Values (g) from the Design Response Spectra

SDC	CMRR		TA-3		TA-16		TA-55		Site-Wide		Dacite	
	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.
3	0.47	0.56	0.47	0.53	0.43	0.50	0.47	0.60	0.47	0.56	0.28	0.27
4	0.72	0.87	0.71	0.78	0.65	0.74	0.72	0.86	0.72	0.86	0.47	0.45
5	1.17	1.50	1.17	1.39	1.07	1.29	1.17	1.50	1.17	1.50	0.84	0.82

g = acceleration equal to gravity, SDC = seismic design criteria, Horiz. = horizontal, Vert. = vertical.
Source: LANL 2007a.

Table 4–6 Comparison of Probabilistic Peak Horizontal Accelerations in g's from 1995 and 2007 Studies

Return Period	1,000 Years		2,500 Years		10,000 Years	
	1995	2007	1995	2007	1995	2007
CMRR	–	0.27	–	0.52	–	1.03
TA-3	0.21	0.27	0.33	0.52	0.56	1.03
TA-16	0.21	0.25	0.32	0.47	0.53	0.93
TA-55	0.22	0.27	0.33	0.52	0.56	1.03

g = acceleration equal to gravity, CMRR = Chemistry and Metallurgy Research Replacement Facility, TA = technical area.
Source: LANL 2007a.

4.2.2.4 Slope Stability, Subsidence, and Soil Liquefaction

There are two changes to the *1999 SWEIS* relative to slope stability, subsidence, and soil liquefaction. The Cerro Grande Fire increased soil erosion due to loss of vegetative cover and hydrophobic soil formation. This in turn decreased slope stability in some localized areas. This effect is dissipating as vegetation returns (Gallaher and Koch 2004). The discussion in the *1999 SWEIS* of slope stability at the Omega West Facility is no longer pertinent because that facility was completely demolished in 2003 (LANL 2004c).

4.2.3 Soils

Most of the LANL facilities are located on mesa tops, where the soils are generally well-drained and thin (0 to 40 inches [0 to 102 centimeters]). A general description of LANL soils was included in the *1999 SWEIS*.

In May 2000, the Cerro Grande Fire burned approximately 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) on LANL (Balice, Bennett, and Wright 2004). The fire severely burned much of the mountainside that drains onto LANL (Gallaher and Koch 2004). The effects of the fire included increased soil erosion due to loss of vegetative cover, formation of hydrophobic soils, and soil disturbance during construction of fire breaks, access roads, and staging areas (DOE 2000f). The increased potential for flooding and erosion led to construction of mitigation structures to retain floodwaters and reinforce road crossings (DOE 2002j).

Hydrophobic soils are formed by high intensity fires when compounds from plant litter are volatilized by the heat of the fire, forced deeper into the soil, and precipitate out as a waxy-like substance on cooler soil particle surfaces (Gallaher and Koch 2004). This limits the paths available for water percolation through the soil. Combined with loss of vegetation, hydrophobic soil formation enhances the potential for increased runoff, soil erosion, downslope flooding, and degradation of water quality. Approximately 9,310 acres (3,768 hectares) of hydrophobic soils were formed in the Jemez Mountains from the Cerro Grande Fire (DOE 2000f).

Soil composition was also affected by the Cerro Grande Fire. The high temperatures associated with forest fires cause a reduction in the oxidation state of metal constituents and combustion of organic carbon in surface soil. A change in the oxidation state of a metal can significantly alter its solubility; this may contribute to the observed release of manganese from soils affected by forest fires (Gallaher and Koch 2004). Studies show that these changes are temporary, usually lasting less than 5 years (Gallaher and Koch 2004).

4.2.3.1 Soil Monitoring

As described in the *1999 SWEIS*, soils on and surrounding LANL are sampled annually as part of the Environmental Surveillance and Compliance Program to determine if they have been contaminated by LANL operations. The soil sampling and analysis program provides information on the inventory, concentration, distribution, and changes over time of radionuclides in soils near LANL. The program has provided annual updates (through the yearbooks) to the data reported in the *1999 SWEIS*. Sediments, which occur along most segments of LANL canyons as narrow bands of canyon-bottom deposits, are not part of the soil monitoring program and are discussed in Section 4.3.1.4.

The following summarizes the discussion provided in *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement* (LANL 2004c), except where otherwise noted. The soil monitoring program at LANL comprises: (1) an institutional component that monitors soil contaminants within and around LANL, and (2) a facility component that monitors soil contaminants within and around the principal low-level waste disposal area at LANL (Area G), as well as the principal explosive test facility at the site (Dual Axis Radiographic Hydrodynamic Test [DARHT]).

As part of the institutional program, soil samples are collected from onsite, perimeter, and offsite (regional) locations (see **Figure 4–10** and **Figure 4–11**). Onsite areas sampled at LANL are not potential release sites or wastewater outfalls. Instead, the majority of onsite sampling stations are located close to and downwind from major facilities and operations at LANL in an effort to assess radionuclide, radioactivity, heavy metals, and organics in soils that may have been contaminated as a result of air stack emissions and fugitive dust (such as the resuspension of dust from potential release sites).

The soil radionuclide and radioactivity samples collected from 1974 through 2005 have been analyzed for tritium; cesium-137; plutonium-238, -239, and -240; americium-241; strontium-90; total uranium; gross alpha; gross beta; and gross gamma activities. As reported in LANL 2004c, sources of radionuclides in soil include natural minerals, atmospheric fallout, and planned or unplanned releases of radioactive gases, liquids, and solids from LANL operations. Naturally-occurring uranium is present in relatively high concentrations in soil and rocks due to the regional geologic setting. Plutonium sources at LANL include LANL operations and atmospheric fallout. Metals in soil may be naturally-occurring or may result from LANL releases (LANL 2004c).

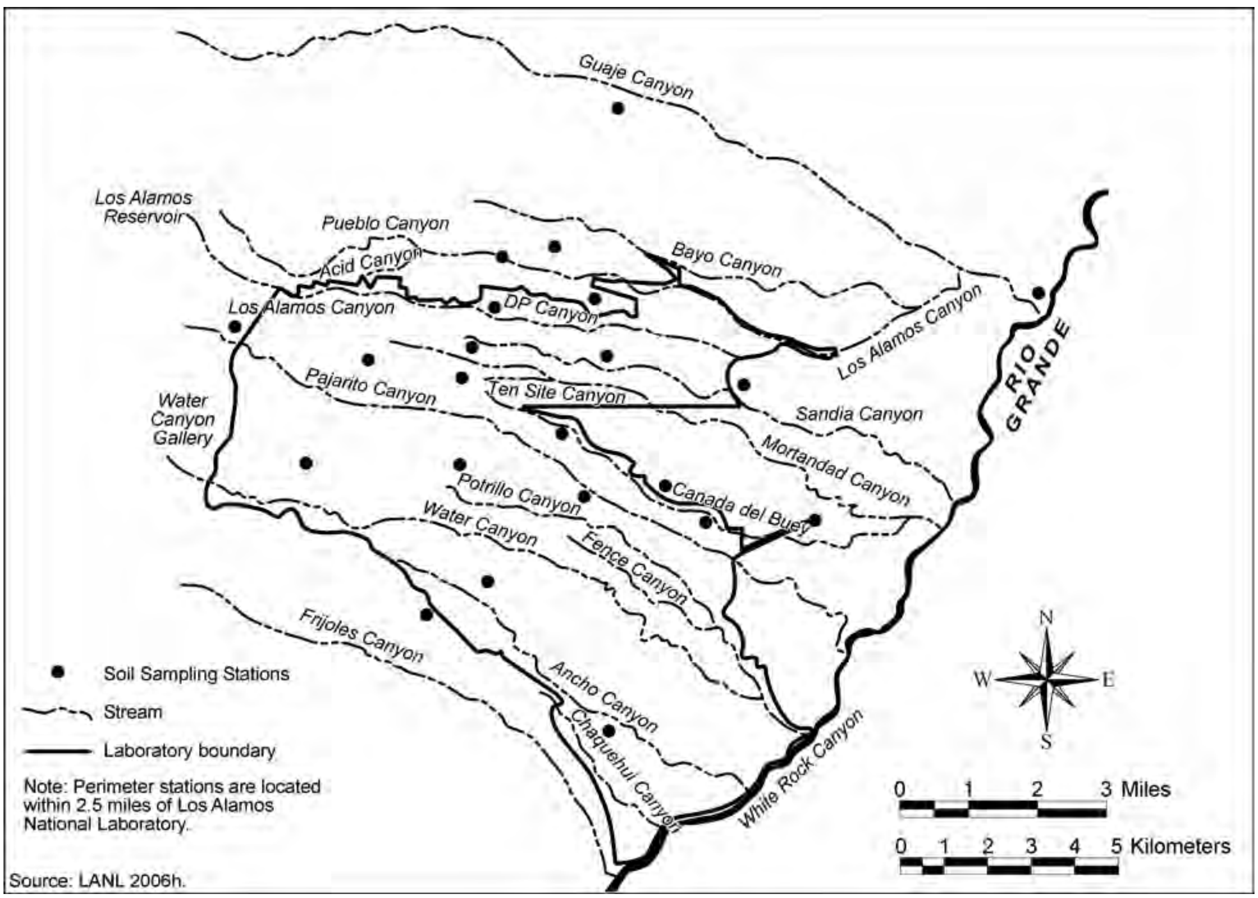


Figure 4–10 Onsite and Perimeter Soil Sampling Locations

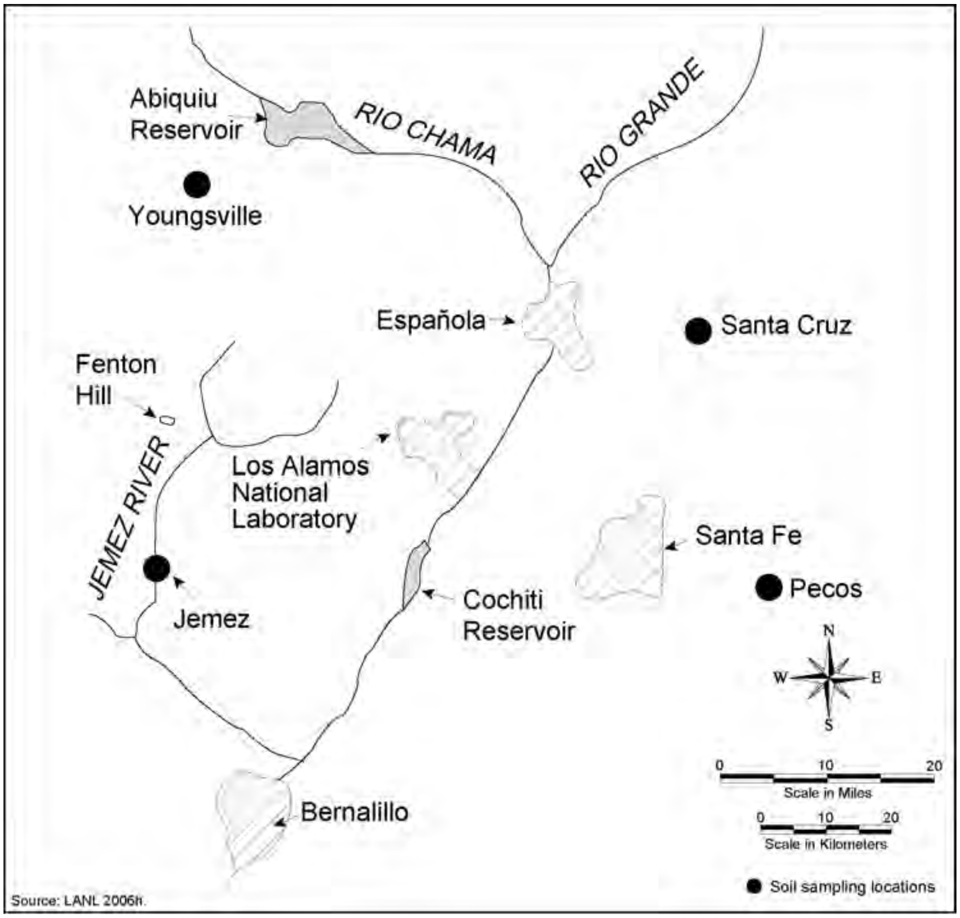


Figure 4–11 Offsite (Regional) Soil Sampling Locations – 2003

LANL onsite and perimeter soil samples are collected and analyzed for radiological and nonradiological constituents, and compared to the regional (background) locations. In general, based on the most recent data, most radionuclide concentrations (activity) in soils collected from individual perimeter and onsite stations were nondetectable (LANL 2004c). Of the radionuclides that were detected, most were still within regional statistical reference levels, indicating that they represent natural and fallout levels. This is consistent with the results presented in the *1999 SWEIS*.

Of the radionuclides detected in soils from perimeter and onsite stations that exceeded regional statistical reference levels, most were plutonium-239 and plutonium-240. Most of the detections were just above the regional statistical reference level, and were probably a result of fallout amplified by higher precipitation (rain) events. However, two soil samples, one onsite (at the DP Site in TA-21) and one at the site perimeter (at the west airport) contained concentrations above regional fallout levels. These levels were probably associated with activities at LANL. The west airport site is located just north and slightly downwind of the former Plutonium Processing Facility at TA-21; this is likely the source of the elevated plutonium result. The DP Site, a former plutonium processing facility that is currently undergoing decontamination and decommissioning, shows a great deal of variation in concentrations of plutonium-239 and plutonium-240 isotopes in soils over time. These variations are likely due to past facility operations or releases from potential release sites and not current operations (LANL 2004c).

Although soil samples at TA-21 (DP Site) contained plutonium-239 and plutonium-240 concentrations above regional statistical reference level, the values are still very low (picocuries range) and far below screening action levels. LANL screening action levels are used to identify the presence of contaminants of concern and are derived from a risk assessment pathway using a 15 millirem per year dose limit. The screening action levels in the *1999 SWEIS* were based on a 10 millirem per year dose limit. LANL also uses screening action levels to identify "hot spots" that require additional sampling and may require remediation. In every case, regional statistical reference levels are much lower than screening action levels.

Trend analyses show that most radionuclides and radioactivity in soils from onsite and perimeter areas at LANL have been decreasing over time. The exceptions are plutonium-238 and gross alpha concentrations not associated with specific radioisotopes. These observations continue the trends identified in the *1999 SWEIS*. The continuing decreases are likely due to: (1) the decrease in LANL operations and improvements in continuing facility operations, (2) the cessation of aboveground nuclear weapons testing in the early 1960s, (3) weathering (wind, water erosion, and leaching), and (4) radioactive decay (half-life). The persistence of plutonium-238 concentrations may be a result of low contaminant mobility, long half-life, and levels that approach background. The persistence of gross alpha levels may indicate that the observed levels approach background.

As part of the institutional program, soils were analyzed for trace and heavy metals. In general, few individual sites from either perimeter or onsite areas have metals concentrations above regional statistical reference levels. Metals that exceeded the regional statistical reference levels included barium, beryllium, mercury, and lead. Although above regional statistical reference levels, the detections were below U.S. Environmental Protection Agency (EPA) screening levels (LANL 2004c), indicating that they do not present a significant health concern. Trending analysis showed that the concentration of most metals does not appear to be rising over time; they appear to be remaining steady or decreasing. This was consistent with the trend reported in the *1999 SWEIS*, which suggested that facility operations are not a continuing source of metal contamination in site soils. However, mercury concentrations in all soils, including regional soils, appeared to be decreasing over time. This decrease was not entirely understood, but may be a reflection of better waste disposal methods and reduced air emissions from regional coal-fired manufacturing facilities (LANL 2006a).

Organic constituents were also studied within and around LANL, particularly after the 2000 Cerro Grande Fire. Volatile organic compounds, semivolatile organic compounds, organochlorine pesticides, polychlorinated biphenyls, high explosives, and dioxin and dioxin-like compounds were assessed in soils from LANL, perimeter, and background soil samples. Most organic compounds were not detected above reporting limits in any of the soils collected within or around LANL. However, two of the less toxic dioxin-like compounds (1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin [OCDD] and 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin [HpCDD]) were detected above reporting limits in most of the soil samples analyzed. These compounds are the least toxic of the six dioxin-like compounds analyzed. They are known byproducts of burning in natural (forest fires) and human-made (residential wood burning and municipal and industrial waste incinerators) settings. The highest observed concentrations of organic contaminants (3.7 parts per trillion of HpCDD and 29.1 OCDD) were from samples collected near the Los Alamos airport (TA-72). The total of these maximum detections is equivalent to

0.029 parts per trillion toxicity equivalents, which is well below the Agency for Toxic Substances and Disease Registry (ATSDR) soil screening level of 50 parts per trillion toxicity equivalents (ATSDR 1997, LANL 2004c). In addition, OCDD was detected at similar concentrations both upwind and downwind of the Cerro Grande Fire area, so it was probably not related to the fire (LANL 2004c).

Under the facility monitoring program, soils are monitored for contaminants around the perimeter of Area G and DARHT. Area G covers approximately 63 acres (25 hectares) in TA-54 at the east end of LANL. The soils and sediment are monitored for tritium, strontium-90, americium-241, cesium-137, plutonium isotopes, and uranium isotopes. Both tritium and plutonium isotopes have been detected at concentrations significantly above regional statistical reference levels, and tritium in soils in some locations is increasing over time. However, a special monitoring study of tritium determined that tritium in vegetation decreases to regional statistical reference levels at a distance of approximately 295 feet (90 meters) from Area G (LANL 2004c).

DARHT covers approximately 20 acres (8 hectares) and is located at TA-15 at the southwest end of LANL. Soils and sediments are monitored for the same radionuclides as at Area G, plus a number of heavy metals. Results are compared with baseline statistical reference levels established over a 4-year-long preoperational period prior to DARHT operations. After 4 years of operation at DARHT, sample analysis results demonstrate that most radionuclides and trace elements in soil, sediment, and biota are within baseline statistical reference levels (LANL 2004c).

As described in *Effects of the Cerro Grande Fire (Smoke and Fallout Ash) on Soil Chemical Properties Within and Around Los Alamos National Laboratory* (LANL 2000d), surface soil samples from LANL were evaluated to determine what effects the wildfire had on soil composition. The analytes were the same radionuclides, metals, and organic compounds as used in the soil monitoring program. For this analysis, the post-fire samples were compared to those collected in 1999 from the same sites. In general, the post-fire results were statistically similar to those collected before the fire, indicating that the impacts to soil chemistry as a result of the fire were minimal.

4.2.3.2 Soil Erosion

A general description of soil erosion at LANL was included in the *1999 SWEIS*. The Cerro Grande Fire increased soil erosion due to loss of vegetative cover and hydrophobic soil formation. This, in turn, increased the frequency and severity of flooding (DOE 2000g); total runoff volume in 2000 increased 50 percent over prefire years (Gallaher and Koch 2004). The increased potential for flooding and erosion led to construction of mitigation structures to retain floodwaters and reinforce road crossings (DOE 2002j). Tree loss due to the bark beetle increased soil erosion by decreasing vegetative cover.

Increased erosion results in steeper canyon walls with greater potential for slope failure. It also produces greater releases of soil particles, with their bound and interstitial legacy contaminants, to LANL streams. The waste legacy constituents are characterized under the soil monitoring program described above. The levels and fate of constituents in stream sediments is described in

Section 4.3.1.5. Increased runoff from fire-impacted areas continued in 2001, 2002, and 2003, but is expected to decrease over time as revegetation occurs (Gallaher and Koch 2004).

4.2.4 Mineral Resources

Potential mineral resources at LANL consist of rock and soil for use as backfill or borrow material for construction of remedial structures such as waste unit caps. Suitable borrow materials in the LANL area include Santa Fe Group sedimentary deposits and Pliocene-age volcanic rocks, especially poorly- to moderately-welded Bandelier Tuff (Stephens and Associates 2005). Quaternary alluvium deposits along stream channels could also be a source of borrow material, but these are typically of limited volume. Similarly, sediment deposits that have formed at the flood control structures built to mitigate the effects of the Cerro Grande Fire could be a potential borrow source, but these too are generally of limited volume.

The only borrow pit presently established onsite at LANL is the East Jemez Road Borrow Pit in TA-61 (Stephens and Associates 2005), which is currently used for soil and rubble storage and retrieval. The pit is cut into the upper Bandelier Tuff, which represents good source material for certain construction purposes (LANL 2005b).

There are numerous commercial offsite borrow pits and quarries in the vicinity; eleven are within 30 miles (48 kilometers) of LANL (this distance is taken as the upper economically viable limit for hauling borrow material to a cover site) (Stephens and Associates 2005). In general, these produce sand and gravel.

4.2.5 Paleontological Resources

A single paleontological artifact has been reported at a site within LANL boundaries (DOE 2003d). The artifact is described as a post-Pliocene (less than 1.6 million year-old) bison bone. It was found in the White Rock-Y area (LANL 2002f). Paleontological artifacts are generally not expected at LANL because near-surface stratigraphy is not conducive to preserving plant and animal remains. The near-surface materials are volcanic ash and pumice that were extremely hot when deposited; most carbon-based materials (such as bones or plant remains) would likely have been vaporized or burned, if present.

4.3 Water Resources

This section addresses surface water, groundwater, sediments, and floodplains located onsite, on adjacent properties, and extending to northern New Mexico and southern Colorado. Wetlands are discussed in Section 4.5.2 because they provide important habitat for many of the animals found on LANL. Water resources in the LANL region are used for human consumption, traditional and ceremonial uses by American Indians, aquatic and wildlife habitat, domestic livestock watering, irrigation, industry, and commercial purposes. Water resources in proximity to LANL may be affected by water withdrawals, effluent discharges, waste disposal, spills and unplanned releases, soil erosion, or stormwater runoff from LANL operations. The LANL area includes 15 subwatersheds as shown in **Figure 4–12**, with 12 local watersheds crossing LANL boundaries. The local watersheds are named for the canyons that receive their runoff.

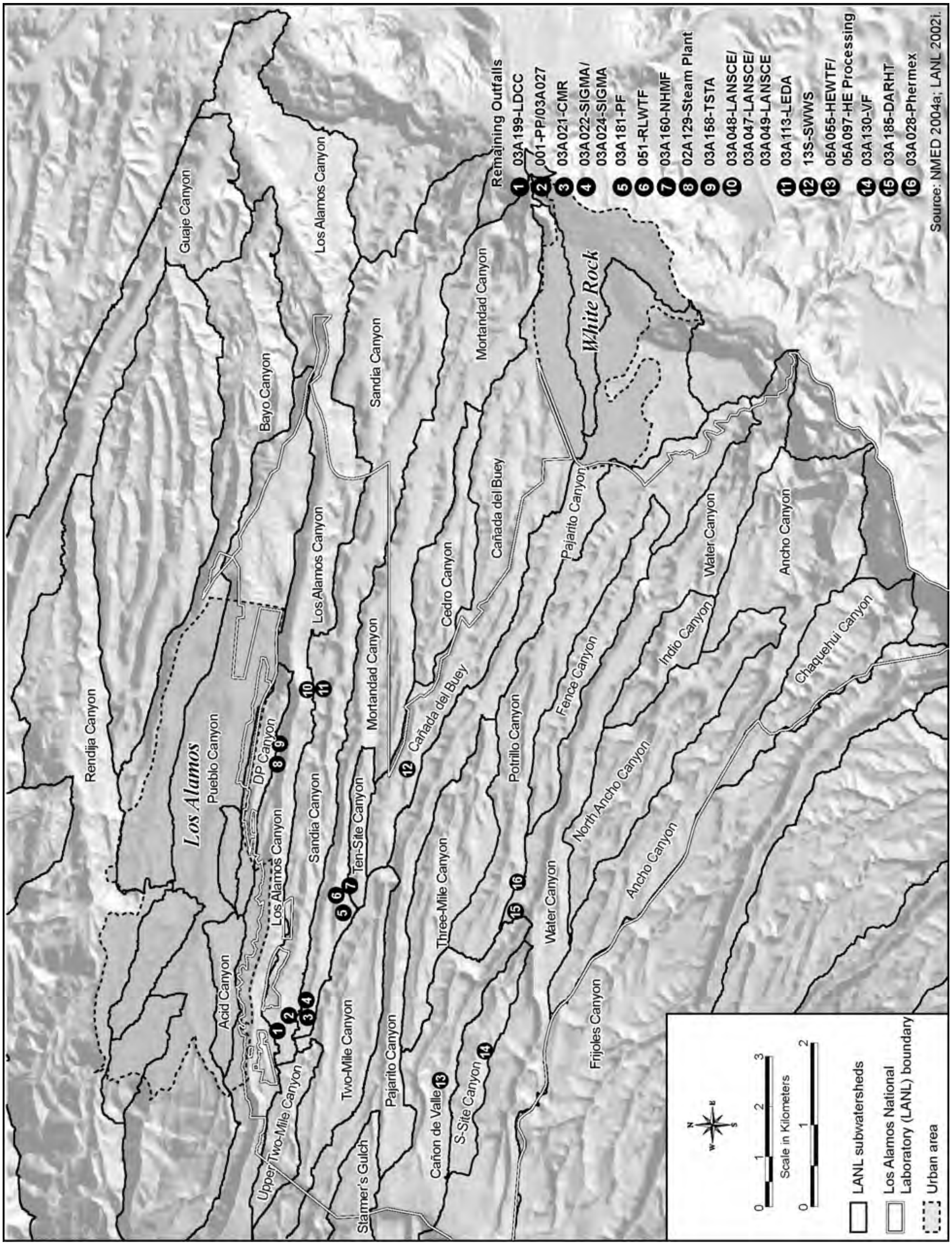


Figure 4–12 Watersheds in the Los Alamos National Laboratory Region

Detailed information on the geology, hydrology, and hydrogeology of the area was presented in Chapter 4, Sections 4.2 and 4.3, of the *1999 SWEIS*, with updated information provided annually in the *SWEIS Yearbooks* (LANL 2001e, 2002e, 2003h, 2004f, 2005f, 2006g, as well as Chapter 4, Section 4.2, and Appendix E of this SWEIS). Since the *1999 SWEIS* analysis, the Cerro Grande Fire changed the water resources environment by removing vegetation and surface organic layers, decreasing the ability of the soil to take in water. These changes caused increased surface water runoff and soil erosion to adversely affect local water resources by accelerating the movement of contaminants in sediments transported in stormwater downstream of LANL. An overview of the Cerro Grande Fire impacts on water resources is further discussed in Section 4.3.1.7.

Another change since the *1999 SWEIS* is related to the Fenton Hill site, a part of LANL located about 20 miles (32 kilometers) west of LANL. In 2003, DOE completed decommissioning the Fenton Hill Hot Dry Rock Geothermal Project by plugging and abandoning all remaining wells. In addition, most structures and equipment associated with the project were removed from the site. There are no environmental permits required for the operations remaining at the site, so Fenton Hill will not be discussed further in this section (LANL 2004c).

Water resources are regulated by a variety of standards, including the Clean Water Act, Safe Drinking Water Act, the New Mexico Water Quality Control Commission standards, and DOE Derived Concentration Guides. These standards and guides are discussed in Chapter 6 of this SWEIS.

Surface Water Terms

For the purposes of this SWEIS, the following terms apply to various forms of surface water.

- *Effluent* or *Discharge* applies only to industrial wastewater released to the environment through a National Pollutant Discharge Elimination System outfall.
- *Flow* applies to streams, springs, stormwater, or effluents, regardless of whether the water flows over an industrial site, a construction site, a natural landscape, or out of an outfall pipe.
- *Runoff* applies only to stormwater, because the precipitation runs off the surface, instead of infiltrating into the ground. Runoff is considered a "discharge" within the NPDES program, but that term will not be used for stormwater in this SWEIS for clarity.
- *Perennial* applies to streams that flow continuously due to natural springs or industrial effluents throughout the year in all years.
- *Ephemeral* applies to streams that flow only in response to local precipitation or snowmelt in the immediate area.
- *Intermittent* applies to streams that surface because the water table is higher than the streambed at certain times of the year.

4.3.1 Surface Water

Surface water may be affected by LANL operations when streams and springs receive industrial effluents discharged from LANL, stormwater flows over the site, and sediments are mobilized by stormwater runoff. At certain times of the year and under certain precipitation and flow conditions, surface water flowing through and from LANL can reach the Rio Grande.

Streams that drain the LANL area are dry for most of the year, and the area's surface water flows primarily in intermittent streams in response to local precipitation or snowmelt. Only about 2 miles (3.2 kilometers) of the over 85 miles (137 kilometers) of watercourses within LANL boundaries are naturally occurring perennial streams. Approximately 3 miles (4.8 kilometers) of watercourses are perennial waters created by supplemental flows from wastewater discharges.

Some of the surface water at LANL comes from shallow groundwater discharging as springs into canyons (LANL 2005h). Surface waters on- and offsite provide recharge to subsurface groundwater via infiltration to alluvial groundwater, intermediate perched groundwater, and the regional aquifer. Surface water is not a source of municipal, industrial, irrigation, or recreational water, though it is used by wildlife. While there is minimal direct use of the surface water within LANL, flows may extend beyond the site boundaries, where there is more potential for use of the water. Certain stream flows extend onto San Ildefonso Pueblo Tribal land and these may be used by Tribal members for traditional or ceremonial purposes, including ingestion or direct contact. Surface waters that flow off LANL property also may reach the Rio Grande, where contaminants could flow downstream.

4.3.1.1 Surface Water and Sediment Quality

Surface water quality is compared to many standards and reference guidelines established by Federal and state agencies. Drinking water standards are used for comparison, although surface water on the Pajarito Plateau is not used for this purpose. Sediments are also compared to several references and risk-based levels to determine if they could cause harm to human health or the environment. **Table 4–7** summarizes the standards and references used to evaluate surface water and sediment quality.

Table 4–8 summarizes the locations of LANL-impacted surface water and sediments. Surface water quality has been affected by LANL operations, with the greatest effects caused by past discharges into Acid, Pueblo, Los Alamos, and Mortandad Canyons.

After evaluating surface water quality data collected from streams within and downstream of LANL, the New Mexico Environment Department (NMED) identified several impaired stream reaches. These data were compared to the standards for the designated use of each stream, according to Section 303(d) of the Clean Water Act. Most surface water on the Pajarito Plateau is designated for use as wildlife habitat, livestock watering, and secondary contact. Some reaches have aquatic life designations. **Table 4–9** lists the impaired reaches within and downstream of LANL. These reaches are displayed in **Figure 4–13**.

Sources of Impacts to Surface Water Resources

LANL personnel recognize and manage the following sources that might impact local surface water resources:

- Industrial effluents discharged through National Pollutant Discharge Elimination System (NPDES) outfalls. This source is referred to as "NPDES-permitted outfalls" and includes point-source discharges from LANL wastewater treatment plants and cooling towers (see Section 4.3.1.2);
- Stormwater runoff, including stormwater runoff from certain industrial activities, construction activities, and solid waste management units (see Section 4.3.1.3);
- Dredge and fill activities or other work within perennial, intermittent, or ephemeral water courses (see Section 4.3.1.4); and
- Sediment transport (see Section 4.3.1.5).

Table 4–7 Standards and References Used for Evaluating Water Quality

Type	Source	Standard or Reference Value	Potentially Applicable To: Pajarito Plateau – Perennial Surface Water (spring supported, effluent supported)	Pajarito Plateau – Intermittent and Ephemeral Surface Waters	Pajarito Plateau – Sediments	Rio Grande – Surface Water	Rio Grande – Sediments
Standard	NMWQCC	Irrigation	NA	NA	NA	X	NA
Standard	NMWQCC	Livestock Watering	X	X	NA	X	NA
Standard	NMWQCC	Wildlife Habitat	X	X	NA	X	NA
Standard	NMWQCC	Secondary Contact	X	X	NA	X	NA
Standard	NMWQCC	Coldwater Aquatic Life	X	NA	NA	X	NA
Standard	NMWQCC	Aquatic Life-acute	X	X	NA	X	NA
Standard	NMWQCC	Aquatic Life-chronic	X	NA	NA	X	NA
Standard	NMWQCC	Human Health (persistent contaminants)	X	X	NA	X	NA
Standard	NMWQCC	Human Health (cancer causing, or toxic)	X	NA	NA	X	NA
Reference	NMWQCC	Groundwater for Human Health	X (filtered samples)	X (filtered)	NA	NA	NA
Reference	NMWQCC	Groundwater other Standards for Domestic Water	X (filtered)	X (filtered)	NA	NA	NA
Reference	EPA	Drinking Water Systems MCL (filtered)	NA	NA	NA	X	NA
Reference	EPA	Fish Consumption and Water	NA	NA	NA	X	NA
Reference	EPA	EPA Region 6 Tap Water Screening Level	X	X (filtered)	NA	NA	NA
Risk-plant and animal	DOE	DOE BCGs (1 rad per day for aquatic animals and plants; 0.1 rad per day for terrestrial animals)	X	X	NA	NA	NA
Risk-human	EPA	EPA Region 6 Residential and Industrial Outdoor Worker Soil Screening Levels (metals, organics, chemicals)	NA	NA	X	NA	X
Risk-human	LANL/USGS	Residential Soil Screening Action Levels (radionuclides)	NA	NA	X	NA	X
Reference	Environment Canada	Guideline for Protection of Aquatic Life	NA	NA	NA	NA	X
Reference	LANL	Background radionuclides and metals	NA	NA	X	NA	NA
Reference	LANL	Background radionuclides	NA	NA	NA	NA	X
Reference	USGS	Prefire metals and organic chemicals	NA	NA	NA	NA	X
Reference	LANL/NMED	Prefire metals and radionuclides	X	X	X	X	X

NMWQCC = New Mexico Water Quality Control Commission, NA = not applicable, EPA = U.S. Environmental Protection Agency, MCL = maximum contaminant level, BCG = Biota Concentration Guide, USGS = U.S. Geological Survey, NMED = New Mexico Environment Department.

Sources: DOE 1990, 2002g; Environment Canada 2002; EPA 2002, 2007a; Gilliom, Mueller, and Nowell 1997; LANL 2006g, 2006h; NMAC 20.6.2; NMAC 20.6.4.

Table 4–8 Surface Water and Sediment Contamination Affected by Los Alamos National Laboratory Operations

Contaminant	*Onsite*	*Offsite*	*Significance*	*Trends*
Radionuclides in Sediments	Higher than background in sediments because of LANL contributions in Pueblo, DP, Los Alamos, Pajarito, and Mortandad Canyons.	Yes, in Los Alamos, Acid, and Pueblo Canyons; and slightly elevated in the Rio Grande and Cochiti Reservoir.	Sediments below health concern, except onsite along a short distance of Mortandad Canyon; exposure potential is limited.	Plutonium-239 and -240 and cesium-137 concentrations temporarily increased after the Cerro Grande Fire, but fell back to pre-fire levels in Pueblo and Los Alamos Canyons
Radionuclides in Surface Water	Higher than background in runoff in Pueblo, DP, Los Alamos, and Mortandad Canyons.	Yes, in Los Alamos and Pueblo Canyons.	Minimal exposure potential because storm events are sporadic. Mortandad Canyon surface water is 7 percent of Biota Concentration Guide.	Flows in Pueblo Canyon occurring more often after the Cerro Grande Fire. Flows in other LANL canyons recovered to near pre-fire levels.
Polychlorinated Biphenyls in Sediments	Detected in sediment in nearly every canyon.	Yes, particularly in Los Alamos and Pueblo Canyons.	Wildlife exposure potential in Sandia Canyon. Elsewhere, findings include non-LANL and LANL sources.	None
Polychlorinated Biphenyls in Surface Water	Detected in Los Alamos and Sandia Canyon runoff and base flow above New Mexico Stream Standards.	No	Wildlife exposure potential in Sandia Canyon. Elsewhere, findings include non-LANL and LANL sources.	Polychlorinated biphenyls are found everywhere in the Rio Grande, both upstream and downstream of LANL
Dissolved Copper, Lead, and Zinc in Surface Water	Detected in many canyons above New Mexico acute aquatic life standards.	Yes, in Los Alamos Canyon	Origins uncertain; probably multiple sources.	None
High Explosive Residues and Barium in Surface Water	Detections near or above screening values in Cañon de Valle base flow and runoff.	No	Minimal potential for exposure.	None
Benzo(a)pyrene	Detections near or above industrial screening levels in Los Alamos Canyon.	Yes, in Los Alamos and Acid Canyons.	Origins uncertain; probably multiple sources.	None

Sources: LANL 2005h, 2006h.

Other possible sources of surface water impacts are isolated spills, former photographic processing facilities, highway runoff, and residual Cerro Grande Fire ash (LANL 2005h). While most of the major sources were discussed in the *1999 SWEIS*, that evaluation focused on the NPDES-permitted outfalls and sediment transport (DOE 1999a; LANL 2004c). Over the past few years, regulatory emphasis has shifted away from the NPDES-permitted outfalls towards managing stormwater runoff from operating facilities, construction sites, and solid waste management units. As New Mexico stream water quality standards are becoming more stringent, LANL programs are emphasizing improved management of its stormwater runoff (NNSA 2004c).

Table 4–9 New Mexico Environment Department List of Impaired Reaches

Impaired Reach	*Unsupported Designated Uses*	*Probable Causes of Impairment*	*Probable Sources of Impairment*
Upper Rio Grande Watershed			
Guaje Canyon (San Ildefonso Pueblo boundary to headwaters)	- Livestock Watering - Wildlife Habitat - Secondary Contact	- Gross Alpha - Selenium	- Inappropriate Legacy Waste Disposal - Natural Sources - Post-development Erosion and Sedimentation - Surface Mining - Watershed Runoff following Forest Fire
Rendija Canyon (Guaje Canyon to headwaters)	- Wildlife Habitat - Secondary Contact	- Selenium	- Natural Sources - Post-development Erosion and Sedimentation - Surface Mining - Watershed Runoff following Forest Fire
Los Alamos Reservoir	- Coldwater Aquatic Life - Livestock Watering - Wildlife Habitat - Irrigation - Primary Contact	- Other	- Watershed Runoff following Forest Fire
Los Alamos Canyon Ephemeral and Intermittent Segments (San Ildefonso Pueblo boundary to Los Alamos Reservoir)	- Livestock Watering - Wildlife Habitat - Limited Aquatic Life - Secondary Contact	- Gross Alpha - Selenium	- Inappropriate Legacy Waste Disposal - Industrial and Commercial Site Stormwater Discharge (Permitted) - Natural Sources - Post-development Erosion and Sedimentation - Watershed Runoff following Forest Fire
Pueblo Canyon (Los Alamos Canyon to headwaters)	- Livestock Watering - Wildlife Habitat - Secondary Contact	- Gross Alpha - Mercury - Selenium	- Contaminated Sediments - Impervious Surface and Parking Lot Runoff - Inappropriate Legacy Waste Disposal - Industrial and Commercial Site Stormwater Discharge (Permitted) - Municipal (Urbanized High Density Area) - Natural Sources - Post-development Erosion and Sedimentation - RCRA Hazardous Waste Sites - Watershed Runoff following Forest Fire
Rio Grande – Santa Fe Watershed			
Sandia Canyon Perennial Segment (Sigma Canyon upstream to LANL NPDES Outfall 001)	- Coldwater Aquatic Life - Livestock Watering - Wildlife Habitat - Secondary Contact	- Polychlorinated biphenyl-1254 - Polychlorinated biphenyl-1260	- Atmospheric Deposition of Toxics - Inappropriate Legacy Waste Disposal - Landfills - Post-development Erosion and Sedimentation
Sandia Canyon Ephemeral and Intermittent Segments (San Ildefonso Pueblo boundary to Sigma Canyon)	- Livestock Watering - Wildlife Habitat - Limited Aquatic Life - Secondary Contact	- Polychlorinated biphenyl-1254 - Polychlorinated biphenyl-1260	- Atmospheric Deposition of Toxics - Inappropriate Legacy Waste Disposal - Landfills - Post-development Erosion and Sedimentation

Impaired Reach	Unsupported Designated Uses	Probable Causes of Impairment	Probable Sources of Impairment
Mortandad Canyon (San Ildefonso Pueblo boundary to headwaters)	- Livestock Watering - Wildlife Habitat - Limited Aquatic Life - Secondary Contact	- Gross Alpha - Selenium	- Impervious Surface and Parking Lot Runoff - Inappropriate Legacy Waste Disposal - Industrial Point Source Discharge - Natural Sources - Post-development Erosion and Sedimentation - Watershed Runoff following Forest Fire
Pajarito Canyon Perennial Segment (Arroyo de la Delfe upstream into Starmers Gulch and Starmers Spring)	- Coldwater Aquatic Life - Livestock Watering - Wildlife Habitat - Secondary Contact	- Gross Alpha - Selenium	- Inappropriate Legacy Waste Disposal - Natural Sources - Post-development Erosion and Sedimentation - Watershed Runoff Following Forest Fire
Pajarito Canyon (Rio Grande to Arroyo de la Delfe and upstream from Starmers Spring)	- Livestock Watering - Wildlife Habitat - Limited Aquatic Life - Secondary Contact	- Gross Alpha - Selenium	- Inappropriate Legacy Waste Disposal - Natural Sources - Post-development Erosion and Sedimentation - Watershed Runoff following Forest Fire
Water Canyon Perennial Segments (Area A Canyon upstream to NM 501) and Cañon de Valle Perennial Segment (LANL stream gage E256 upstream to Burning Ground Spring)	- Coldwater Aquatic Life - Livestock Watering - Wildlife Habitat - Secondary Contact	- Gross Alpha - Selenium	- Inappropriate Legacy Waste Disposal - Industrial Point Source Discharge - Industrial and Commercial Site Stormwater Discharge (Permitted) - Natural Sources - Post-development Erosion and Sedimentation - Watershed Runoff Following Forest Fire
Water Canyon and Cañon de Valle Ephemeral and Intermittent Segments (portions within DOE lands)	- Limited Aquatic Life - Livestock Watering - Wildlife Habitat - Secondary Contact	- Gross Alpha - Selenium	- Inappropriate Legacy Waste Disposal - Industrial Point Source Discharge - Industrial and Commercial Site Stormwater Discharge (Permitted) - Natural Sources - Post-development Erosion and Sedimentation - Watershed Runoff following Forest Fire
Rito de los Frijoles (Rio Grande to headwaters)	- High Quality Coldwater Fishery - Primary Contact - Secondary Contact	- DDT - Fecal Coliform - Water Temperature - Turbidity	- Natural Sources - Other Recreational Pollution Sources - Other Spill Related Impacts - Source Unknown

RCRA = Resource Conservation and Recovery Act, DDT = dichlorodiphenyl-trichlorethane, NPDES = National Pollutant Discharge Elimination System.
Sources: NMED 2004a, NMWCC 2006.

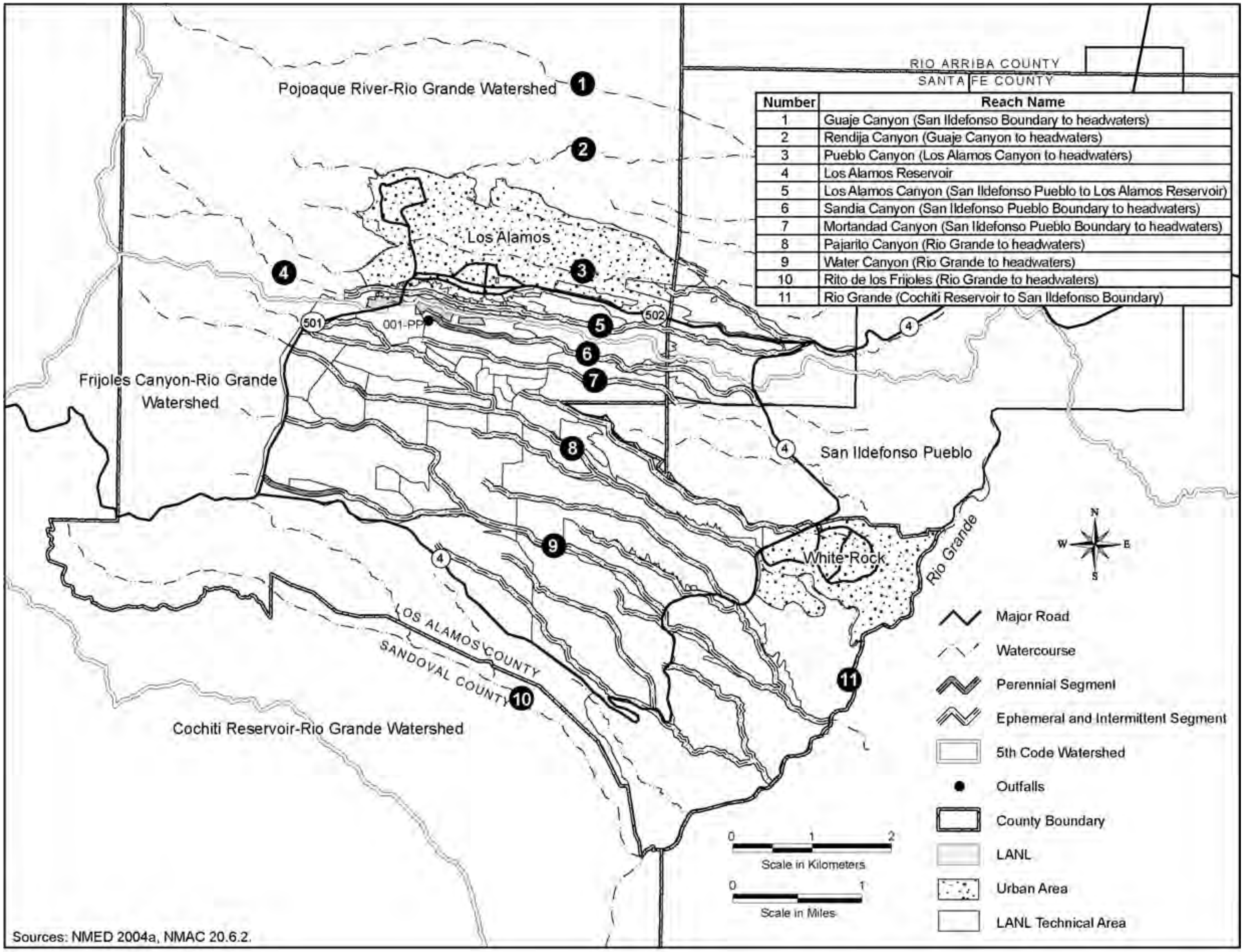


Figure 4–13 Impaired Reaches in the Vicinity of Los Alamos National Laboratory

In accordance with DOE Order 450.1, "Environmental Protection Program," and other statutory requirements, LANL personnel routinely monitor surface water, stormwater, and sediments as part of their ongoing environmental monitoring and surveillance program. The monitoring results are published annually in Environmental Surveillance Reports. One improvement since the *1999 SWEIS* is that LANL personnel expanded the focus to a site-wide monitoring program that integrates groundwater, surface water, stormwater, and sediment monitoring, on a watershed basis.

The *1999 SWEIS* presented surface water quality data from 1991 to 1996. Updated information was collected and presented yearly in the LANL Environmental Surveillance Reports, and current data are now available through 2005 (LANL 2005h). An overview of the 2005 data is presented below to provide an understanding of the current surface water quality conditions.

- While nearly every major watershed shows some level of impact from LANL operations, the overall quality of most surface water is described as good. Most samples of 200 possible contaminants have concentrations that are far below regulatory standards or risk-based advisory levels (LANL 2006h).

- Past discharges of radioactive liquid effluents into Pueblo (including its tributary Acid Canyon), DP, and Los Alamos Canyons and current releases from the Radioactive Liquid Waste Treatment Facility into Mortandad Canyon have introduced americium-241, cesium-137, plutonium-238, plutonium-239, plutonium-240, strontium-90, and tritium into both surface waters and canyon sediments (LANL 2005h). The sum of the ratios of all radionuclides to their Biota Concentration Guides is less than 11 percent in the major canyons (LANL 2006h).

- Radioactivity in lower Pueblo Canyon and Mortandad Canyon surface water at locations below the Radioactive Liquid Waste Treatment Facility outfall, as compared to the DOE Biota Concentration Guide, is shown in **Table 4–10**. This is similar to the conditions described in the *1999 SWEIS* (DOE 1999a; LANL 2004d, 2006h).

In addition to environmental monitoring, LANL personnel maintain other compliance programs. Liquid effluents from NPDES-permitted outfalls are required to meet limits established by the NPDES permit program (see Section 4.3.1.2) and the groundwater discharge permit program. Currently, LANL has one groundwater discharge permit for the TA-46 sanitary wastewater systems plant, the Metropolis Center, and the TA-3 power plant combined outfalls, and has submitted an application for another groundwater discharge permit for the TA-50 Radioactive Liquid Waste Treatment Facility outfall.

LANL activities that require excavation, filling, or other work within a watercourse are subject to Section 404 of the *Clean Water Act* and require dredge and fill permits issued by the U.S. Army Corps of Engineers and certification per Section 401, Water Quality Certification, by the NMED. These permits include operating conditions that must be observed to protect water quality and wildlife and ensure compliance with New Mexico stream standards (LANL 2006h). These activities are referred to as dredge and fill or Sections 404 and 401 activities and are discussed further in Section 4.3.1.4.

Table 4–10 Estimated Average Annual Concentrations of Radionuclides in Base Flows in Pueblo and Mortandad Canyons Compared with the Biota Concentration Guides

Radionuclide	BCGs (picocuries per liter)	Lower Pueblo Canyon (at NM 502)		Mortandad Canyon below TA-50 Radioactive Liquid Waste Treatment Facility Outfall	
		Estimated 2005 Time-Weighted Annual Average (picocuries per liter)	Ratio to BCG	Estimated 2005 Time-Weighted Annual Average (picocuries per liter)	Ratio to BCG
Americium-241	400	0.4	0.001	5.1	0.013
Cesium-137	20,000	Not detected	0.0	20	0.001
Tritium	300,000,000	Not detected	0.0	237	0.0000008
Plutonium-238	200	Not detected	0.0	2.1	0.0105
Plutonium-239 and Plutonium-240	200	11	0.055	2.9	0.0145
Strontium-90	300	0.4	0.0013	3.4	0.0011
Uranium-234	200	1.7	0.0085	2.0	0.01
Uranium-235 and Uranium-236	200	0.1	0.0005	1.1	0.0055
Uranium-238	200	1.6	0.008	1.9	0.0095
Sum of Ratios			0.07	–	0.07

BCG = Biota Concentration Guide, TA = technical area.
Source: LANL 2006h.

4.3.1.2 Industrial Effluents

Liquid effluents from LANL's industrial and sanitary outfalls are permitted under the NPDES Industrial Point Source Outfall Program (called NPDES-permitted outfalls). The NPDES permit requires routine monitoring of discharges and reporting of sampling results. The permit specifies the parameters to be measured and the sampling frequency (EPA 2007b).

Notable changes since the *1999 SWEIS* include a reduction in the number of permitted outfalls and the total effluent flow from outfalls, changes to LANL treatment facilities at the Radioactive Liquid Waste Treatment Facility at TA-50 and the High-Explosives Wastewater Treatment Facility at TA-16, and water conservation projects that recycle treated effluent to cooling towers from the TA-46 Sanitary Wastewater Systems Plant (formerly known as the Sanitary Wastewater Systems Consolidation Plant).

LANL has 21 outfalls currently permitted under the industrial permit program. **Table 4–11** shows the number of outfalls and the type of effluent that is discharged through the outfalls.

The 21 NPDES-permitted outfalls at LANL discharge into five local canyons in the LANL region, with the amount of discharge varying from year to year. Figure 4–13 shows the location of the NPDES-permitted industrial outfalls. In 2005, approximately 198 million gallons (749 million liters) of effluent were discharged from all permitted outfalls. This represents a reduction in the number of outfalls, the number of watersheds receiving flow, and the total amount of effluent discharged since publication of the *1999 SWEIS*. Thirty-five outfalls were removed from service as a result of efforts to reroute and consolidate flows and eliminate outfalls; one outfall was reinstated to serve the Laboratory Data Communication Center (TA-3-1498) cooling towers (DOE 1999a, LANL 2005f). The annual flow from permitted outfalls and discharges by watershed is shown in **Table 4–12**.

Table 4–11 National Pollutant Discharge Elimination System Industrial Point Source Outfalls

Number of Outfalls	*Type of Discharge*
1	Power Plant Discharge
1	Boiler Blowdown Discharge
15	Treated Cooling Water Discharge
2	High Explosive Wastewater Treatment
1	Radioactive Liquid Waste Treatment
1	Sanitary Wastewater Treatment
Total 21	

Source: EPA 2007b.

Table 4–12 National Pollutant Discharge Elimination Systems Permitted Outfalls and Discharges by Watershed

Canyon	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Cañada del Buey [a]							
Number of permitted outfalls	3	1	1	1	1	1	1
Discharge (million gallons per year)	2.6	0	0	0	0	0	0
Guaje [b]							
Number of permitted outfalls	6	0	0	0	0	0	0
Discharge (million gallons per year)	1.7	0	0	0	0	0	0
Los Alamos							
Number of permitted outfalls	7	5	5	5	5	5	5
Discharge (million gallons per year)	45.2	37.4	19.34	36.79	34.52	29.57	53.58
Mortandad							
Number of permitted outfalls	6	5	5	5	5	5	5
Discharge (million gallons per year)	39.3	31.6	4.21	31.4	33.12	15.9	16.84
Pajarito [c]							
Number of permitted outfalls	2	0	0	0	0	0	0
Discharge (million gallons per year)	0	0	0	0	0	0	0
Pueblo							
Number of permitted outfalls	1	0	0	0	0	0	0
Discharge (million gallons per year)	0.9	0	0	0	0	0	0
Sandia							
Number of permitted outfalls	6	4	4	5	5	5	5
Discharge (million gallons per year)	213.2	180.2	100.38	108.58	140.41	116.43	127.54
Water [d]							
Number of permitted outfalls	5	5	5	5	5	5	5
Discharge (million gallons per year) (Includes discharge to Cañon de Valle, a tributary)	14.3	16.2	0.102	1.41	1.77	0.62	0.50
Totals							
Number of permitted outfalls	36	20	20	21	21	21	21
Discharge (million gallons per year)	317.2	265.4	124.04	178.18	209.82	162.52	198.46

[a] Includes Outfall 13S from the Sanitary Wastewater Systems Plant, which is permitted to discharge to Cañada del Buey or Sandia Canyon. The discharge is currently piped to TA-3 and ultimately discharged to Sandia Canyon via Outfall 001.
[b] Includes 04A-176 discharge to Rendija Canyon, a tributary to Guaje Canyon.
[c] Includes 06A-106 discharge to Threemile Canyon, a tributary to Pajarito Canyon.
[d] Includes 05A-055 discharge to Cañon de Valle, a tributary to Water Canyon.
Note: To convert gallons to liters, multiply by 3.7853.
Sources: LANL 2003h, 2004f, 2005f, 2006g.

Five canyons (Pueblo, Cañada del Buey, Guaje, Chaquehui, and Ancho Canyons) that previously received LANL discharges are no longer receiving any industrial effluent. Pajarito Canyon has not received any effluent since 1998. Water Canyon and its tributary, Cañon de Valle, Sandia Canyon, Mortandad Canyon, and Los Alamos Canyon continue to receive LANL effluent discharges. Cañada del Buey is permitted to receive effluent from the TA-46 Sanitary Wastewater Systems Plant, but that effluent has been routed to Sandia Canyon since the plant opened (LANL 2005f). Total effluent discharges to the canyons from LANL decreased by about 37 percent over the past 6 years.

It should be noted that the method used to measure and report flow rates at NPDES-permitted outfalls has significantly changed since the *1999 SWEIS*. Historically, instantaneous flow was measured and extrapolated over a 24-hour day, 7-day week period. Flow meters, used since 2001 in many (but not all) outfalls and measuring stations, provide more accurate flow measurements. At those outfalls without meters, the flow is still calculated according to the previous method. Without comparable values, trend analysis of yearly flows is difficult.

The distribution of total industrial effluent contributed by the various facilities (Key and non-Key Facilities) has also changed since the *1999 SWEIS*. Annual effluents generated and discharged are listed by facility in **Table 4–13**. Total effluent discharges from all facilities in 2005 were 63 percent of the total discharges in 1999. In 2005, Key Facilities discharged about 63 million gallons (240 million liters) of effluent, representing 32 percent of the total annual flow; and non-Key Facilities discharged about 135 million gallons (511 million liters) of effluent, or 68 percent of the annual flow. Flows from Key and non-Key Facilities have fluctuated, but generally decreased since 1999. The apparent increase in effluent from the Tritium Facility is due to increased effluent discharges from the TA-21 Steam Plant (LANL 2006g).

Quality of Effluent from NPDES-Permitted Outfalls

LANL personnel collect weekly, monthly and quarterly samples to analyze effluents for compliance with NPDES permit levels. The *1999 SWEIS* reported that LANL had “chronic problems meeting NPDES industrial/sanitary permit conditions” (DOE 1999a). This condition has improved significantly. Since 2000, LANL has maintained an average compliance rate with permit conditions of 99.75 percent. The current compliance rate is summarized in **Table 4–14**. Permit exceedance trends are shown in **Figure 4–14**. The number of samples exceeding permit limits in Table 4–14 may differ from the number of exceedances shown in Figure 4–14 because one sample may exceed two limits. Each of these samples were counted as two exceedances until October 2004, when the method of reporting exceedances was changed so a single sample could only represent one exceedance of permit limits (LANL 2006a). In the event that a permit level is exceeded, DOE reports the condition to the EPA and takes corrective action to address the noncompliance. Details of all exceedance events are provided in the Environmental Surveillance Reports for the respective years (LANL 1999b, 2000e, 2001f, 2002d, 2004a, 2004d, 2005h, 2006h). Generally, exceedances of permit standards in the 5 years since 2000 were of excess total residual chlorine.

Table 4–13 National Pollutant Discharge Elimination Systems Permitted Outfalls and Discharges by Facility

Facility	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Plutonium Complex							
Number of permitted outfalls	1	1	1	1	1	1	1
Discharge (million gallons per year)	8.6	6.5	0.41	2.82	3.02	2.72	2.40
Tritium Facility [a]							
Number of permitted outfalls	2	2	2	2	2	2	2
Discharge (million gallons per year)	9.0	8.6	0.39	13.4	19.03	22.09	32.98
CMR Building							
Number of permitted outfalls	1	1	1	1	1	1	1
Discharge (million gallons per year)	4.5	2.3	0.02	0.76	2.16	1.19	0.92
Sigma Complex							
Number of permitted outfalls	2	2	2	2	2	2	2
Discharge (million gallons per year)	5.77	3.9	0.06	2.00	7.62	1.97	3.80
High Explosives Processing Facility							
Number of permitted outfalls	3	3	3	3	3	3	3
Discharge (million gallons per year)	0.2	0.1	0.04	0.03	0.02	0.037	0.029
High Explosives Testing Facility							
Number of permitted outfalls	3	2	2	2	2	2	2
Discharge (million gallons per year)	14.3	16.1	9.00 [b]	1.38	1.75	0.58	0.47
LANSCE							
Number of permitted outfalls	4	4	4	4	4	4	4
Discharge (million gallons per year)	37.2	30.5	20.45	24.04	16.46	8.12	21.00
Biosciences Facilities (previously called Health Research Laboratory)							
Number of permitted outfalls	1	0	0	0	0	0	0
Discharge (million gallons per year)	0	0	0	0	0	0	0
Radiochemistry Facility							
Number of permitted outfalls	1	0	0	0	0	0	0
Discharge (million gallons per year)	0	0	0	0	0	0	0
Radioactive Liquid Waste Treatment Facility	1	1	1	1	1	1	1
Number of permitted outfalls	5.3	4.9	3.6	2.92	2.97	2.14	1.83
Discharge (million gallons per year)							
Number of permitted outfalls	0	0	0	0	0	0	0
Discharge (million gallons per year)	0	0	0	0	0	0	0
Applies to each of the following facilities: - Pajarito Site - Machine Shops - MSL - Waste Management - TFF - Operations							
Sub-Total Key Facilities							
Number of permitted outfalls	19	16	16	16	16	16	16
Discharge (million gallons per year)	85.0	72.5	24.99	47.17	53.03	38.85	63.43
Non-Key Facilities							
Number of permitted outfalls	17	4	4	5	5	5	5
Discharge (million gallons per year)	232	192.5	99.01	130.83	156.79	123.67	135.03
Totals							
Number of permitted outfalls	36	20	20	21	21	21	21
Discharge (million gallons per year)	317	265	124	178	209.8	162.52	198.46

CMR = Chemistry and Metallurgy Research, LANSCE = Los Alamos Neutron Science Center, MSL = Materials Science Laboratory, TFF = Target Fabrication Facility.

[a] The TA-21 Steam Plant Outfall is included in the Tritium Facility outfall totals and is usually 90 percent or more of the total flow attributed to this Key Facility, although it serves other facilities within that technical area.

[b] Value was incorrectly reported in the LANL 2003h Table 3.2-4 as .006638. The correct value is 9.0, per LANL 2004c.

Note: To convert gallons to liters, multiply by 3.785.

Source: LANL 2003h, 2004c, 2004f, 2005f, 2006g.

Table 4–14 Effluent Quality Monitoring and Compliance with Permit Limits for National Pollutant Discharge Elimination Systems-Permitted Outfalls

	1999	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Industrial Outfalls							
Number of permitted outfalls (as of end of calendar year)	19	20	20	20	20	21	21
Number of samples collected	1,248	1,121	1,085	1,084	958	1,283	949
Number of samples exceeding permit limits	14 [a]	0	4	2 [b]	3 [c]	1 [d]	1
Yearly compliance rate (percent)	98.88	100	99.63	99.82	99.69	99.92	99.89
Sanitary Outfalls							
Number of permitted outfalls (as of end of calendar year)	1	1	1	1	1	1	1
Number of samples collected	175	200	134	129	132	145	126
Number of samples exceeding permit limits	0	0	0	0	0	0	0
Compliance rate (percent)	100	100	100	100	100	100	100

[a] Number of samples differs from Environmental Surveillance Report for 1999 because two samples exceeding permit limits were taken from the Guaje Well, which had been transferred to Los Alamos County ownership in 1998 (LANL 2006a).
[b] One sample exceeded both monthly average and daily maximum permit limits, so it counted as two exceedances.
[c] Two samples exceeded both monthly average and daily maximum permit limits, so they each counted as two exceedances.
[d] One sample exceeded both monthly average and daily maximum permit limits, but is counted as one exceedance under the new reporting method.

Sources: LANL 1999b, 2000e, 2001f, 2002d, 2004a, 2004d, 2005h, 2006a, 2006h.

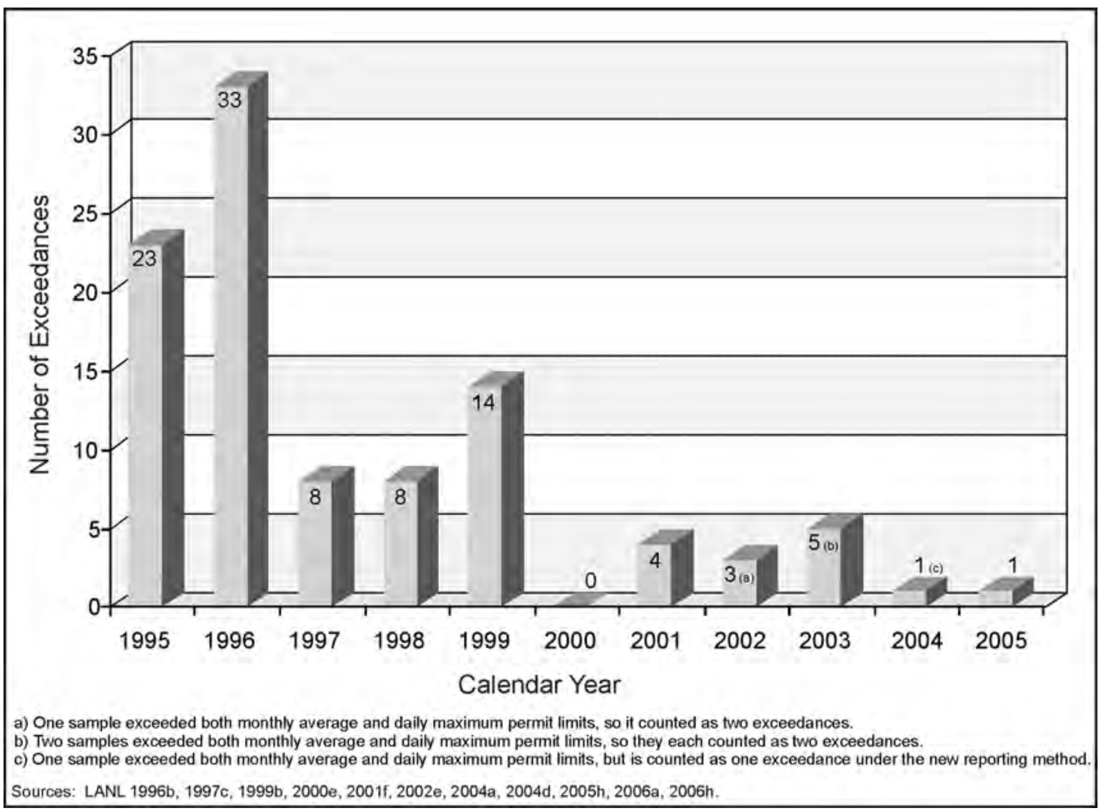


Figure 4–14 National Pollutant Discharge Elimination Systems Permit Exceedance Trend

Wastewater Treatment Facility Outfalls

LANL has three wastewater treatment facilities permitted to discharge treated effluent. The sanitary outfall shown in Table 4–14 refers to the TA-46 Sanitary Wastewater System Plant. The other two wastewater treatment facilities are the TA-50 Radioactive Liquid Waste Treatment Facility and the TA-16 High Explosives Wastewater Treatment Facility. Information on the operations of treatment facilities is presented in Section 4.9. Details on the improvements made to the treatment processes at the various wastewater treatment facilities may be found in the *SWEIS Yearbooks* (LANL 2002e, 2003h, 2004f, 2005f, 2006g).

The volume of treated effluent discharged from the TA-50 Radioactive Liquid Waste Treatment Facility has steadily decreased since the *1999 SWEIS*. In 2005, the Radioactive Liquid Waste Treatment Facility discharged 1.83 million gallons (6.9 million liters) compared to the 5.3 million gallons (20 million liters) discharged in 1999. Annual effluent discharges are shown in Table 4–13.

Effluent quality from the Radioactive Liquid Waste Treatment Facility has improved since the *1999 SWEIS.* At that time, the Radioactive Liquid Waste Treatment Facility effluent did not meet water quality discharge standards, resulting in a letter of noncompliance issued by NMED to LANL (LANL 2004c). New treatment processes have been installed since then to improve effluent quality. With these improvements, calendar year 2005 marked the sixth consecutive year that the Radioactive Liquid Waste Treatment Facility effluent had no violations of the NPDES permit limits or exceedances of the DOE Derived Concentration Guides for radioactive liquid wastes (Del Signore and Watkins 2005, LANL 2006a).

During this same 6-year period, the Radioactive Liquid Waste Treatment Facility has also met voluntary NMED groundwater standards for nitrates, fluoride, and total dissolved solids. Similarly, perchlorate concentrations in Radioactive Liquid Waste Treatment Facility effluent has been below the detection limit since March 2002, when perchlorate treatment equipment was installed. In addition, Radioactive Liquid Waste Treatment Facility tritium discharges have been less than one percent of the DOE Derived Concentration Guide since March 2001. Tritium-contaminated effluent that exceeds this voluntary standard of 20,000 picocuries per liter, which is the EPA drinking water standard, is now treated via evaporation at the TA-53 Radioactive Liquid Waste Treatment Plant (LANL 2004d). **Table 4–15** summarizes the water quality in the Radioactive Liquid Waste Treatment Facility effluent for 2005 for certain contaminants.

Since 1999, construction of TA-16 High Explosives Wastewater Treatment Facility has been completed and full operation has begun to comply with Federal Facility Compliance Act Agreement AO Docket No. VI-94-1210. With the operation of this new facility, 19 NPDES-permitted outfalls that previously received contamination from high explosives discharges have been eliminated. Three high explosives processing outfalls remain in use and the effluent discharged through these outfalls was reduced to 0.029 million gallons (0.11 million liters) per year in 2005. Yearly effluent discharged is shown in Table 4–13, High Explosives Processing Facility. The High Explosives Wastewater Treatment Facility is discussed further in Section 4.9 (LANL 2004d, 2005f, 2006g).

Table 4–15 Selected Water Quality Data for Radioactive Liquid Waste Treatment Facility Effluent in 2005

Contaminant	*Average Effluent Concentration in 2005*	*Standard Concentration Limit*	*Water Quality Standard*
Sum of 39 radionuclide ratios, including tritium	Less than 0.18	1.0 Sum of Ratios	DOE Derived Concentration Guideline
Nitrogen as nitrate	3.7 milligrams per liter	10 milligrams per liter	NMED Groundwater Standard for Human Health
Fluoride	0.24 milligrams per liter	1.6 milligrams per liter	NMED Groundwater Standard for Human Health
Total dissolved solids	182 milligrams per liter	1,000 milligrams per liter	NMED Groundwater Standard for Domestic Water Supply
Perchlorate	Not detected	(a)	No current standard
Tritium	3,200 picocuries per liter	2,000,000 picocuries per liter	DOE Derived Concentration Guideline
		20,000 picocuries per liter	EPA Primary Drinking Water Standard

NMED = New Mexico Environment Department, EPA = U.S. Environmental Protection Agency.
[a] The EPA has proposed a drinking water standard for perchlorate of 4 micrograms per liter, but it has not been issued yet.
Sources: LANL 2005h, 2006a, 2006h; Del Signore and Watkins 2005.

Treated liquid effluent from the TA-46 Sanitary Wastewater Systems Plant is currently pumped to storage tanks at TA-3 for reuse or is discharged to Sandia Canyon through an NPDES-permitted outfall.

The *1999 SWEIS* reported that the Los Alamos County Bayo Wastewater Treatment Facility discharges into Pueblo Canyon where that effluent could mobilize sediment contaminants from former LANL operations in Acid Canyon downstream. This facility is not owned or operated by LANL, but it may have an impact on contaminant transport in surface water and groundwater contamination (LANL 2005h).

4.3.1.3 Stormwater Runoff

During New Mexico's summer rainy season, there can be a large volume of stormwater runoff flowing over LANL facilities and construction sites picking up pollutants. The most common pollutants transported in stormwater flows are radionuclides, polychlorinated biphenyls, and metals (LANL 2005h). At the time of publication of the *1999 SWEIS*, conventional programs were in place at LANL to manage and control stormwater runoff from its industrial activities and construction projects. Since then, LANL has improved its monitoring of stormwater runoff. The program improvements are the result of changes in the EPA NPDES stormwater permitting program, increased regulatory attention on stormwater flows from solid waste management units, and ongoing programmatic changes that improve monitoring activities and implement best management practices for stormwater pollution prevention.

Stormwater runoff at LANL was managed under a Multi-Sector General Permit for industrial activities and a General Permit for construction projects in 1999. The Multi-Sector General Permit covered stormwater runoff from 25 onsite industrial activities, which included all solid waste management units as one of those industrial activities. Until March 2003, the Construction General Permit requirements addressed the management of stormwater runoff from various construction activities disturbing 5 or more acres (2 hectares) (64 *Federal Register* [FR] 68721). After March 2003, the threshold for obtaining a permit was lowered to 1 acre (0.4 hectare).

As conditions of these general permits, LANL developed and implemented Stormwater Pollution Prevention Plans at industrial and construction sites. Stormwater monitoring was conducted downstream of the waste management areas (TA-54, Areas G and J, and TA-50) and in 29 locations within eight watersheds (DOE 1999a). Several new gaging stations and automated samplers have been added since 2001. Samples are analyzed and results are published biannually in the discharge monitoring reports. In addition, changes in the stormwater management program, including the status of stormwater pollution prevention plans and stormwater monitoring activities, have been reported in the annual Environmental Surveillance Reports.

Currently, DOE's strategy for managing stormwater runoff includes the following programs:

- The *NPDES Industrial Stormwater Permit Program*, which regulates stormwater runoff from industrial activities under a Multi-Sector General Permit. Stormwater monitoring and erosion controls are required at these sites.

- An integrated *Stormwater Monitoring Program* that monitors stormwater runoff on a watershed basis and at individual solid waste management units. Erosion controls are required at sites where a water quality threshold has been exceeded. LANL recently began to implement these programs in response to the 2004 Federal Facility Compliance Agreement between the EPA and DOE.

- The *NPDES Construction Stormwater Program*, which regulates stormwater from construction activities disturbing 1 acre (0.4 hectare) or more, per the EPA Construction General Permit.

Table 4–16 shows a summary of the stormwater program activity between 1999 and 2004. The current status of the program is discussed in the following sections.

Table 4–16 Summary of Stormwater Program Activity

	1999	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
National Pollutant Discharge Elimination System Industrial Stormwater Program							
Number of industrial activities permitted for discharge of stormwater	22	19	20	18	17	15	15
National Pollutant Discharge Elimination System Stormwater Construction Program							
Number of construction projects permitted under General Permit for Stormwater Discharges from Construction Activities	6	8	10	13	21	34	37
Number of stormwater pollution prevention plans implemented at construction sites	Not applicable	Not applicable	23 [a]	44 [a]	51 [b]	67 [b]	64 [b]
Number of stormwater pollution prevention plan inspections conducted at construction sites	Not applicable	Not applicable	Not applicable	435	675	616	833

[a] Required for construction sites disturbing 5 acres or more.
[b] Required for construction sites disturbing 1 acre or more.
Sources: LANL 1999b, 2000e, 2001f, 2002d, 2004a, 2004d, 2005h, 2006a, 2006g.

Recent data from stormwater runoff monitoring detected some contaminants onsite and offsite, but the exposure potential for these contaminants is limited (see Table 4–8). Radionuclides have been detected in runoff at higher levels than the 15 picocuries per liter livestock watering criterion in Guaje, Pueblo, Los Alamos, Mortandad, Pajarito, and Water Canyons, with sporadic detections extending offsite in Pueblo and Los Alamos Canyons. As the areas burned in the Cerro Grande Fire recovered, total suspended solids that transport radionuclides decreased along with the radionuclide concentrations. Los Alamos Canyon and Sandia Canyon runoff and base flows contain polychlorinated biphenyls at levels above New Mexico human health stream standards (NMAC 20.6.4.900.B), but polychlorinated biphenyl levels are above background levels both upstream and downstream of LANL in the Rio Grande. Dissolved copper, lead and zinc have been detected in many canyons above the New Mexico acute aquatic life stream standards, and these metals were detected offsite in Los Alamos Canyon. Some of these polychlorinated biphenyl and metals' detections were upstream of LANL facilities, which indicates that non-LANL urban runoff was one source of the contamination. Mercury was detected slightly above wildlife habitat stream standards in Los Alamos and Sandia Canyons. The installation of erosion controls near the polychlorinated biphenyl and mercury sources to minimize further migration of these contaminants is an example of the watershed-based approach to surface water quality protection. Surface water in Cañon de Valle, a tributary of Water Canyon, occasionally has explosive residue levels greater than the 6.1 parts per billion EPA Tap Water Health Advisory level, but the barium levels have dropped below the New Mexico Groundwater Standard (LANL 2005h). Other organics detected in stormwater runoff above New Mexico Water Quality Standards include benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene. Inorganics detected in stormwater runoff include aluminum, silver, arsenic, cadmium, and selenium (LANL 2006h).

NPDES Industrial Stormwater Permit Program

The NPDES Industrial Stormwater Permit Program regulates stormwater flows from industrial activities at LANL (including solid waste management units). Historically, these flows were managed under the 1995 NPDES Multi-Sector General Permit. The current EPA Multi-Sector General Permit, effective since December 2000, regulates stormwater runoff from the following conventional industrial activities at LANL:

- Hazardous waste treatment, storage, and disposal facilities (including solid waste management units);
- Landfills and land application sites;
- Steam and electric power generating facilities;
- Asphalt batch plant operations;
- Metal fabrication activities;
- Primary metal activities; and
- Vehicle maintenance activities, and warehousing.

Under the Multi-Sector General Permit, DOE maintains and implements stormwater pollution prevention plans for industrial locations; maintains and samples monitoring stations for each industrial activity; and implements best management practices to control runoff and erosion from the industrial locations (NNSA 2004b). A *Storm Water/Surface Water Pollution Prevention Best Management Practices Guidance Document* has been developed by DOE to describe these practices (LANL 1998b). As of 2005, LANL protected 25 industrial activity locations with 15 stormwater pollution prevention plans, sampled stormwater flow at over 70 monitoring stations, inspected and maintained best management practices, and published and reported monitoring results to EPA and NMED in discharge monitoring reports (LANL 2006b).

NPDES Stormwater Construction Program

At the time of the *1999 SWEIS*, stormwater from construction projects was regulated under an NPDES General Permit. EPA changed the disturbed land threshold requiring a Construction General Permit from 5 to 1 acre (2 to 0.4 hectares) in 2003, when it updated the Stormwater Construction regulations. Under the current Construction General Permit Program, permits are required for all LANL construction activities or other projects that disturb 1 acre (0.4 hectare) or more. Conditions of the permit require the development and implementation of site-specific stormwater pollution prevention plans and the use of best management practices to reduce or eliminate the potential for offsite erosion and stormwater contamination. Construction projects with stormwater pollution prevention plans are inspected regularly to ensure compliance with the terms of the Construction General Permit (LANL 2004d).

In 2004, the LANL *Engineering Standards Manual* and the *LANL Master Construction Specifications* were updated to require that all land-disturbing projects, regardless of size, control the transport of sediment and other pollutants from disturbed areas. Meeting this requirement would maintain sediment yield and stormwater runoff rates within the watershed at values equal to or less than those experienced prior to any development, significantly minimizing post-development impacts on the surrounding area. This would be accomplished by stabilizing all disturbed areas through revegetation or placement of permanent structures or other equivalent measures (asphalt, concrete, gravel), as well as managing runoff from the impermeable surfaces through permanent controls such as detention ponds with controlled outlets. Best management practices would prohibit the flow of stormwater runoff across a designated environmental restoration site (such as a potential release site, solid waste management unit, or area of concern), minimizing the potential for the transport of legacy pollutants from these areas (LANL 2004b, 2004j, 2006e). The current program protects more construction sites from erosion and contaminant transport than were covered in 1999.

Another improvement began in 2003 with the use of a geographic information system-based tracking system to help manage Construction General Permit sites. The tracking system maintains records for each construction site, such as site coordinates, inspections, conditions of best management practices, Stormwater Pollution Prevention Plan deficiencies, and deficiency corrections. Construction General Permit information for LANL is accessible to the public through postings in the Los Alamos County Municipal Building (LANL 2004d).

Information in Table 4–16 shows the increase in Stormwater Construction Program activities since the *1999 SWEIS*, including the number of permits issued, Stormwater Pollution Prevention Plans implemented, and inspections conducted.

Stormwater Monitoring from Solid Waste Management Units

The management of stormwater runoff from solid waste management units has changed significantly since the *1999 SWEIS*. From 1992 through 2003, solid waste management units were considered an industrial activity and stormwater runoff was managed under the Multi-Sector General Permit Program. Since 2003, DOE has been transitioning towards managing stormwater runoff from the solid waste management units under an individual NPDES industrial activity permit. DOE began implementing an integrated stormwater monitoring program to meet the anticipated requirements of the Federal Facility Compliance Agreement in mid-2004 and submitted the first part of an individual permit application in late 2004. The Federal Facility Compliance Agreement is an interim step for managing runoff from solid waste management units until the individual permit is issued. The Agreement was issued in 2005 and is to remain in effect until the goals of the agreement are completed. More information on the Federal Facility Compliance Agreement is provided in Chapter 6 of this SWEIS (EPA 2005a; NNSA 2004b, 2004c).

DOE's integrated stormwater program under the Federal Facility Compliance Agreement includes the following two major elements.

- A watershed-based monitoring program. This includes approximately 60 automated monitoring and gaging stations located within nine LANL watersheds. Watershed monitoring is performed under a Stormwater Monitoring Plan, which was submitted to EPA and NMED in 2004 and will be updated annually (LANL 2005f, NNSA 2004b).

- Site-specific sampling at solid waste management units and areas of concern. This program requires stormwater sampling immediately downstream of approximately 300 designated sites on a rotating basis over a four-year schedule. The program will be performed under a unit-specific stormwater pollution prevention plan.

For the watershed program, gaging stations monitor flow rates. Stormwater samples are analyzed for radionuclides, metals, polychlorinated biphenyls, dioxin and furan, high explosives, perchlorate, cyanide, and suspended sediment concentrations (EPA 2005a, LANL 2006h). The sampling data are routinely published in monthly and annual reports submitted to EPA and NMED. Monitoring results are compared to stormwater-specific screening action levels and are the basis for corrective actions, the use of best management practices, and potential source removal. Erosion control measures installed to minimize sediment transport or pollutant migration are inspected after major storm events. The plans for each program (the Stormwater Monitoring Program and the unit-specific stormwater pollution prevention plans) are updated annually to include new information and requirements to ensure continuous improvement of the program. The stormwater program information has been integrated into the geographic information system-based tracking system to help manage the monitoring sites and maintain records, including stormwater pollution prevention plan inspections, the condition of best management practices, and the progress of corrective actions.

Fully implemented in 2005, the integrated stormwater monitoring program triggers actions that will minimize erosion and the transport of pollutants from solid waste management units, and provides information on a watershed scale to identify problems that could violate New Mexico surface water quality standards. With these changes, the adverse impacts to surface water from stormwater runoff are expected to be less in the future than the impacts identified in the *1999 SWEIS* (LANL 2006e, NNSA 2004c).

4.3.1.4 Watercourse Protection

DOE conducts a variety of activities that require excavation, filling, crossing, working in, or otherwise disturbing a watercourse or wetland. These activities may be subject to Sections 401 and 404 of the Clean Water Act, commonly called the *Dredge and Fill 404 and 401 Permit Program*. A 404 and 401 permit sets specific conditions for the use of best management practices to protect water quality and to ensure compliance with New Mexico surface water quality standards (DOE 1999a). Since the *1999 SWEIS,* DOE has continued to obtain permits and comply with Sections 404 and 401 permit conditions for construction activities conducted in watercourses.

Table 4–17 shows a summary of the Clean Water Act Sections 404 and 401 permit activities between 1999 and 2004. Permitted activities typically last for less than one year.

As a result of increased runoff after the Cerro Grande Fire, DOE conducted numerous dredge and fill activities to stabilize road crossings, clean roadside culverts, and armor utility lines crossing LANL canyons. Each project was required to obtain a 404 and a 401 permit, implement stormwater pollution prevention plans and best management practices, and meet permit conditions to protect surface waters. Most of these project activities have now been completed, but the stormwater pollution prevention plans will remain in place until the sites have been stabilized (LANL 2004c).

Table 4–17 Summary of Dredge and Fill Permits Issued Each Year

	1999	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Dredge and Fill Permit (Section 404/401) Program							
Number of permits for dredge and fill activities in water courses	9	9	24	8	2	2	2

Sources: LANL 2006a, 2006h.

4.3.1.5 Watershed and Sediment Monitoring

DOE monitors watersheds and sediments onsite, offsite, and at regional locations. Several new onsite gaging stations and automated samplers have been added to the monitoring network since the Cerro Grande Fire. Flow records for LANL stream gages have been published annually since 1995. The most recent report is *Surface Water Data at Los Alamos National Laboratory, 2003 Water Year* (Schaull et al. 2004). Sediments are sampled from all major canyons that cross LANL (onsite and offsite), as well as from the Rio Grande and area reservoirs, along tributary canyons, in major canyons upstream and downstream of LANL, and at watercourse junctions with the Rio Grande. Detailed information about sampling activities and monitoring results are published annually in LANL Environmental Surveillance Reports.

Sediments deposited in and along canyons on the Pajarito Plateau occur as narrow bands that can be transported by surface water, effluent discharges, stormwater runoff, spills, or flooding within the canyons. Past LANL activities have resulted in contamination of sediments both onsite and downstream, primarily transported by effluent discharges from LANL outfalls and stormwater runoff (DOE 1999a). Polychlorinated biphenyls have been detected in sediments in all the major canyons that cross LANL property, with the exception of Ancho Canyon and Cañada del Buey. The highest concentrations of polychlorinated biphenyls were found in Sandia Canyon sediments below LANL's main TA. Polychlorinated biphenyls and benzo(a)pyrene were detected on a widespread basis in 2004 sediment samples. The *LANL 2004 Environmental Surveillance Report* presents maps showing the distribution and concentrations of these organic compounds. The highest concentrations of the benzo(a)pyrene were found in Los Alamos Canyon sediments near downtown Los Alamos. The highest concentrations were several times greater than EPA Region 6 screening levels for residential and industrial outdoor workers. Recent environmental restoration investigations concluded that the polycyclic aromatic hydrocarbons in this area were principally derived from urban sources, such as asphalt (LANL 2005h).

The condition of LANL stream flows and sediments has changed since 1999 as programs for monitoring sediments and watersheds have evolved and improved. Major program changes include the following:

- *Improved stormwater monitoring under the Federal Facilities Compliance Agreement*. As discussed in Section 4.3.1.3, DOE is implementing a site-wide Stormwater Monitoring Plan that prescribes an integrated, watershed-based approach for stormwater monitoring and includes controls to minimize erosion and sediment transport.

- *Redistribution of contaminated sediments following the Cerro Grande Fire*. Following the Cerro Grande Fire, contaminated sediments in canyons were transported and redistributed downstream by higher volumes of stormwater runoff from the affected areas (Ford-Schmid, Englert, and Bransford 2004). The post-fire changes to the canyons and sediments are discussed in Section 4.3.1.7.

- *Decreased discharge of effluent from LANL into canyons*. The number of outfalls discharging effluent to canyons has decreased from 36 in 1999 to 21 in 2004. Comparing 2005 operating data to 1999 data, discharges to Sandia Canyon decreased about 40 percent (85.7 million gallons [324 million liters] per year); Los Alamos Canyon discharges increased about 19 percent (about 8.4 million gallons [32 million liters] per year); discharges into Mortandad Canyon decreased about 57 percent (22.5 million gallons [85 million liters] per year); and discharges into Water Canyon decreased about 97 percent (about 13.8 million gallons [52.2 million liters] per year) (LANL 2006g).

- *Removal of contaminated sediments from Los Alamos Canyon.* In 2001, DOE removed contaminated sediment in Los Alamos Canyon, which was known to contain radionuclide contamination from LANL's past operations. Approximately 915 cubic yards (700 cubic meters) of soil and sediment were removed from a 2.5 acres (1 hectare) site, minimizing the potential for contaminant transport in the event of a flood.

Sediments in the LANL area contain naturally occurring minerals, metals, and radionuclides. Sediments also contain contaminants that are the result of historic LANL operations. The *1999 SWEIS* presented a general understanding of sediment quality with regard to the presence of radionuclides, metals, and organics, based on sampling results from 1994 through 1996. DOE continues to monitor for these constituents and has added polychlorinated biphenyls, high explosive residues, barium, and six radionuclides to the list of analyzed constituents (LANL 2005h, Gallaher and Koch 2004). Monitoring results are compared against a variety of reference standards, screening action levels, and background values as described in Table 4–7. With these improvements, DOE has a better understanding of sediment contamination in the area than in 1999.

During the 2005 monitoring season, most samples above background levels came from stormwater runoff (see the discussion of recent stormwater runoff data in Section 4.3.1.3). Sediments contaminated with radionuclides remained below residential screening action levels throughout the site, and temporary increases in plutonium-239, plutonium-240, and cesium-137 concentrations have decreased to near pre-Cerro Grande Fire levels.

4.3.1.6 Floodplains

Floodplains are areas adjacent to watercourses that can become inundated with surface waters during high flows from runoff due to precipitation or snowmelt. At LANL, the floodplains are generally located in the canyons that lie between the mesa fingers (DOE 2002d). DOE regulations [10 CFR 1022.4] consider the critical action floodplain to be those areas affected during a 500-year flood (has a 0.2 percent chance of occurrence in any given year). The base floodplain, which is the floodplain considered by DOE's Resource Conservation and Recovery Act (RCRA) Permit, is the 100- year floodplain (has a 1.0 percent chance of occurrence in any given year) [40 CFR 270.14(b)(11)(iii)]. To meet the requirements of its RCRA permit, DOE delineated the 100-year floodplain boundaries within the facility in 1992 (McLin 1992). DOE considered the 100-year flood at LANL to be created by the 100-year, 6-hour storm (McLin, Van Eeckhout, and Earles 2001).

In May 2000, the Cerro Grande Fire changed the extent and elevation of the floodplains in the canyons that traverse LANL. The Cerro Grande Fire created hydrophobic soils and removed vegetation, so surface water runoff and soil erosion were greatly increased over pre-fire levels. Due to concerns about the increased potential for flooding of LANL facilities and homes down-canyon from the burned areas, several flood and sediment retention structures were constructed as part of the emergency response. These structures include:

- a flood retention structure in Pajarito Canyon to retain sediment and prevent flooding;
- a low-head weir and sediment detention basin in lower Los Alamos Canyon to retain and prevent sediments from moving offsite;
- reinforcements to the reservoir in upper Los Alamos Canyon to serve as a catchment basin for stormwater runoff and sediment.

- four road crossing reinforcements along Anchor Ranch Road in Twomile Canyon and along NM 501 at Twomile Canyon, Pajarito Canyon, and Water Canyon; and
- a steel diversion wall above TA-18 in Pajarito Canyon.

These structures will remain in place until vegetative growth returns the watershed to approximately pre-Cerro Grande Fire or at least stable conditions. When that occurs, all or part of the flood retention structure and the entire steel diversion wall above TA-18 will be removed (DOE 2002j). Due to the increased chance of flooding after the Cerro Grande Fire, the floodplain boundaries were remapped for all the major canyons within the LANL facility (see **Figure 4–15**) (McLin, Van Eeckhout, and Earles 2001).

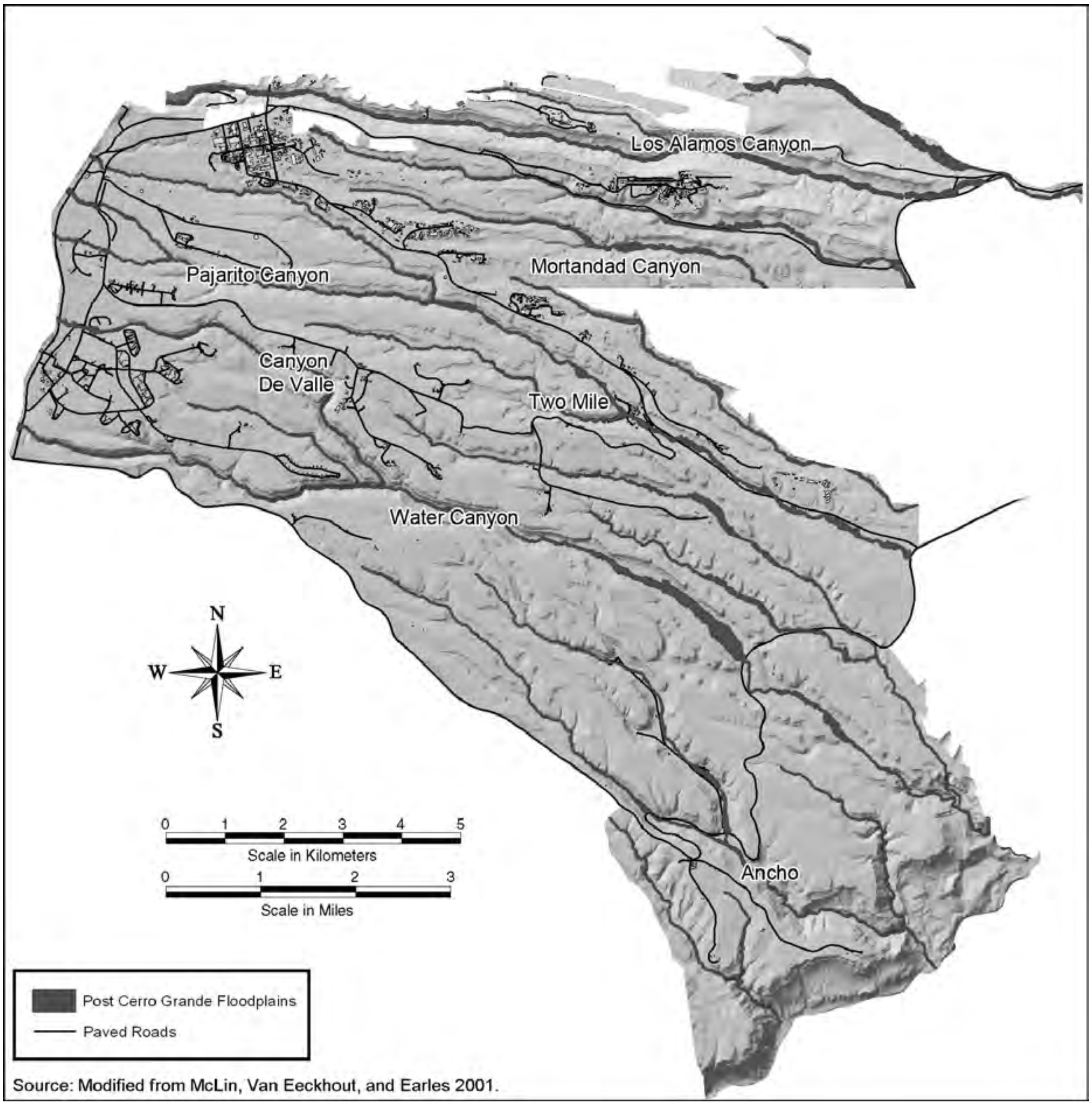


Figure 4–15 Post-Cerro Grande Fire Floodplains

Figure 4–15 represents a single point in time, as 4 years of vegetative growth in the burned forests west of LANL increased infiltration and reduced runoff volumes to the channels. The flood retention structures caused increased floodplain elevations upstream of the structures, and decreased flood elevations downstream. Sediment transport has altered the size and shape of the floodplains, so continued refinement of the post-fire floodplain maps is essential to determining an accurate picture of the LANL canyons (McLin, Van Eeckhout, and Earles 2001).

Using a geographic information system, LANL staff compared the post-Cerro Grande Fire floodplain files with the building location files. A list of buildings was generated including eight at TA-39 in Ancho Canyon, three at TA-41 in Los Alamos Canyon, and four at TA-72 in Los Alamos Canyon, that are completely within the post-Cerro Grande Fire 100-year floodplain boundaries. In addition, there were twelve buildings at TA-39, three buildings at TA-41, eight buildings at TA-72, one building at TA-18 in Pajarito Canyon, and one building at TA-36 in Potrillo Canyon that were partially within the post-Cerro Grande Fire 100-year floodplain boundaries. Most of these structures are small storage buildings, guard stations, well heads, water treatment stations, and some light laboratory buildings. Some facilities are characterized as moderate hazard due to the presence of sealed sources or x-ray equipment, but most have low hazard or no hazard designations. The Solution High-Energy Burst Assembly Building at TA-18 is within the 100-year floodplain, but the assembly is located there only during an experiment. The Omega West reactor is no longer located within the Los Alamos Canyon floodplain, as it was decommissioned and demolished in July 2003. There have never been waste management facilities in the 100-year floodplain (DOE 2002d; LANL 1998a, 2004c).

4.3.1.7 Overview of Cerro Grande Fire Impacts on Los Alamos Watersheds

The Cerro Grande Fire in May 2000 adversely affected the major canyons that cross LANL. The fire destroyed vegetation and changed the surface soils, causing increases in the amount of stormwater runoff entering the canyons. This increased stormwater runoff carried more soil, sediment, and ash from the entire affected watershed, including some areas at LANL that contain contaminants such as chemicals and radioactive materials (Ford-Schmid, Englert, and Bransford 2004). Sediment and ash from the burned areas of the Cerro Grande Fire have largely filled in the Los Alamos Reservoir. The reservoir now is periodically dredged to provide flood control, but it is no longer used for recreation, swimming, fishing, or irrigation (LANL 2004a). All of this raised concerns about adverse impacts to downstream water quality, as shown in Table 4–9, where selenium is listed as a probable cause of impairment due to mobilization from the Cerro Grande Fire.

Following the Cerro Grande Fire, the NMED contracted with Risk Assessment Corporation to perform a comprehensive, multi-media, analysis of risks to humans from exposure to LANL- and fire-associated contaminants (RAC 2002). One of the methods of contaminant transport analyzed was stormwater, which carried LANL- and fire-contaminated sediments and ash downstream of the LANL boundaries. After considering hypothetical exposures to radionuclides and chemicals through a variety of activities, such as farming, the report concluded that overall risks were within EPA acceptable ranges. Those findings were consistent with the conclusions of separate studies conducted by a multi-agency risk assessment team (IFRAT 2002) and by DOE (Kraig et. al. 2002).

After the Cerro Grande Fire, runoff events were monitored through the summer rainy seasons of 2000 through 2004. In 2005, DOE published two summary reports on the four years of post-fire monitoring and the resulting impacts to water quality and sediments (Gallaher and Koch 2004, LANL 2005j). The first report included results of sampling performed by DOE, as well as sampling performed by NMED and the U.S. Geological Survey. The second report is a summary of water quality and stream flow after the Cerro Grande Fire, that addresses issues raised by the after-effects of the fire (LANL 2005j). The NMED also published reports describing its findings of post-fire changes to stream flow and stormwater transport (Ford-Schmid and Englert 2004, Ford-Schmid, Englert, and Bransford 2004). A summary of the findings of these reports with regard to significant post-fire changes in runoff, sediment, and water quality is presented below.

In the first rainy season after the fire, water quality across the Los Alamos area was dominated by fire-created contaminants. By the end of the 2002 rainy season, most contaminant concentrations in surface water fell to near pre-fire levels (LANL 2004k). However, during 2003, the suspended sediment transport in downstream runoff continued to be elevated at about one order of magnitude higher than pre-fire conditions (Gallaher and Koch 2004).

Stormwater runoff increased significantly after the Cerro Grande Fire, due to the loss of vegetative cover. The first post-fire storms producing peak runoff flows in some drainages that were more than 1,000 times greater than pre-fire levels (LANL 2004a). Total runoff volumes for the year 2000 increased 50 percent over pre-fire years, and increased runoff continued in 2001, 2002, and 2003 at rates 2 to 4 times higher than pre-fire averages. In 2003, the total runoff from LANL was 2.7 times higher than pre-fire conditions, indicating that the effects from the fire are still present. Partial recovery of the area is indicated by the significantly lower peak flows and runoff yields from most drainages in 2002 and 2003. Unlike pre-fire years, most of the runoff in 2001 through 2003 was in Pueblo Canyon, where inventories of legacy contaminants are present in sediments. In 2002 and 2003, the runoff rates in areas south of Pueblo Canyon, which includes most of LANL, were similar to pre-fire conditions (Gallaher and Koch 2004). Significant urbanization of upper Pueblo Canyon may account for the continued high runoff volumes (LANL 2005j).

The most significant change after the Cerro Grande Fire was the increased concentration and transport of radionuclides, particularly plutonium-239 and plutonium-240, in stormwater runoff and sediments. This is due to higher stream flows that carry larger suspended sediment concentrations. Natural and LANL-derived radioactive particles are bound to these suspended sediments, so large floods in Pueblo Canyon, in particular, carried LANL-derived plutonium downstream. Median concentrations of total radionuclides in runoff increased 10 to 50 times from pre-fire levels, with most (95 percent or more) of the radionuclides bound to suspended sediments. LANL personnel estimate that the yearly movement of plutonium-239, and plutonium-240 beyond LANL boundaries during the 3 years after the fire increased by as much as 55 times over the previous 5-year average (LANL 2004k, 2005j; Gallaher and Koch 2004).

Plutonium has been transported beyond LANL boundaries in Pueblo Canyon, Los Alamos Canyon, and Acid Canyon. LANL-derived plutonium at levels near atmospheric fallout may have been transported 2 miles (3.2 kilometers) across the Pueblo of San Ildefonso boundary (LANL 2005h). Plutonium found in the Rio Grande riverbank and Cochiti Reservoir core sediments was analyzed using isotopic "fingerprinting" methods to determine its origin. This analysis found that about 60 percent of the Cochiti Reservoir sediment could be attributed to atmospheric fallout. The remaining 40 percent of the plutonium was primarily traceable to historic releases from the pre-1960s LANL operations in the Pueblo Canyon watershed (Gallaher and Efurd 2002).

Figures 4–16 and **4–17** show the changes in radionuclide concentrations in stormwater runoff and the increased transport of plutonium-239 and plutonium-240 in sediments compared to pre-fire levels. Concentrations of plutonium-238, plutonium-239, plutonium-240, and uranium in stormwater increased from pre-fire levels, with the most notable increase in plutonium-239, plutonium-240 concentrations from the pre-fire average of 2.3 picocuries per liter to a 2002 average of 105 picocuries per liter. The increases in plutonium-238, plutonium-239, plutonium-240, and americium-241 were attributed to contamination deposited during LANL historical operations, while cesium-137 and strontium-90 concentrations were attributed to fire-related effects and not LANL operations. By 2003, stormwater runoff from LANL contained significantly lower concentrations of radionuclides (except uranium), indicating improved conditions and reduced impacts from the Cerro Grande Fire. Uranium concentrations were attributed to runoff from LANL and from other sources (Gallaher and Koch 2004).

Downstream LANL Runoff, Pre-Cerro Grande Fire to 2003

Post-fire monitoring found that, by 2004, most flows had returned to normal conditions, so the pre- and post-fire monitoring data comparisons are limited to 2000 through 2003. Monitoring showed that storm events in 2001 through 2003 transported plutonium-contaminated sediments from Pueblo Canyon downstream into lower canyons at a level two orders of magnitude higher than pre-fire runoff (Gallaher and Koch 2004). NMED reported a similar rate of plutonium-239 and plutonium-240 transported in suspended sediments (Ford-Schmid, Englert, and Bransford 2004). From 2000 through 2003, DOE estimates that 64 millicuries of plutonium-239 and plutonium-240 were transported in suspended sediments in runoff downstream of Pueblo Canyon, representing about six percent of the inventory of plutonium in the canyon (Gallaher and Koch 2004). In comparison, NMED estimates 87 millicuries of plutonium-239 and plutonium-240 was transported between 2000 and 2002, representing about nine percent of the pre-fire plutonium inventory (Ford-Schmid, Englert, and Bransford 2004). A summary of estimated suspended transport of plutonium-239 and plutonium-240 by runoff before the Cerro Grande Fire and in the years 2000 through 2003 is presented in Figure 4–17. The total estimated plutonium-239 and plutonium-240 transported offsite in stormwater runoff was 5 microcuries in 2005 (LANL 2006h). Concentrations of americium and uranium in sediments also increased and are attributed to historic LANL activities (Gallaher and Koch 2004).

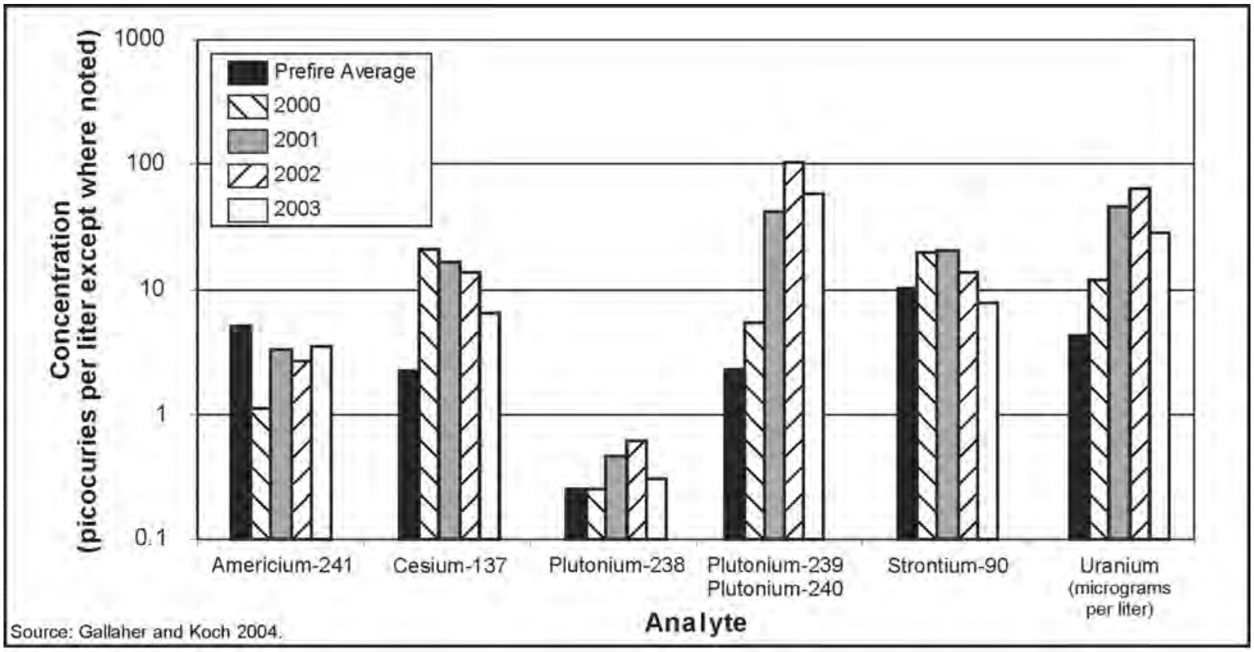


Figure 4–16 Flow-Weighted Average Concentrations of Radionuclides, Pre-Cerro Grande Fire to 2003

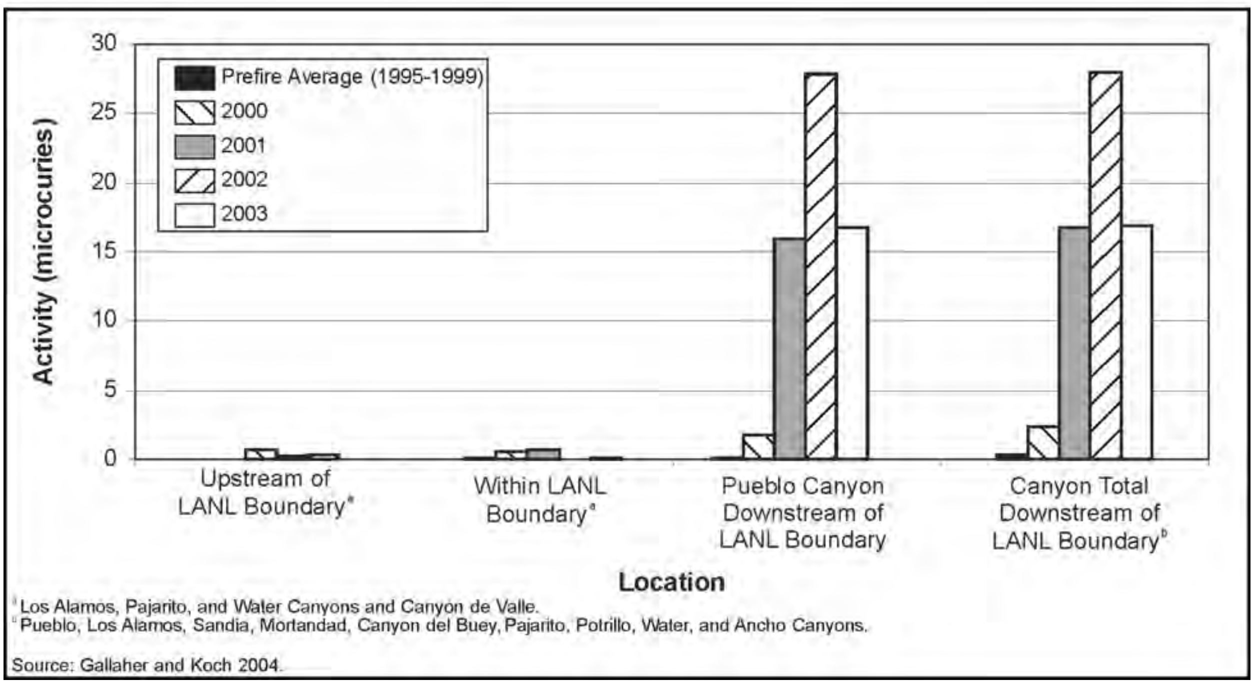


Figure 4–17 Estimated Plutonium-239 and Plutonium-240 Transported by Suspended Sediment in Runoff, Pre-Cerro Grande Fire to 2003

Post-fire stormwater runoff at LANL exceeded the applicable water standards for total gross alpha (New Mexico livestock watering standard) and the 100 millirem per year Derived Concentration Guide for plutonium-239 and plutonium-240. One runoff sample in 2000 contained plutonium-239 and plutonium-240, slightly higher than the EPA drinking water standard, so sediments were removed from the local area in 2001. A review of gross alpha results showed that concentrations at locations upstream of LANL were comparable to or higher than those within LANL. This indicates that other factors than LANL operations contributed to the high concentrations of gross alpha, which correlated with increased sediment concentrations in runoff after the fire. By 2003, the gross alpha activities in stormwater runoff were similar to those in pre-fire years. Concentrations of cesium-137, tritium, plutonium-238, strontium-90, and uranium in stormwater runoff between 2000 through 2003 remained within the applicable water quality standards. Amendable cyanide and total dissolved solids in runoff exceeded the New Mexico water quality standard in 2000 and 2001; however, amendable cyanide did not exceed standards during 2002 and 2003. Bicarbonate, calcium, cyanide, magnesium, nitrogen, phosphorous, potassium, barium, manganese, and strontium all showed elevated concentrations in post-fire runoff. The concentrations of these constituents declined progressively from 2000 through 2002 and were largely undetected in 2003 (Gallaher and Koch 2004).

Post-fire monitoring also detected metals in several locations. Total recoverable selenium was detected in many canyons at levels exceeding the New Mexico surface water stream standard for wildlife habitat of 5 micrograms per liter. Most of the selenium was probably due to non-LANL sources, because concentrations at locations upstream of LANL were comparable to or higher than those within LANL. In 2002, about 20 percent of storm runoff samples contained detectable concentrations of mercury, at levels below New Mexico short-term (acute) aquatic life standards. Spills of mercury have occurred at LANL in the past, but it remains uncertain if the mercury in the runoff is from LANL operations. Background levels of mercury in waters and sediments are appreciable. Mercury in runoff is a concern because it can enter the Rio Grande and accumulate in fish. Concentrations of mercury in Rio Grande sediments downstream of LANL were statistically similar to those measured upstream of the site. Dissolved metals concentrations in stormwater runoff were detected at concentrations greater than New Mexico groundwater standards for barium and chromium and New Mexico acute aquatic life surface water standards for copper and zinc. Because some of these higher concentrations were also found upstream or north of LANL, it is uncertain if they were due to site operations. Given the short duration of the stormwater runoff events, there is minimal opportunity for direct exposure to the water (LANL 2005h). The only metal consistently found at levels higher than New Mexico livestock watering and wildlife habitat stream standards was aluminum, which occurs naturally in soils (LANL 2005j).

With regard to changes in the Rio Grande and downstream reservoirs, LANL personnel concluded that post-fire runoff did not have an appreciable influence on flow rates or the water quality of the Rio Grande. Dissolved concentrations of radionuclides and metals in Rio Grande surface water were lower than EPA drinking water standards and comparable to pre-fire concentrations, indicating no lasting impacts to the river water from the fire. However, sediment samples collected from Cochiti Reservoir showed an increase in cesium-137, plutonium-238, and plutonium-239 concentrations from 3 to 6 times above pre-fire concentrations. These increases were attributed to the increased transport of LANL-impacted sediments from Pueblo Canyon.

Concentrations of cesium-137, plutonium-239, and plutonium-240 in the sediment were below risk-based screening levels (Gallaher and Koch 2004, LANL 2005j).

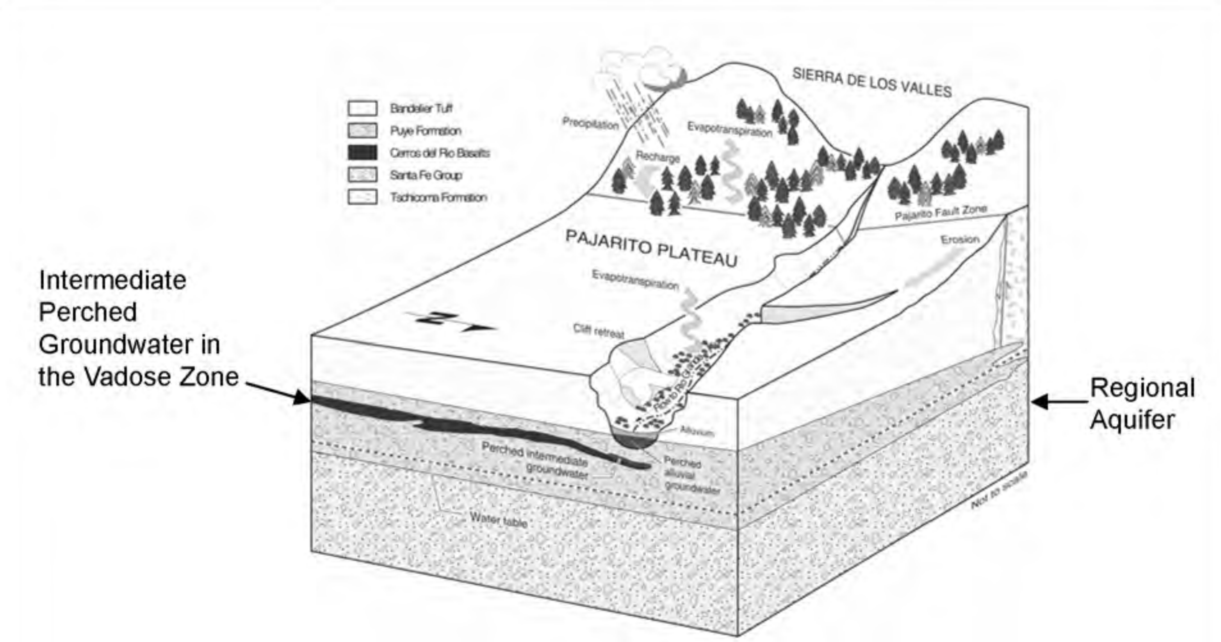
After the Cerro Grande Fire, NNSA constructed flood control structures at LANL and implemented a number of projects to control sediments and provide retention and deceleration of stormwater flows, as discussed in Section 4.3.1.6. The following projects continue to have beneficial impacts to the local canyons.

- Best management practices, including native vegetation planting and installation of jute matting, rock check dams, log silt barriers, and straw wattles, were implemented at 91 locations with possible contamination to control runoff and sediment transport.
- Contaminated sediment was removed from existing sediment traps in Mortandad Canyon, increasing the capacity of the existing traps and reducing further migration of the contamination.
- As discussed in Section 4.3.1.5, contaminated sediment was removed from areas in Los Alamos Canyon known to contain radionuclide contamination from LANL operations, minimizing the potential for contaminant transport in the event of a flood.
- The disposition of the flood control structures has not yet been determined. Options for complete or partial removal were evaluated in an Environmental Analysis document: *Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at LANL* (DOE 2002j). LANL personnel will continue monitoring and maintaining these structures until they are removed or until the affected watersheds are recovered or hydrologically stable (LANL 2004c).

Comparing post-fire and pre-fire conditions shows significant changes in the volume of stormwater runoff and sediment yield, which affects water quality. The increased stormwater flow and sediment transport is expected to diminish with time, as infiltration increases with the growth of new vegetation in the burned areas. Accelerated transport of legacy contaminants (radionuclides) occurred after the Cerro Grande Fire, with contaminated sediments moving from Pueblo Canyon into lower canyons. There are indications that stormwater runoff and sediment transport from most of the burned watersheds have improved and metal and radionuclide contaminant levels in stormwater runoff from the burned hillsides west of LANL have returned to near pre-fire levels. Sediment from these burned areas was deposited in the canyons, and erosion of this sediment continues, although the sediment load in stormwater runoff is decreasing. Watershed conditions are expected to return to pre-fire conditions by 2010 (DOE 2002j; LANL 2004d, 2005j).

4.3.2 Groundwater

Groundwater in the LANL area is located in several different places in the rocks underneath the site. **Figure 4–18** illustrates the hydrologic cycle on a typical watershed such as the Pajarito Plateau. Some precipitation runs off the ground surface into a local drainage (stormwater runoff); some soaks into the soil, where it is used by plants and released back into the atmosphere (evapotranspiration); and some infiltrates into the soil, passing through the plant root zone into the rocks, becoming part of the groundwater system (recharge).



Source: Modified from LANL 2005i.

Figure 4–18 Illustration of the Hydrologic Cycle at Los Alamos National Laboratory

The amount of rainfall in the LANL region is generally controlled by elevation. The Pajarito Plateau receives much less rainfall than the slopes of the Sierra de los Valles. Plants on the plateau use most of the water that enters the soil. Where the ground surface in the canyons is at or below the elevation of saturated layers of alluvium or rock, discharge of groundwater may occur as springs.

The three modes of groundwater occurrence are: 1) perched alluvial groundwater in canyon bottom sediments, 2) zones of intermediate-depth perched groundwater whose location is controlled by availability of recharge and by changes in rock permeability, and 3) the regional aquifer beneath the Pajarito Plateau. In wet canyons, stream runoff percolates through the alluvium until downward flow is impeded by less permeable layers of tuff, maintaining shallow bodies of perched groundwater within the alluvium. If not impeded by less permeable layers, surface water will eventually reach the regional aquifier.

Underneath portions of Pueblo, Los Alamos, Mortandad, and Sandia Canyons, intermediate perched groundwater occurs within the lower part of the Bandelier Tuff and within the underlying Puye Formation and Cerros del Rio Basalt. These intermediate-depth groundwater bodies are formed in part by recharge from the overlying perched alluvial groundwater. Intermediate groundwater occurrence is controlled by availability of recharge and variations in permeability of the rocks underlying the plateau. Depths of the intermediate perched groundwater vary. For example, intermediate perched groundwater has been found a shallow as 120 feet (37 meters) in Pueblo Canyon and as deep as 750 feet (230 meters) in Mortandad Canyon.

Some intermediate perched water occurs in volcanics on the flanks of the Sierra de los Valles to the west of LANL. This water discharges at several springs (Armstead and American) and yields a significant flow from a gallery in Water Canyon. Intermediate perched water also occurs within the LANL border just east of the Sierra de los Valles, in the Bandelier Tuff at a depth of approximately 700 feet (210 meters). The source of this perched water may be infiltration from streams that discharge from canyons along the mountain front and underflow of recharge from the Sierra de los Valles. Refer to Appendix E, Section E.6.2.2, for further discussion of the occurrence of perched water.

The regional aquifer of the Los Alamos area occurs at a depth of approximately 1,200 feet (370 meters) along the western edge of the plateau and about 600 feet (180 meters) along the eastern edge. The regional aquifer lies about 1,000 feet (300 meters) beneath the mesa tops in the central part of the plateau. Water in the aquifer flows generally east or southeast toward the Rio Grande, and groundwater model studies indicate that underflow of groundwater from the Sierra de los Valles in the Jemez Mountains is the main source of recharge for the regional aquifer (Nylander et al. 2003). Groundwater flow from the Sierra de los Valles to the Pajarito Plateau may be affected by the Pajarito Fault.

Figure 4–18 illustrates the relationships between perched water, the regional groundwater table, and the rocks beneath the surface in the LANL area. About 350 to 620 feet (110 to 190 meters) of unsaturated tuff, basalt, and low moisture content sediments separate the alluvial and perched groundwater zones and the regional aquifer (LANL 2005h).

Perched groundwater occurs in alluvium (sediment deposited by streams), found in the canyon bottoms, or at greater depths in the Bandelier Tuff or Puye Formation. The zones of perched water are typically not continuous, but are created where rock layers with low permeability impede downward water movement (LANL 2005i). These rock layers vary greatly in their ability to transmit water in saturated and unsaturated states. None of these perched water zones (shallow or intermediate) provide enough water to be a source for municipal drinking water.

Runoff or effluent discharges that does not infiltrate into the mesa tops flows down the canyons, and can enter the alluvium to form an unconfined groundwater body, particularly during spring snowmelt and mid- to late-summer thunderstorms. There are major LANL discharges into Sandia, Mortandad, and Los Alamos Canyons that help create alluvial groundwater bodies below those canyons.

Deep below the ground surface, there is an area of saturation that forms the regional groundwater aquifer. The regional aquifer is the only aquifer in the area capable of serving as a municipal water supply; the regional aquifer suppliers various customers including LANL, Los Alamos County, and others located in parts of Santa Fe and Rio Arriba Counties (LANL 2005h). A regional aquifer model was created for the *1999 SWEIS* to estimate the amount of groundwater stored beneath the Pajarito Plateau. More recently developed models have focused on the amount of drawdown in the aquifer and the effects of pumping near the water supply wells for Los Alamos County. The recent regional drought would only affect water levels through increased withdrawals for water supply use, because recharge from the surface occurs at a slow rate that changes only over a period of decades. The annual drop in the water table remains at 1 to 2 feet (0.3 to 0.6 meters) per year as projected in the *1999 SWEIS*.

4.3.2.1 Flow and Transport of Groundwater

Knowledge about the mechanisms of groundwater recharge and contaminant transport into the regional aquifer has increased since the *1999 SWEIS* was prepared. Additional characterization wells have been drilled at LANL, and groundwater hydrology has been modeled as part of the Hydrogeologic Work Plan, to further understand the hydrogeology and detect contamination in the regional aquifer (LANL 2003c). Additional information on geology and hydrology in the LANL vicinity is presented in Appendix E.

The Bandelier Tuff is an important rock formation due to its resistance to downward flow and its ability to capture and hold contaminations. The tuff is a complex of several volcanic ash and pumice falls that occurred at different periods during the history of the region. The porosity, permeability, and water content of the tuff are the principal physical characteristics that affect groundwater movement. Refer to Appendix E, Section E.6.3, for additional discussion of the hydrogeologic characteristics of the Bandelier Tuff.

The chemical interaction between tuff and water is also important. Volcanic glass in the tuff captures some contaminants by chemically attaching them to mineral surfaces (adsorbing) or by taking them into the structure of the minerals themselves (absorbing). As a result, large volumes of contaminants can be trapped, some permanently and some temporarily. The combination of these physical and chemical processes in the unsaturated tuff slows the movement of some contaminants toward the regional groundwater table.

Most of the alluvium in the canyon channels is composed of weathered tuff and pumice fragments that strongly hold some of the contaminants. Some of the contaminants introduced to the canyons by LANL outfalls are held in these perched water zones by adsorption to the sediments. Lateral movement of contaminants in the canyon channels and movement of contaminants downward into local perched water bodies underlying the canyon channels are being monitored (LANL 2005i).

4.3.2.2 Groundwater Quality in the Los Alamos National Laboratory Area

Groundwater chemistry varies with some general properties of the groundwater environment, such as the acidity of the water and the chemistry of local rock. Uranium, silicon, sodium, arsenic, and other chemical constituents that are common in the volcanic rocks of the LANL area appear as natural constituents in the groundwater of the Jemez Mountains region. Of interest for regional groundwater quality are levels of contaminants larger than those expected from naturally occurring groundwater constituents.

Since the 1940s, liquid effluent disposal by DOE has degraded water quality in the shallow perched groundwater that lies beneath the floor of several canyons. These water quality impacts extend, in a few cases, to perched groundwater at depths of a few hundred feet beneath these canyons. Recharge to the regional aquifer from the shallow contaminated perched groundwater bodies occurs slowly because the perched water is separated from the regional aquifer by hundreds of feet of unsaturated rock. As a result, little contamination reaches the regional aquifer from the shallow perched groundwater bodies, and water quality impacts on the regional aquifer, although present, are small.

Groundwater Quality Standards

LANL staff currently applies regulatory standards and risk levels to evaluation of groundwater samples. Standards and risk levels exist for both radioactive and nonradioactive contaminants.

For radioactive contaminants, LANL staff compares concentrations in samples from water supply wells that draw water from the regional aquifer to (1) EPA maximum contaminant levels for public drinking water systems and (2) the derived concentration guides for ingested water calculated from DOE's 4-millirem[1] per year drinking water dose limit (see below). For risk-based radioactivity screening, groundwater samples from sources other than water supply wells are compared to EPA maximum contaminant levels and to DOE's 4-millirem drinking water derived concentration guides.

EPA's maximum contaminant levels for public drinking water systems are contained in 40 CFR Part 141 and were derived for radionuclides and nonradionuclides in accordance with the provisions of the Safe Drinking Water Act. EPA maximum contaminant levels were established on the basis of limiting the risk from consuming contaminants in the water to very small levels and are often used as a standard or for comparison purposes for groundwater protection or remediation. For radionuclides, the EPA standard limits the radiation dose to a person drinking water from a public drinking water system to 4 millirem per year from manmade radionuclides emitting beta and photon radiation. EPA maximum contaminant levels for these radionuclides represent the concentration of each radionuclide in water that would result in an annual dose of 4 millirem, assuming consumption of 2 liters of water per day. EPA has also established maximum contaminant levels for other radionuclides or for groups of radionuclides (such as alpha-emitting radionuclides). For example, the EPA maximum contaminant level for tritium is 20,000 picocuries per liter of water, while the EPA maximum contaminant level for strontium-90 is 8 picocuries per liter.

In DOE Order 5400.5, "Radiation Protection of the Public and the Environment," DOE limits the radiation dose that may be received by members of the public from all routine DOE activities to 100 millirem in a year from all pathways. DOE also limits the radiation dose to persons drinking water from a DOE-supplied system to 4 millirem per year from water consumption alone.[2] To assist in compliance with these requirements, and for screening purposes, DOE has established derived concentration guides for exposure to individual radionuclides through air and water pathways. The derived concentration guides for ingested water in DOE Order 5400.5 correspond to the concentrations of individual radionuclides in water that, if ingested at a rate of 2 liters per day, would result in an annual dose of 100 millirem (100-millirem DOE derived concentration guide). A 4-millirem derived concentration guide for a radionuclide is derived by multiplying the 100-millirem derived concentration guide for that radionuclide by 0.04 (4-millirem DOE derived concentration guide).

---

[1] *A millirem is a measure of the overall dose to an individual, whether from external radiation or contact with radioactive material. The dose is calculated by using radiation weighting factors and tissue weighting factors to adjust for the various types of radiation and the various tissues in the body receiving the radiation. Federal government standards limit the dose that the public may receive from operations at facilities such as LANL.*

[2] *DOE also requires operation of DOE facilities so that liquid effluents will not cause a private or public drinking water system downstream of the facility discharge to exceed the drinking water radiological limits in 40 CFR Part 141.*

For nonradioactive contaminants, the New Mexico drinking water regulations and EPA maximum contaminant levels for nonradioactive constituents apply as regulatory standards in water supply samples and may be used as risk-based screening levels for other groundwater samples.

The New Mexico Water Quality Control Commission groundwater standards apply to concentrations of nonradioactive chemical quality parameters in all groundwater samples (NMAC 20.6.4). The toxic pollutants listed in the standards were screened at a risk level of 10^{-5} (1 chance in 100,000) for cancer-causing substances or a Hazard Index of one for non-cancer-causing substances. A Hazard Index of 1 or less indicates that no (noncancer) adverse human health effects are expected to occur. LANL staff uses the EPA Region 6 tap water screening levels to screen for New Mexico Water Quality Control Commission toxic pollutant compounds (EPA 2007a). For cancer-causing substances, because the Region 6 tap water screening levels are at a risk level of 10^{-6} (1 chance in a million), LANL staff uses 10 times these values to screen for a risk level of 10^{-5} (1 chance in 100,000). Because groundwater is a source of flow to springs and other surface waters that are used by neighboring Native American Tribes and wildlife, the standards for groundwater or the New Mexico Water Quality Control Commission surface water standards, including the wildlife habitat standards, apply to this water (LANL 2004d, NMAC 20.6.4). Examples of standards and screening levels used at LANL for nonradioactive contaminants include the 10-milligram-per-liter EPA drinking water maximum contaminant level for nitrate and the 1-milligram-per-liter New Mexico groundwater standard for molybdenum for irrigation use. The New Mexico groundwater standard for barium is 1 milligram per liter, while the EPA Region 6 tap water screening level for RDX (an explosive) is 6.1 parts per billion. For perchlorate, EPA established a drinking water equivalent level of 24.5 milligram per liter in 2006 (LANL 2006h).

Groundwater Monitoring Program

The March 1, 2005, Compliance Order on Consent (Consent Order) specifies the process for conducting groundwater monitoring at LANL and requires submittal of an Interim Facility Groundwater Monitoring Plan (Interim Plan) to NMED for approval. Prior to approval of this Interim Plan in June 2006, LANL staff expanded the number of groundwater locations monitored during 2005 to comply with the draft Consent Order. As the result of the Consent Order, DOE is changing the focus to watershed-specific investigations to find groundwater contamination and contaminant transport mechanisms.

From 1998 through 2004, 25 monitoring wells reaching to the regional aquifer were constructed. Additionally, six intermediate-depth wells were drilled (LANL 2005i).

By the end of 2005, 21 additional characterization wells were drilled using air rotary in the vadose zone and water, foam, mud, or EZ-MUD (a polymer) rotary in the saturated zone. Geologic cores were collected in the upper vadose zone in some of the wells. Geologic cuttings were collected at defined intervals during the drilling operations, and geophysical logging was conducted in each well to enhance understanding of the stratigraphy and rock characteristics (LANL 2006h).

Seven intermediate-depth wells were also installed on LANL property in and adjacent to Mortandad Canyon to improve the conceptual model of the geology, hydrogeology, and hydrochemistry of the area. The data collected from these intermediate wells will be used for numerical modeling studies addressing contaminant migration in the vadose (unsaturated) zone (LANL 2006h).

Sampling in 2006 indicated that chromium contamination is present in the regional aquifer in a limited area beneath Sandia and Mortandad Canyons and in perched groundwater beneath Mortandad Canyon. Chromium contamination was not detected in water-supply wells. In recognition of these results, the LANL contractor prepared an *Interim Measures Work Plan for Chromium Contamination in Groundwater* (LANL 2006d). The goals of the work plan are to:

- Determine the primary sources of chromium contamination and the nature of operations associated with the releases;
- Characterize the present-day spatial distribution of chromium and related constituents;
- Collect data to evaluate the geochemical and physical/hydrologic processes that govern chromium transport; and
- Collect and evaluate data to help guide subsequent investigations and remedy selection.

To accomplish these goals, work plan activities include:

- Conducting quarterly sampling of selected regional aquifer and intermediate groundwater wells;
- Investigating surface water and alluvial groundwater loss in Sandia Canyon;
- Installing six core holes in lower Sandia Canyon;
- Installing five alluvial wells in lower Sandia Canyon;
- Determining chromium distributions in the upper vadose zone from archival and new cores collected from Los Alamos, Sandia, and Mortandad Canyons;
- Rehabilitating well R-12 in lower Sandia Canyon;
- Refining the understanding of background concentrations and speciation of chromium in groundwater; and
- Collecting and synthesizing data and information to support conceptual model development and remedy selection.

Results of monitoring for contamination of environmental media around LANL are reported annually in LANL environmental surveillance reports. Contamination detected in monitoring samples reflects worldwide fallout of radioactive particles from nuclear weapons testing; nuclear accidents such as Chernobyl; releases from industrial, commercial, medical, and household uses of chemicals and radionuclides; and releases from decades of activities at LANL. Some contaminants are present onsite at levels above applicable standards and guidelines. Elevated levels are investigated to confirm the validity of the results, determine the source and extent of the contamination, and evaluate needed control and cleanup technologies.

Perched Alluvial and Intermediate-Depth Groundwater

Perched alluvial and intermediate-depth groundwaters are not used as drinking water supplies. The following review of sampling results is taken from the 2005 LANL environmental surveillance report (LANL 2006h).

The discharge of radioactive effluents has caused alluvial groundwater contamination in DP, Los Alamos, and Mortandad Canyons. Strontium-90 is consistently measured in these canyons at levels above its 8-picocuries-per-liter EPA drinking water maximum contaminant level. Mortandad Canyon also has a localized groundwater concentration of plutonium-238, plutonium-239, plutonium-240, and americium-241 above the 4-millirem DOE derived concentration guide for these radionuclides. Mortandad Canyon is the only location where in the mid 1990s, tritium was detected above the 20,000-picocuries per liter EPA drinking water maximum contaminant level; measured levels dropped below this standard in 2001, and have been dropping steadily since then. None of the radionuclide levels exceeded the 100-millirem-per-year DOE derived concentration guide for public dose from all pathways (LANL 2004d, 2005h).

In Pueblo Canyon, samples from one intermediate well contained 944 picocuries per liter of tritium. Tritium concentrations in other intermediate well samples ranged from nondetectable to 34 picocuries per liter. Samples from all four alluvial wells in Pueblo Canyon indicated strontium-90 in concentrations ranging from 6 percent to 14 percent of the 8 picocuries per liter EPA drinking water maximum contaminant level. Three wells had detectable levels of plutonium-239 and -240. In Los Alamos Canyon, samples from two intermediate wells that are downstream from a former radioactive liquid waste discharge into DP Canyon contained 4,300 and 890 picocuries per liter of tritium.

In DP and Los Alamos Canyons, alluvial groundwater samples showed strontium-90 in concentrations above the 8-picocuries per liter EPA drinking water maximum contaminant level, while in DP Spring, the strontium-90 concentrations were above the 4-millirem DOE derived concentration guide screening level. Other LANL-derived radionuclides were found in alluvial groundwater, but in concentrations well below the 4-millirem DOE derived concentration guide screening level. Since the cessation of discharges, tritium concentrations in alluvial groundwater samples from DP and Los Alamos Canyons have fallen to levels between 80 and 200 picocuries per liter. Plutonium-238 concentrations in samples from lower Los Alamos Canyon were just above the detection limit for this radionuclide.

Tritium was found in four wells in intermediate groundwater in Mortandad Canyon in concentrations ranging from 4,300 to 23,500 picocuries per liter. Upstream toward the effluent discharge location the tritium concentration was 136 picocuries per liter. Technetium-99 was detected in three wells in concentrations ranging from 2.6 to 7.9 picocuries per liter.

Radionuclide levels in Mortandad Canyon alluvial groundwater (which is not a source of drinking water) were, in general, highest in samples nearest to the TA-50 Radioactive Liquid Waste Treatment Facility outfall. In years prior to 2005, the concentrations of strontium-90, plutonium-238, plutonium-239 and -240, and americium-241 exceeded the 4-millirem DOE derived concentration guides for these radionuclides. In 2005, results for the following radionuclides were near or above their 4-millirem DOE derived concentration guide screening levels: strontium-90; total uranium (likely an outlier, it was not supported by a laboratory replicate); and unfiltered americium-241, plutonium-238, and plutonium-239 and -240. The strontium-90 levels were above the EPA drinking water maximum contaminant level by a factor of up to 5.4.

In Pajarito Canyon, tritium was found at a concentration of 60 picocuries per liter in an intermediate-depth borehole near the eastern LANL boundary. No LANL-derived radionuclides were found in samples from five intermediate springs in the canyon.

In the intermediate perched zone of the Water Canyon watershed, tritium was detected in three wells and in several springs. Concentrations ranged from 7 to 68 picocuries per liter for the wells and from 70 to 195 picocuries per liter for the springs. Plutonium-239 and -240 were found in concentrations just above the analytical method detection limit in one unfiltered sample from a well in an intermediate perched zone, but not in the filtered sample.

Until new treatment methods were installed in 1999 to remove nitrate and in 2002 to remove perchlorate, discharges from the Radioactive Liquid Waste Treatment Facility caused high levels of nitrate and perchlorate in both alluvial and intermediate perched groundwater in Mortandad Canyon. In 2003 and 2004, nitrate levels were below the 10-milligram-per-liter EPA maximum contaminant level in alluvial groundwater samples in Mortandad Canyon, after being close to or exceeding that level in previous years. Nitrate concentrations in Pueblo Canyon have been in the vicinity of the nitrate maximum contaminant level in recent years.

Perchlorate was detected in four Mortandad Canyon wells in concentrations ranging from 81 to 256 micrograms per liter. EPA has not established a drinking water standard for perchlorate, but in January 2006, established a Drinking Water Equivalent Value of 24.5 micrograms per liter. Perchlorate was detected in all groundwater zones in Mortandad Canyon in 2005 in Pueblo Canyon off the LANL site, and just above the perchlorate background level (0.08 micrograms per liter) in the alluvial groundwater in Cañon de Valle. Sample concentrations of perchlorate in Mortandad Canyon alluvial and intermediate groundwater exceeded the EPA Drinking Water Equivalent Value.

Perchlorate concentrations in alluvial wells in Pueblo Canyon ranged from nondetectable to 1.9 micrograms per liter. Perchlorate values from the intermediate zone were nondetectable or background, except for a sample result of 1.5 micrograms per liter from one well. In Los Alamos Canyon, samples from intermediate-depth wells contained 8.1 and 2.5 micrograms per liter of perchlorate. In Sandia Canyon, perchlorate was not detected in samples from the intermediate groundwater.

Except for Bulldog Spring, perchlorate was found at background levels in intermediate waters in Pajarito Canyon. The Bulldog Spring perchlorate concentration was 0.6 micrograms per liter. Sampling results for alluvial springs and wells showed that perchlorate was either not detected or within background ranges.

---

[3] *Several of the newer monitoring wells are equipped with ports so that groundwater can be monitored at different depths.*

Perchlorate in the Water Canyon watershed intermediate wells and springs in the intermediate perched zones ranged from not detected to below background (0.58 micrograms per liter) for the wells and slightly above background (0.74 micrograms per liter) for the springs.

The chemical 1,4-dioxane was detected in two wells sampled from the perched intermediate zone in Mortandad Canyon. Although there is no Federal or state standard for 1,4-dioxane, LANL and NMED are working to determine the extent and impact of this contaminant.

Recently sampled perched water from intermediate and regional aquifer wells within the Mortandad, Los Alamos, and Sandia watersheds showed increasing concentrations of total dissolved chromium.

In Water Canyon, chromium concentrations were high in unfiltered samples and nickel concentrations were high in filtered and unfiltered samples taken from intermediate depths. At a depth of 755 feet (230 meters) below ground surface, unfiltered chromium concentrations ranged from 17 to 45 micrograms per liter; except in 2005 when the measured concentration was 153 micrograms per liter. The filtered chromium concentration at the same well and depth ranged from 0.8 micrograms to 6.2 micrograms per liter. If the values for filtered and unfiltered chromium were similar, which was not the case, it would indicate the presence of hexavalent chromium. At a depth of 892 feet (272 meters) below ground surface, unfiltered concentrations of chromium ranged from 6.7 micrograms to 35 micrograms per liter, except in 2005, when the value was 70 micrograms per liter. At the same well and depth, filtered chromium concentrations ranged between 0.7 and 1.9 micrograms per liter. These concentrations are less than the New Mexico standard of 50 micrograms per liter for chromium in filtered samples. For nickel, recent (2005) filtered concentrations at depths of 758 and 892 feet (231 and 272 meters) below ground surface were 720 micrograms and 520 micrograms per liter, respectively. The EPA maximum contaminant level for nickel is 100 micrograms per liter.

Samples from Test Well 1A in Pueblo Canyon, an older intermediate well, showed high iron, manganese, lead, and zinc concentrations related to rust and flaking from aging well components. Molybdenum is found in Los Alamos Canyon alluvial groundwater resulting from treatment chemicals no longer used in TA-53 cooling towers. Levels of molybdenum in the alluvial groundwater have been quite variable in recent years, perhaps because of large variations in stream flow caused by drought conditions. Barium and RDX (an explosive) are present in alluvial groundwater of Cañon de Valle in concentrations exceeding the New Mexico groundwater standard of 1 milligram per liter and the EPA Region 6 screening level of 6.1 parts per billion, respectively (LANL 2004d).

Regional Groundwater Quality

Water produced by regional aquifer wells at LANL continues to meet Federal and state drinking water standards, but contaminants reaching the regional aquifer have been documented (LANL 2005i). Naturally occurring uranium is the primary radionuclide detected in the regional aquifer and has been found in concentrations near the EPA drinking water maximum contaminant level of 30 micrograms per liter. Tritium is present at trace levels beneath Pueblo, Los Alamos, and Sandia Canyons. Tritium concentrations in Pueblo Canyon regional aquifer monitoring wells increased downstream, from nondetection at Test Well 4 (above a former outfall of radioactive wastewater in Acid Canyon, a tributary to Pueblo Canyon) to 117 picocuries per liter at Test Well 1 (near Otowi-1). Tritium in the former supply well Otowi-1 was measured at a concentration of 33 picocuries per liter. In Los Alamos Canyon, sample results indicated tritium concentrations up to 14.9 picocuries per liter (LANL 2006h).

Beneath Mortandad Canyon, a sample result from a regional aquifer well showed a technetium-99 concentration of 5.24 picocuries per liter, which is smaller than the 4-millirem DOE derived concentration guide of 4,000 picocuries per liter. After reanalysis, technetium-99 was not detected in three other samples from this well. Samples from another well showed that tritium concentrations increased from 2 picocuries per liter in 2000 to 31 picocuries per liter in 2005. This was attributed to some contribution of recent recharge to the regional aquifer. Samples from another well indicated tritium in concentrations up to 181 picocuries per liter. No other regional aquifer well in Mortandad Canyon had repeatable low-detection limit detections of tritium (the method detection limit is about 1 picocurie per liter).

Water supply wells on the mesa top south of Cañada del Buey had one sampling event in 2005. Tritium was detected in one sample, but was not detected in a reanalysis.

In 2005, samples from supply well PM-2 in Pajarito Canyon did not contain tritium detectable by the low-detection-limit method. Two apparent detections of DOE-derived radionuclides (cobalt-60 and combined plutonium-239 and -240) were found in Pajarito Canyon regional aquifer well samples. The cobalt-60 results are inconsistent with other data from two sampling events in 2005. Plutonium-239 and -240 detected in a filtered sample was not detected in the corresponding unfiltered sample, or in two reanalyses of the filtered sample. Samples from the only regional well in Pajarito Canyon that indicated tritium (well R-22, east of the low-level radioactive waste management facility MDA G) showed results of 2 to 3 picocuries per liter from 5 upper well screens and 11 picocuries per liter at the deepest well screens.

No tritium was found in any regional aquifer samples within the Water Canyon watershed. In Ancho Canyon, strontium-90 was found at a concentration slightly above its detection limit in a field blank and in one sample from a depth of 670 feet (204 meters) below ground surface. Strontium-90 was not detected in a filtered sample.

Perchlorate has been detected in the regional aquifer beneath Pueblo and Mortandad Canyons, with a few sample concentrations reaching as high as 6 parts per billion, and is present in concentrations smaller than 1 part per billion in groundwater throughout northern New Mexico. Perchlorate was detected in the regional aquifer in supply well Otowi-1 in Pueblo Canyon. Supply well Otowi-1 was taken off line because sample results indicated concentrations of perchlorate that averaged one tenth of the EPA Drinking Water Equivalent Value (or about 2.45 micrograms per liter). Perchlorate in a Los Alamos Canyon sample was 0.98 micrograms per liter, while samples from other regional aquifer and supply wells in Los Alamos Canyon were at background levels (smaller than 0.6 micrograms per liter). The PCB compound Aroclor-1254 was found in one sample, but was not found in any of the four samples collected during the previous year and is most likely an analytical artifact (LANL 2006h).

Samples from Sandia Canyon regional wells showed perchlorate concentrations in the range of 0.77 and 0.62 micrograms per liter, or slightly above the background range. Samples from supply wells PM-1 and PM-3 showed concentrations of about 0.42 micrograms per liter, also within the background range. Perchlorate in the regional aquifer below Mortandad Canyon has increased from less than 5 to 7 micrograms per liter. This increase was attributed to the lingering effects of well installation caused by the addition of water during drilling or well development or some change of concentration within the surrounding groundwater during this time. In other regional aquifer wells in Mortandad Canyon, perchlorate sample results were smaller than 0.5 micrograms per liter. Sampling at water supply wells PM-4 and PM-5 indicated a perchlorate presence of 0.34 micrograms per liter. This result was unchanged from previous samples and was similar to samples from other water supply wells in northern New Mexico.

In 2005, samples from supply well PM-2 in Pajarito Canyon showed an average perchlorate concentration of 0.31 micrograms per liter for six perchlorate analyses. These results were similar to prior data. Perchlorate was within its background range in samples from a regional aquifer well in the same canyon. Perchlorate concentrations in Water Canyon watershed samples were either not detected or were smaller than 0.31 micrograms per liter (background). Perchlorate in samples from a regional well located in Ancho Canyon was either not detected or was within the background range.

Samples from Water Canyon have shown elevated levels of the explosives compounds RDX and trinitrotoluene (TNT), as well as the organic solvents perchloroethylene and trichloroethylene. These solvents were found at levels near EPA Region 6 tap water screening levels, but slightly below EPA maximum contaminant levels (LANL 2004c, 2006h).

Naturally-occurring arsenic is present in Guaje Canyon wells in concentrations smaller than the EPA maximum contaminant levels. Several of the newer regional aquifer wells had high levels of aluminum, iron, and manganese due to drilling fluid or turbidity effects in samples.

On December 23, 2005, DOE notified NMED that samples collected in May, September, and November of 2005 from the regional aquifer in Mortandad Canyon contained chromium concentrations between 375 and 404 parts per billion. This exceeds the New Mexico Water Quality Control Commission standard of 50 parts per billion and the EPA maximum contaminant level of 100 parts per billion (Bearzi 2005). NMED directed DOE to provide an Interim Measures Work Plan. The plan was to provide a detailed assessment of hydraulic properties of the regional aquifer from data obtained from wells in Mortandad and Sandia Canyons and from monitoring wells in Los Alamos and Pajarito Canyons. Also, NMED required assessments of historical pumping, groundwater gradients, and effluent discharges. DOE was required to report the results of geochemical and geophysical studies related to the investigations, investigate surface water and alluvial water loss to the subsurface, and provide groundwater sampling plans.

An interim measures investigation was conducted by LANL and reported in November 2006 in accordance with the Consent Order. The report describes work performed to address chromium contamination problems in the groundwater at LANL and to ensure the protection of drinking water while long-term measures are being evaluated and implemented. Results of the investigation indicate that, although the predominant zone of infiltration into the vadose zone occurs in the middle reaches of Sandia Canyon, water-balance calculations show that infiltration may occur further up the canyon than initially thought (LANL 2006k).

Regional groundwater sampling data from monitoring wells and production wells showed that wells R-11 and R-28 have the highest levels of hexavalent chromium contamination (derived from past laboratory activities, primarily effluent from cooling-water systems). The highest concentration of total dissolved chromium was sampled at regional aquifer monitoring well R-28 in Mortandad Canyon, where the concentration increased from 375 to 428 micrograms per liter in filtered samples collected in 2005 and 2006. The hexavalent chromium concentration ranged from 376 to 423 micrograms per liter. The concentration of total dissolved chromium measured in regional aquifer monitoring well R-11 in Sandia Canyon increased from 18.4 to 29.4 micrograms per liter in samples collected during 2005 and 2006. The increasing concentrations imply that these wells may be on the leading edge of a chromium plume (LANL 2006k). Other wells may have slightly elevated chromium levels, but further assessments are required. Two deep wells are planned and the need for deep drilling is to be assessed as part of the next phase of the work plan. The focus will be on the nature and extent of all contamination and will not be limited to chromium (LANL 2006k).

Filtered samples collected at well R-15 showed concentrations of total dissolved chromium ranging from 2.6 to 7.9 micrograms per liter. Concentrations of hexavalent chromium in samples collected on January 30, 2006, ranged from 7 (filtered) to 7.1 (unfiltered) micrograms per liter. These results were slightly elevated for total dissolved chromium and hexavalent chromium compared to background concentrations for the regional aquifer. Detectable concentrations of total dissolved chromium and hexavalent chromium in samples collected from other wells ranged from 2.73 to 12.3 micrograms per liter for unfiltered samples and from 0.93 to 8.2 micrograms per liter for filtered samples (LANL 2006k). Hexavalent chromium concentrations in samples from a regional aquifer well in Sandia Canyon averaged 20 micrograms per liter in both filtered and unfiltered samples.

Chromium was found at 31.4 micrograms per liter in an unfiltered sample obtained from a well in Pajarito Canyon, at a depth of 907 feet below ground surface, but was found at 1.8 micrograms per liter in the filtered sample. Because prior unfiltered samples ranged from nondetectable to 3.2 micrograms per liter, the 2005 LANL Environmental Surveillance Report states that, “this latest unfiltered chromium result does not yet lend itself to a pattern that can be evaluated,” (LANL 2006h).

4.4 Air Quality and Noise

4.4.1 Climatology and Meteorology

The LANL area climate is described in the *1999 SWEIS*. Changes in the meteorological data collection system at LANL and the meteorological data summary are discussed in this section, based on information in the *Information Document In Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement* (LANL 2004c).

Climatological averages for atmospheric variables such as temperature, pressure, winds, and precipitation presented in this subsection are based on observations made at the official LANL meteorological weather station from 1971 to 2000. The current official weather station, which has five sample heights (4, 37.5, 75, 150, and 300 feet [1.2, 11, 23, 46, and 92 meters]), is located at TA-6 (LANL 2004c). Five other meteorological towers are also used at LANL. The locations of all six meteorological towers are shown in **Figure 4–19**.

Normal (30-year mean) minimum and maximum temperatures for the communities of Los Alamos and White Rock and Los Alamos Townsite temperature extremes are reported in the *1999 SWEIS*. Average rainfall and snowfall extremes are also reported in the *1999 SWEIS*. Normal (30-year mean) precipitation for the communities of Los Alamos and White Rock (see **Figure 4–20**) and the extremes of precipitation are unchanged for the expanded period 1971 through 2000 (DOE 1999a, LANL 2004c).

Figure 4–19 Los Alamos National Laboratory Meteorological Network

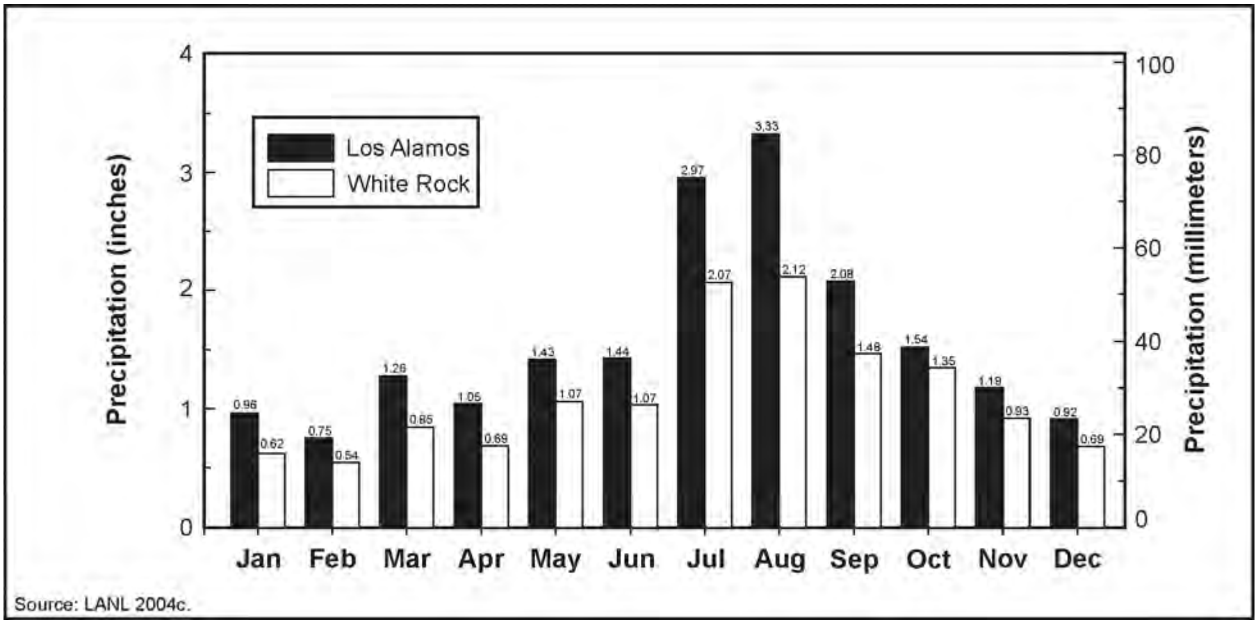


Figure 4–20 Los Alamos Area Mean Precipitation (1971 to 2000)

Since preparation of the *1999 SWEIS*, perhaps the most widespread and pervasive change in the region has been drought. LANL precipitation records show that between 1995 and 2004 there was only 1 year (1997) with above average precipitation. Precipitation patterns leading into the recent drought are strikingly similar, but of greater duration, to the period from 1953 to 1956, commonly referred to as the 1950s drought. The 1950s drought consisted of 4 years of progressively declining rainfall, with a sharp increase in precipitation in 1957 that ended the drought. The recent drought has been partially responsible for several disturbances that have greatly affected the regional environment. Dry weather facilitated the Cerro Grande Fire in May 2000, and set the stage for the bark beetle infestation that started around the summer of 2002 (LANL 2004c). Precipitation in 2004 was close to average, and in 2005 it was above average; however, there was a return to drought conditions toward the end of the year (LANL 2005h, 2006h).

4.4.1.1 Wind Conditions

Wind speed, direction, and turbulence are pertinent to air quality analysis. Los Alamos County winds average 7 miles per hour (3 meters per second). Wind speeds vary seasonally, with the lowest wind speeds occurring in December and January. The highest winds occur in the spring (March through June) due to intense storms and cold fronts. The highest recorded wind in Los Alamos County was 77 miles per hour (34 meters per second). Surface winds often vary dramatically with the time of day, location, and elevation, due to the region's complex terrain. Average wind direction and wind speed for the four primary measurement stations are plotted in wind roses and are presented in **Figures 4–21, 4–22**, and **4–23**. **Figure 4–24** presents the same wind information for the LANL measurement site on Pajarito Mountain and in Los Alamos Canyon at TA-41. For all stations except Pajarito Mountain, the data plotted are from 1996 through 2000. Pajarito Mountain's data spans 1998 through 2000. A wind rose is a vector representation of wind velocity and duration. It appears as a circle with lines extending from the center representing the direction from which the wind blows. The length of each spoke is proportional to the frequency at which the wind blows from the direction indicated. The frequency of calm winds (less than 1 mile per hour [0.5 meter per second]) is presented in the center of the wind rose (LANL 2004c).

In addition to seasonal changes in wind conditions, surface winds often vary with the time of day. An up-slope air flow can develop over the Pajarito Plateau in the morning hours. By noon, winds from the south usually prevail over the entire plateau. The prevalent nighttime flow ranges from the west-southwest to northwest over the western portion of the plateau. These nighttime winds result from cold air drainage off the Jemez Mountains and the Pajarito Plateau (LANL 2004c).

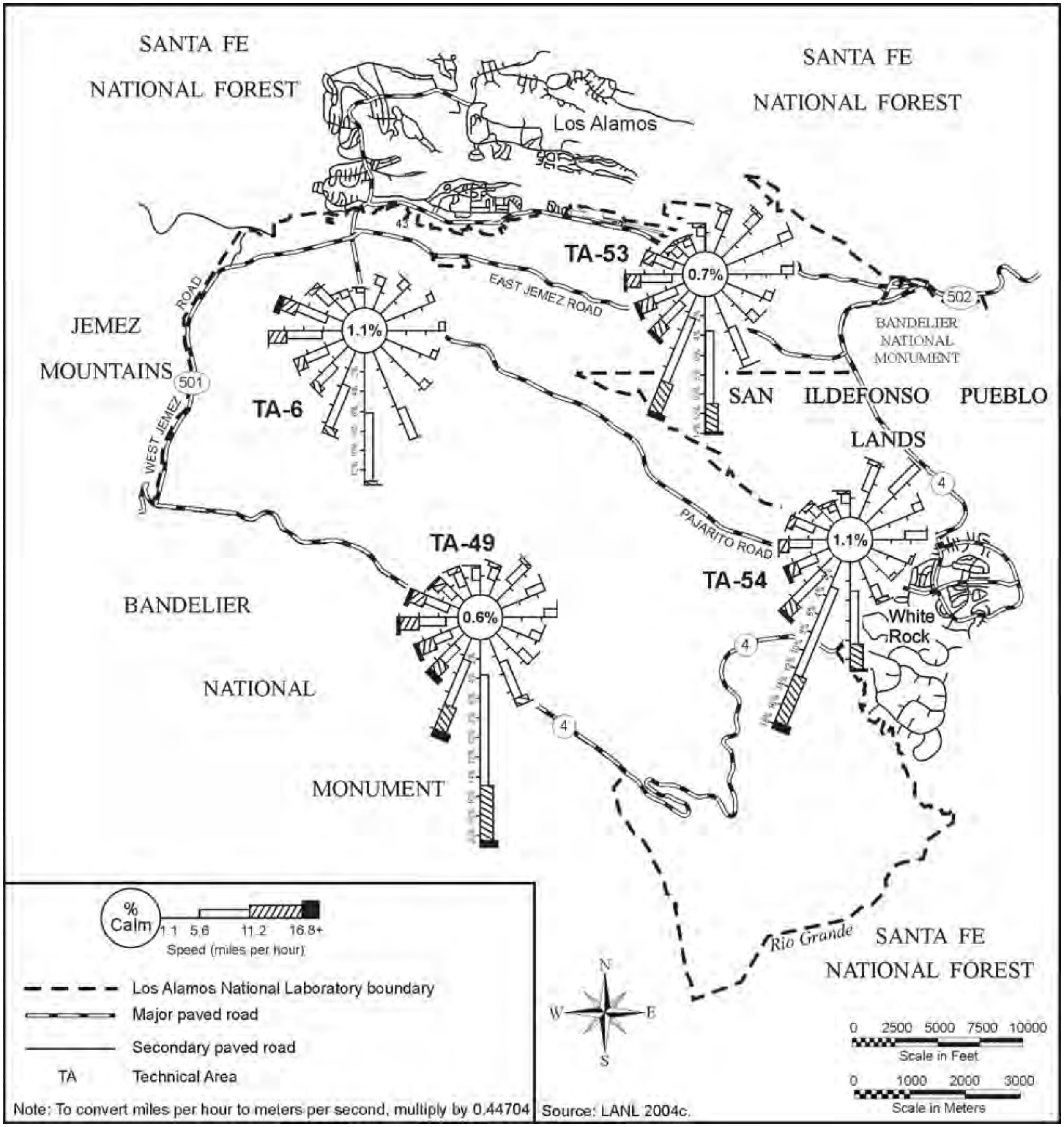


Figure 4–21 Los Alamos National Laboratory Meteorological Stations with Daytime Wind Rose Data

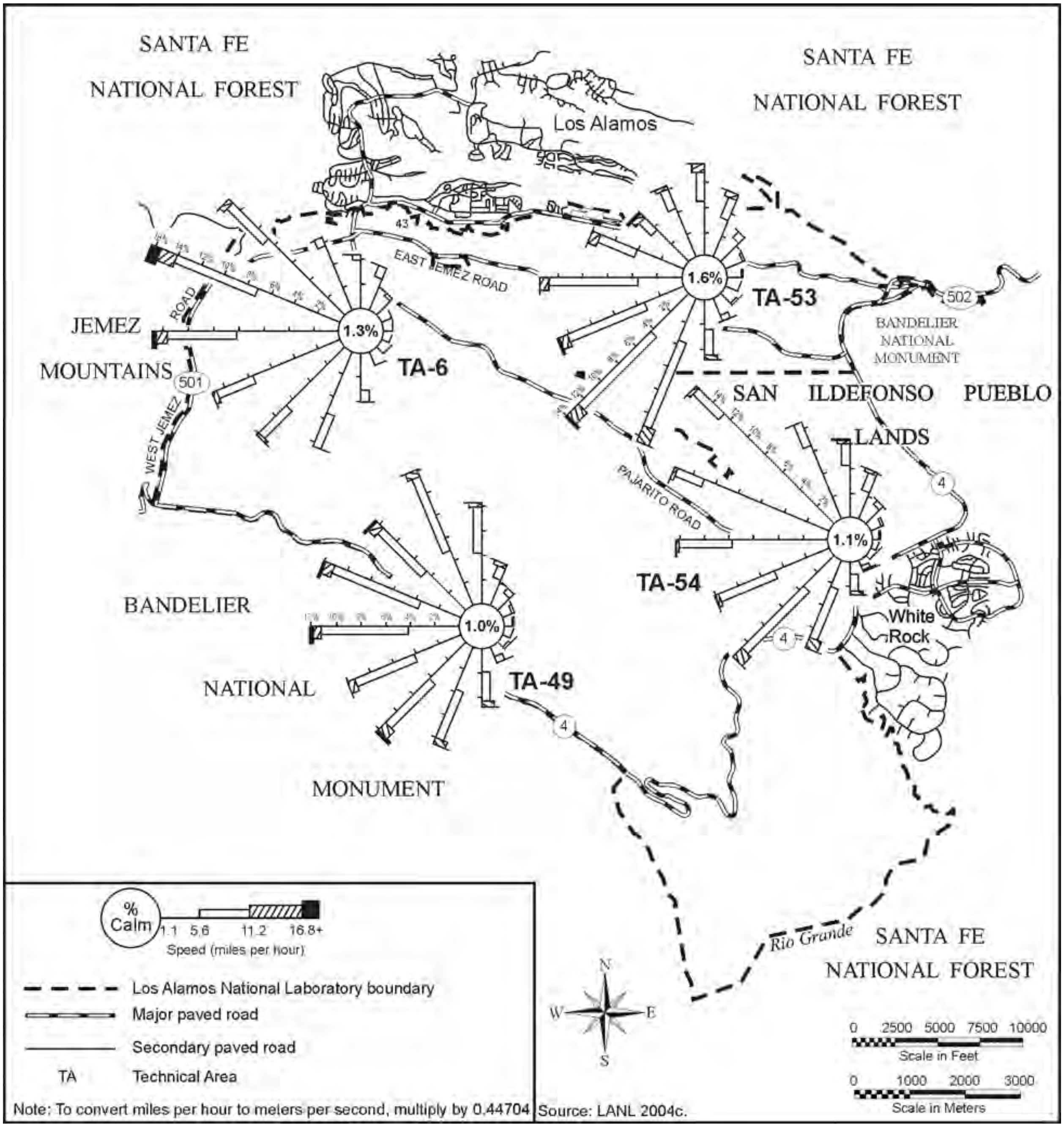


Figure 4–22 Los Alamos National Laboratory Meteorological Stations with Nighttime Wind Rose Data

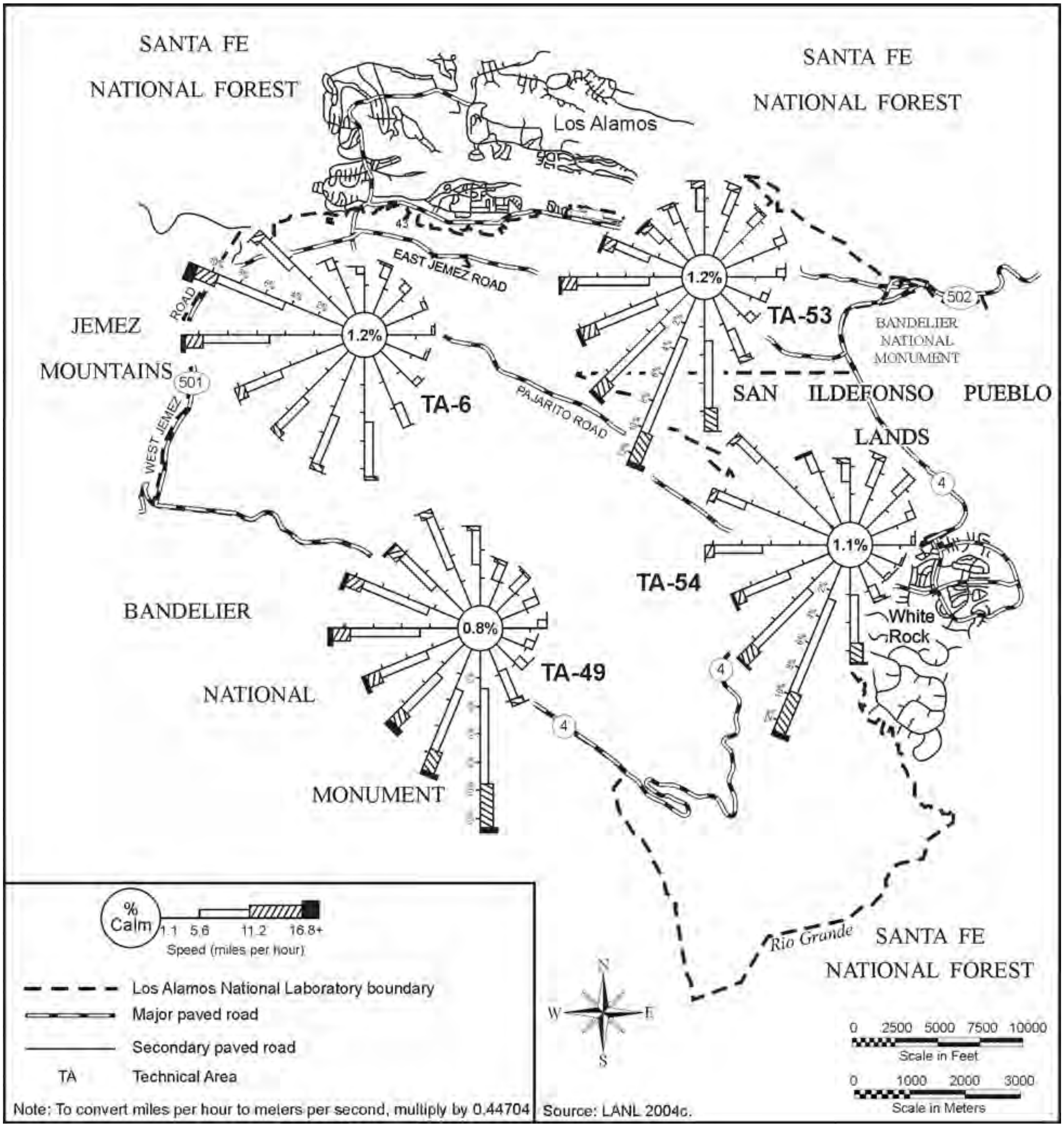


Figure 4–23 Los Alamos National Laboratory Meteorological Stations with Total Wind Rose Data

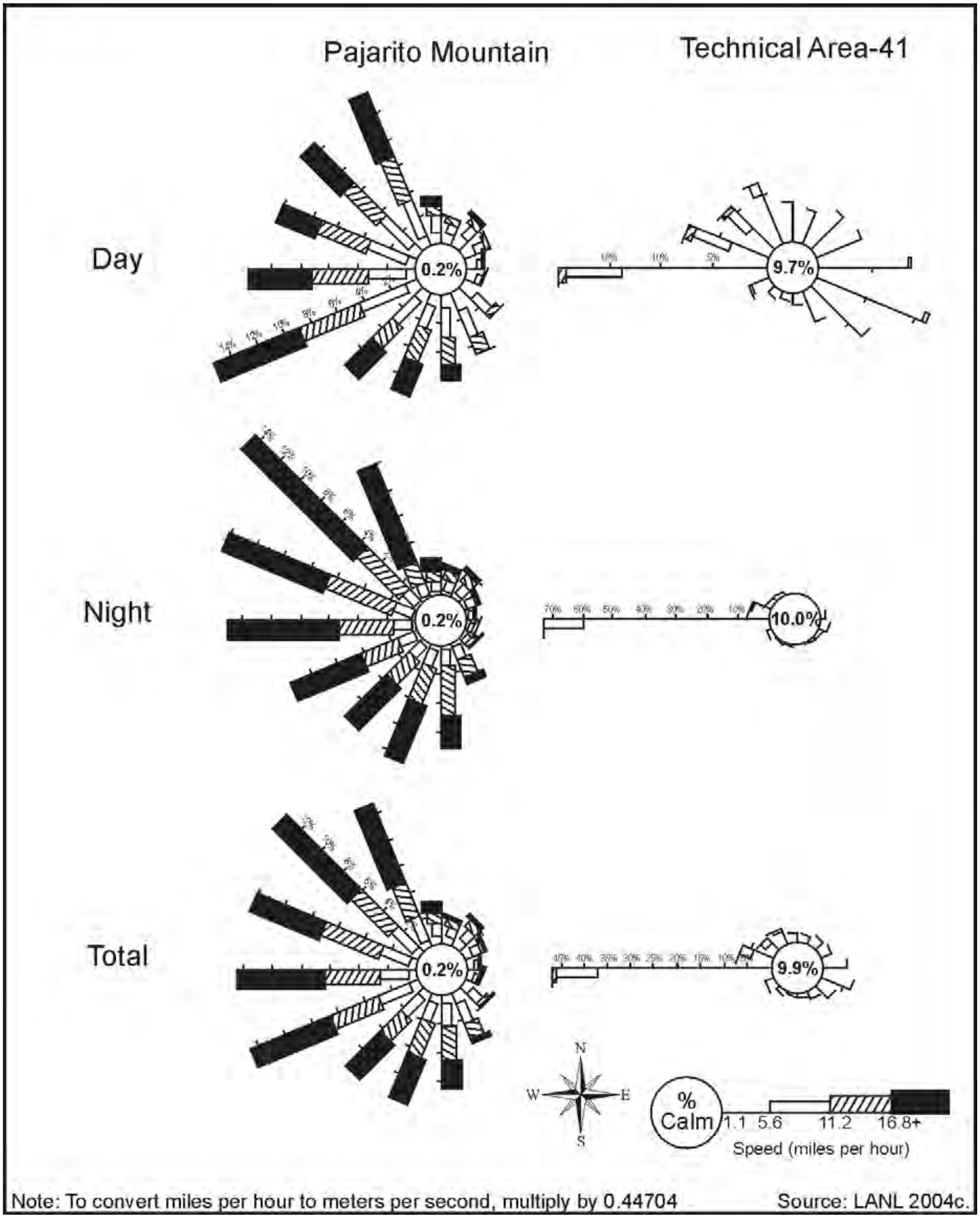


Figure 4–24 Pajarito Mountain and Technical Area 41 Associated Wind Rose Data

Analyses of Los Alamos Canyon wind data indicate a difference between the air flow in the canyon and the air flow over the Pajarito Plateau. Cold air drainage flow is observed about 75 percent of the time during the night and continues for an hour or two after sunrise until an up-canyon flow forms. Nighttime canyon flows are predominantly weak drainage winds from the west. Because of the stability of these nighttime canyon flows and the relatively weak mesa winds, the development of rotors at night in the canyon is rare. But, a turbulent longitudinal whirl or "rotor" that fills the canyon can develop when the wind over the Pajarito Plateau has a strong cross-canyon component (LANL 2004c).

The irregular and complex terrain and rough forest surfaces in the region also affect atmospheric dispersion. The terrain and forests increase horizontal and vertical turbulence and dispersion. The dispersion generally decreases at lower elevations where the terrain becomes smoother and less vegetated. The region's canyons channel the air flow which limits dispersion (LANL 2004c).

Light wind conditions under clear skies can create strong, shallow surface inversions that trap the air at lower elevations and severely restrict dispersion. These light wind conditions occur primarily during the autumn and winter months, with intense surface air inversions occasionally occurring. Inversions are most severe during the night and early morning. Overall dispersion is greater with strong winds in the spring. However, vertical dispersion is greatest during summer afternoons. Deep vertical mixing occurs in the summer afternoons, lowering concentrations near the surface (LANL 2004c).

4.4.1.2 Severe Weather

Thunderstorm and hailstorm frequency and occurrences of other severe weather events are discussed in the *1999 SWEIS*. An average of 60 thunderstorms occurs in Los Alamos County in a year. Hailstorms occur frequently with measurable accumulations.

4.4.2 Nonradiological Air Quality

LANL operations can result in the release of nonradiological air pollutants that can affect the air quality of the surrounding area. Information regarding the applicable air quality standards and guidelines and existing nonradiological air quality are presented in this section.

4.4.2.1 Applicable Requirements and Guidelines

The Clean Air Act mandates that EPA establish National Ambient Air Quality Standards (NAAQS) for pollutants of nationwide concern. These pollutants, known as criteria pollutants, are carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, lead, and particulate matter. As of July 18, 1997, in addition to the particulate matter equal to or less than 10 microns (10 micrometers) in aerodynamic diameter (PM_{10}), a new standard became effective for particulate matter equal to or less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$). EPA designated New Mexico as attaining the $PM_{2.5}$ standards (40 CFR 81.332) (LANL 2004c).

In 1997, EPA revised the NAAQS for ground-level ozone, setting it at 0.08 parts per million averaged over an 8-hour timeframe. Litigation delayed implementation of this standard for several years. However, in March 2002, the District of Columbia Circuit Court rejected all remaining challenges to the 8-hour ozone standard and EPA began implementing the requirements. The entire State of New Mexico, including Los Alamos County, has been designated as in attainment with the 8-hour ozone standard (40 CFR 81.332) (LANL 2004c).

National primary air quality standards define levels of air quality judged necessary, with an adequate margin of safety, to protect public health. National secondary ambient air quality standards define levels of air quality judged necessary to protect public welfare from any known or anticipated adverse effects of a pollutant. A primary NAAQS has been established for carbon monoxide, and both primary and secondary standards have been established for the remaining criteria pollutants. The area encompassing LANL and Los Alamos County is classified as an attainment area for all six criteria pollutants (40 CFR 81.332) (LANL 2004c).

The State of New Mexico has also established ambient air quality standards for carbon monoxide, sulfur dioxide, nitrogen dioxide, total suspended particulates (which is not PM_{10}), hydrogen sulfide, and total reduced sulfur. Additionally, New Mexico established permit requirements for toxic air pollutants. Toxic air pollutants are chemicals that are generally found in trace amounts in the atmosphere, but that can result in chronic health effects or increase the risk of cancer when they are present in amounts that exceed established health-based limits. Because of the financial constraints and the unavailability of sufficient information on the effects of toxic air pollutants, New Mexico has not established ambient standards for toxic chemicals. To approach this issue, New Mexico has developed permit requirements that are used by the NMED for determining if a new or modified source emitting a toxic air pollutant would be issued a permit under Subpart IV 20.2.72 NMAC (New Mexico Administrative Code) (LANL 2004c). Although many operations at LANL were in existence before August 31, 1972, when NMED air permit regulations were first applicable, operations are now subject to a site-wide operating permit.

In accordance with Title V of the Clean Air Act, as amended, and 20.2.70 NMAC, the management and operating contractor and DOE submitted a Clean Air Act operating permit application to NMED in December 1995. In 2002, the management and operating contractor and DOE submitted a revised operating permit application as requested by NMED. NMED issued a Notice of Completeness for both applications and issued operating permit P100 in April 2004 (LANL 2004c, NMED 2004b), as well as a modified permit P100M1 in June 2006 (NMED 2006a). Air quality permits are discussed further in Chapter 6.

The primary purpose of the operating permit program is to identify all Federal and state air quality requirements applicable to LANL operations so that a single site-wide permit can be granted. Under this permit, the management and operating contractor at LANL tracks pollutant emissions by reporting semiannual emissions, based on chemical purchase data, material and fuel usage, knowledge of operations, and suitable emission factors (LANL 2004c). Appendix B, Table B–2, of the SWEIS lists chemicals used at LANL in 2004 (LANL 2005f).

Emissions of criteria and hazardous air pollutants from activities at LANL are subject to the limitations in the Title V operating permit. These limits are summarized in **Table 4–18**. In addition, there are limits on visible emissions. The permit also includes limitations derived from the New Source Performance Standard for Small Industrial-Commercial-Institutional Steam Generating Units (40 CFR Part 60 Subpart Dc), which is applicable to two TA-55 boilers;

Table 4–18 Operation Permit Emission Limits

Facility	Emissions (tons per year unless stated)					
	Nitrogen Oxides	Carbon Monoxide	Volatile Organic Compounds	Sulfur Dioxide	Particulate Matter	Hazardous Air Pollutants
LANL – Entire Facility	245	225	200	150	120	24 combined/ 8 individual
Asphalt Production (TA-60-BDM)	1.0	2.6	1.0	1.0	0.04 grams per dry standard cubic foot, 35.4 pounds per hour	NA
Beryllium Activities						
CMR Facility (TA-3-29)	NA	NA	NA	NA	Beryllium 10 grams per 24 hours	NA
Sigma Facility (TA-3-66)	NA	NA	NA	NA	Beryllium 10 grams per 24 hours	NA
Beryllium Test Facility (TA-3-141)	NA	NA	NA	NA	Beryllium 0.35 grams per 24 hours 3.5 grams per year	NA
TA-16-207	NA	NA	NA	NA	Beryllium 10 grams per 24 hours	NA
TA-35-87	NA	NA	NA	NA	Beryllium 10 grams per 24 hours	NA
Target Fabrication Facility (TA-35-213)	NA	NA	NA	NA	Beryllium 1.8×10^{-4} grams per hour, 0.36 grams per year	NA
Plutonium Facility (TA-55-PF4)						
Machining Operation	NA	NA	NA	NA	Beryllium - 0.12 grams per 24 hours, 2.99 grams per year Aluminum - 0.12 grams per 24 hours, 2.99 grams per year	NA
Foundry Operation	NA	NA	NA	NA	Beryllium - 3.49×10^{-5} grams per 24 hours, 8.73×10^{-4} grams per year Aluminum - 3.49×10^{-5} grams per 24 hours, 8.73×10^{-4} grams per year	NA
Boilers and Heaters [a]	80	80	50	50	50	NA
Carpenter Shops						
TA-15-563	NA	NA	NA	NA	2.81	NA
TA-3-38	NA	NA	NA	NA	3.07	NA
Chemical Usage (facility wide)	NA	NA	200	NA	NA	8 individual chemical 24 total
Degreasers – TA-55-DG-1, TA-55-DG-2, and TA-55-DG-3	NA	NA	200 facility wide	NA	NA	8 individual 24 total
Internal Combustion Sources						
TA-33-G-1 (diesel generator)	18.1 tons per year, 40.3 pounds per hour	15.2 tons per year, 33.7 pounds per hour	0.3 tons per year, 0.7 pounds per hour	2.5 tons per year, 5.5 pounds per hour	TSP 0.6 tons per year, 1.4 pounds per hour PM_{10} 0.6 tons per year, 1.4 pounds per hour	NA
Various Standby Generators [b]	NA	NA	NA	NA	NA	NA
Data Disintegrator/ Industrial Shredder	NA	NA	NA	NA	TSP 9.9 tons per year, 2.3 pounds per hour PM_{10} 9.9 tons per year, 2.3 pounds per hour	NA

Facility	Emissions (tons per year unless stated)					
	Nitrogen Oxides	**Carbon Monoxide**	**Volatile Organic Compounds**	**Sulfur Dioxide**	**Particulate Matter**	**Hazardous Air Pollutants**
Power Plant at TA-3-22						
TA-3-22-1	10.2 pounds per hour gas 11.3 pounds per hour oil	7.0 pounds per hour gas 6.5 pounds per hour oil	1.0 pounds per hour gas 0.3 pounds per hour oil	1.1 pounds per hour gas 9.6 pounds per hour oil	TSP 1.3 pounds per hour gas 4.3 pounds per hour oil PM_{10} 1.3 pounds per hour gas 3.0 pounds per hour oil	NA
TA-3-22-2	10.2 pounds per hour gas 11.3 pounds per hour oil	7.0 pounds per hour gas 6.5 pounds per hour oil	1.0 pounds per hour gas 0.3 pounds per hour oil	1.1 pounds per hour gas 9.6 pounds per hour oil	TSP 1.3 pounds per hour gas 4.3 pounds per hour oil PM_{10} 1.3 pounds per hour gas 3.0 pounds per hour oil	NA
TA-3-22-3	10.2 pounds per hour gas 11.3 pounds per hour oil	7.0 pounds per hour gas 6.5 pounds per hour oil	1.0 pounds per hour gas 0.3 pounds per hour oil	1.1 pounds per hour gas 9.6 pounds per hour oil	TSP 1.3 pounds per hour gas 4.3 pounds per hour oil PM_{10} 1.3 pounds per hour gas 3.0 pounds per hour oil	NA
Boilers Combined	60.2 tons per year	41.3 tons per year	5.6 tons per year	7.9 tons per year	TSP 8.4 tons per year PM_{10} 8.2 tons per year	NA
TA-3-22 CT-1	23.8 pounds per hour 33.2 tons per year	170.9 pounds per hour 19.8 tons per year	1.0 pounds per hour	1.4 pounds per hour 1.9 tons per year	TSP 1.6 pounds per hour 2.3 tons per year PM_{10} 1.6 pounds per hour 2.3 tons per year	NA

NA = not available, CMR = Chemistry and Metallurgy Research, TSP = total suspended particulate, PM^{10} = particulate matter less than 10 microns in aerodynamic diameter, TA = technical area.

[a] Including TA-16-1484-BS-1, TA-16-1484-BS-2, TA-21-357-1, TA-21-357-2, and TA-21-357-3, TA-48-1-BS-1, TA-48-1-BS-2, TA-48-1-BS-6, TA-50-2, TA-53-365-BHW-1, TA-53-365-BHW-2, TA-55-6-BHW-1, TA-55-6-BHW-2, TA-59-BHW-1, TA-59-BHW-2.

[b] Standby generators are limited to an average of 168 hours per year; tons per year to metric tons per year, multiply by 0.9072.

Note: To convert pounds per hour to kilograms per hour, multiply by 0.45359; tons per year to metric tons per year, multiply by 0.90718.

Source: NMED 2006a.

New Source Performance Standard for Hot Mix Asphalt Facilities (40 CFR Part 60 Subpart I); New Source Performance Standard for Stationary Gas Turbines (40 CFR Part 60 Subpart GG), which is applicable to the new gas turbine; National Emission Standards for Hazardous Air Pollutants for Beryllium (40 CFR Part 61 Subpart C) which is applicable to beryllium operations at TA-3, TA-16, TA-35, and TA-55; National Emission Standards for Hazardous Air Pollutants for Asbestos (40 CFR Part 61 Subpart M) which may be applicable to some demolition projects; National Emission Standards for Hazardous Air Pollutants for Radon Emissions from DOE Facilities (40 CFR Part 61 Subpart Q) applicable to operations at TA-55; and National Emission Standards for Hazardous Air Pollutants for Radionuclides other than Radon from DOE Facilities (40 CFR Part 61 Subpart H), which is discussed further in Chapter 4, Section 4.6.1.2 and in Appendix C, Section C.1.1.5. National Emissions Standards for Halogenated Solvent Cleaning (40 CFR Part 63 Subpart T) is applicable to certain activities at TA-55 and specifies applicable controls (NMED 2006a).

4.4.2.2 Sources of Nonradiological Emissions

Criteria pollutants released from LANL operations are emitted primarily from combustion sources such as boilers and emergency generators. Although motor vehicle emissions have an impact on local air quality, no quantitative analysis of vehicle emissions was performed as part of the *1999 SWEIS*. Instead, vehicle emissions were included in the assumed background concentrations for each of the criteria pollutants in the *LANL SWEIS* analysis (LANL 2004c).

Estimated emissions from operations at LANL for the years 1999 through 2004 are shown in **Table 4–19**. These data include emissions from the operation of facilities at LANL. Construction emissions from new facilities and facility upgrades during the period 1999 through 2004 resulted in temporary increases in LANL emissions. Construction emissions were not quantified in the *1999 SWEIS* or in the *SWEIS Yearbook 2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (SWEIS Yearbook – 2005)* (LANL 2006g). Most of the National Environmental Policy Act (NEPA) documents for activities that were under construction during the period 1999 to 2004 determined that impacts from construction emissions would be small and of short duration and similar to other construction activities at LANL. The data presented for criteria pollutants in the *SWEIS Yearbook – 2005* are summarized as annual emissions for each pollutant. Appendix B, Attachment 1, of the *1999 SWEIS* presents criteria pollutant emissions for individual combustion sources.

Table 4–19 Emissions of Criteria Pollutants

Pollutant [a]	*Emissions (tons per year)*						
	1999	*2000*	*2001*	*2002*	*2003*	*2004* [b]	*2005* [b]
Carbon monoxide	32	26	29.08	28.1	31.9	35.4	35.1
Nitrogen oxides	88	80	93.8	64.7	49.6	50.5	50.5
Particulate matter	4.5	3.8	5.5	15.5 [c]	22.1 [c]	4.8	5.0
Sulfur oxides	0.55	4.0 [d]	0.82	1.3 [e]	1.6 [e]	1.5	1.9

[a] Tons per year.
[b] Values include emissions from small boilers and heaters and standby generators not included in previous years' emissions inventories, but included on LANL's Title V Operating Permit Emissions Report.
[c] Increased emissions of particulate matter were primarily due to operation of three air curtain destructors used to burn wood and slash from the fire mitigation activities.
[d] The higher emissions of sulfur oxides were due to the main steam plant burning fuel oil during the Cerro Grande Fire.
[e] The increased emissions of sulfur oxides were due to operation of the three air curtain destructors used to burn wood and slash from fire mitigation activities.
Note: To convert tons per year to metric tons per year, multiply by 0.9072.
Sources: LANL 2003h, 2006g.

Increased particulate matter emissions in 2002 and 2003 were attributable primarily to operation of three air curtain destructors that were used to burn wood and slash from the fire mitigation activities around LANL. Operation of the air curtain destructors emitted 12.2 tons (10 metric tons) of particulate matter and 1 ton (0.9 metric tons) of sulfur oxides in 2002. The air curtain destructors emitted a total of 19.1 tons (17.3 metric tons) of particulate matter and 1.3 tons (1.2 metric tons) of sulfur oxides during 2003. The air curtain destructors were shut down in September 2003 (LANL 2003h, 2004f).

Sulfur oxides emissions in 2000 increased as a result of burning fuel oil in the main steam plant during the Cerro Grande Fire. Use of alternate fuel is not typical of steam plant operations and was necessary due to natural gas supplies being cut off to the area during the fire (LANL 2003h).

Approximately two-thirds of the most significant criteria pollutant, nitrogen oxides, results from the TA-3 steam plant. In late 2000, DOE received a permit from NMED to install flue gas recirculation equipment on the steam plant boilers to reduce emissions of nitrogen oxide. This equipment became operational in 2002, and initial source tests indicated a reduction in emissions, of approximately 64 percent. The water pump, which was a large source of nitrogen oxide emissions, was transferred to Los Alamos County in November 2001 (LANL 2003h, 2004f).

The Clean Air Act, as amended, requires that Federal actions conform to the host State's "State Implementation Plan." A State Implementation Plan provides for the implementation, maintenance, and enforcement of the NAAQS for the six criteria pollutants, sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Conformance with the State Implementation Plan is required to eliminate or reduce the severity and number of violations of NAAQS and to expedite the attainment of NAAQS. No Department, agency, or instrumentality of the Federal Government shall engage in or support in any way (i.e., provide financial assistance for, license or permit, or approve) any activity that does not conform to an applicable implementation plan. The final rule for *Determining Conformity of General Federal Actions to State or Federal Implementation Plans* (58 FR 63214) took effect on January 31, 1994. LANL is within an area that is currently designated as an attainment area for criteria air pollutants. Therefore, the actions considered in the *1999 SWEIS* and the other proposed projects considered in this *SWEIS* do not require a conformity determination.

Air pollutant emissions for Key Facilities at LANL are presented in Appendix A of the *SWEIS Yearbook – 2005* and are based on chemical usage in these areas (LANL 2006g). Total emissions of hazardous air pollutants and volatile organic compounds for 2000 through 2005 are presented in **Table 4–20**.

Table 4–20 Emissions of Hazardous Air Pollutants and Volatile Organic Compounds from Chemical Use

Pollutant	***Emissions (tons per year)***					
	2000	***2001***	***2002***	***2003***	***2004***	***2005***
Hazardous Air Pollutants	6.5	7.4	7.74	7.32	5.71	5.4
Volatile Organic Compounds	10.7	18.6	14.9	11.2	7.95	11.2

Note: To convert tons per year to metric tons per year, multiply by 0.9072.
Source: LANL 2006g.

The total emissions of hazardous air pollutants and volatile organic compounds showed considerable variation over the period 2000 through 2005. Operation of the air curtain destructors resulted in increases of hazardous air pollutants and volatile organic compounds during 2002 and 2003. The air curtain destructors accounted for 2.1 and 22.9 tons (1.9 and 20.8 metric tons) of hazardous air pollutants and volatile organic compound, respectively, in 2002. In 2003, they accounted for 3.3 and 36.0 tons (3.0 and 32.7 metric tons) of hazardous air pollutants and volatile organic compounds, respectively. As noted above, the air curtain destructors were shutdown in September 2003 (LANL 2004f). With the completion of Cerro Grande Rehabilitation Project tree thinning and removal, emissions of hazardous air pollutants and volatile organic compounds returned to lower levels more typical of pre-fire conditions. Emissions of volatile organic compounds were lower in 2004 due to the shutdown of activities in July 2004 (LANL 2006g).

Toxic and hazardous air pollutant emissions from LANL activities are released primarily from laboratory, maintenance, and waste management operations. Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility with great fluctuations in both the types of chemicals emitted and their emission rates. DOE has a program to review new operations for their potential to emit toxic and hazardous air pollutants. Toxic air pollutant emissions from the use of chemicals are generally below the levels for which the State of New Mexico would require a permit for a new source under its permit regulations for toxic air pollutant emissions (NMAC 20.2.72.400 - 502). The Title V operating permit limits the emissions of hazardous air pollutants such that operations at LANL are below the major source threshold for hazardous air pollutants. Emissions of hazardous air pollutants are monitored and reported annually to NMED as required by the permit. Past actual emissions of hazardous air pollutants have been well below the threshold (LANL 2004c).

In the *1999 SWEIS*, a list of 382 chemicals of interest was selected for evaluation. A comparison of a calculated maximum emission rate derived from health-based standards to the potential emission rate from key LANL facilities was made. In this analysis, a screening level emission value was developed for each chemical and for each TA where that chemical was used. A screening level evaluation value is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year) period, would not exceed a health-based guideline value. This value was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at that TA over the course of 1 year were available to become airborne (LANL 2004c).

Estimates for selected toxic and hazardous air pollutant emissions from key LANL facilities were made in the *1999 SWEIS* based on chemical use at LANL and assumed stack and building parameters. Chemical purchasing records for these key facilities have been reviewed each year and estimated emissions reported in the annual Yearbooks (LANL 2003h, LANL 2004f, LANL 2006g). The amount of individual chemicals purchased varies from year to year. However, in some areas the total amounts of the chemicals of interest have stayed relatively constant from year to year. For example, at TA-3 during the period 1999 and 2002, the total chemical usage has varied by about plus or minus 25 percent. The variation in estimated chemical emissions would be expected to be similar (LANL 2004c). At other areas such as at the High-Explosives Processing areas, chemical emissions show greater variability from year to year. Evaluation of emissions of individual chemicals indicates that most chemicals would be emitted at levels below the screening levels identified in the *1999 SWEIS*.

DOE Order 450.1, "Environmental Protection Program," requires DOE facilities to incorporate an environmental management system approach into their Integrated Safety Management Systems. This includes the protection of resources from wildland and operational fires. Fires are conducted from time to time at LANL for the reduction of forest fuel to reduce the potential for wildland fires. These fires result in emissions of various chemical compounds such as fine particulate matter, nitrogen oxides, carbon monoxide, and organic compounds. Some impairment of visibility at Bandelier National Monument can result from these fires. Air quality impacts from prescribed fires are controlled through proper planning and the regulatory process (NMAC 20.2.60 and 20.2.65) (DOE 2004f).

4.4.2.3 Existing Ambient Air Conditions

Only a limited amount of ambient air monitoring has been performed for nonradiological air pollutants within the LANL region. NMED operated a DOE-owned ambient air quality monitoring station adjacent to Bandelier National Monument between 1990 and 1994 to record sulfur dioxide, nitrogen dioxide, ozone, and PM_{10} levels as discussed in the *1999 SWEIS*. DOE and NMED discontinued operation of this station in fiscal year 1995 because recorded values were well below applicable standards.

The State of New Mexico does not have an ambient air quality standard for beryllium. Beryllium concentrations are monitored at over 20 sites located near potential beryllium sources at LANL or in nearby communities. For comparison purposes, the results are compared to the ambient standard from the National Emission Standard for Hazardous Air Pollutants standard for beryllium of 10 nanograms per cubic meter (40 CFR Part 61 Subpart C). DOE is not required to monitor to this standard because all beryllium-permitted sources meet the emission standards, but it is used in this case for comparative purposes. All monitored beryllium values were 2 percent or less of the National Emission Standard for Hazardous Air Pollutants Standard (LANL 2006h).

After the Cerro Grande Fire in the spring of 2000, there was concern that an adequate baseline of nonradiological ambient air sampling was not in place at LANL. Therefore, in 2001, DOE designed and implemented a new air monitoring program, entitled NonRadNET, to provide nonradiological background ambient data under normal conditions. The NonRadNET program includes real-time ambient sampling for PM_{10} and $PM_{2.5}$. Additionally, air samples were collected in the first year of this program and analyzed for up to 20 inorganic elements and up to 160 volatile organic compounds. The results for PM_{10} and $PM_{2.5}$ are included for 2005 in **Table 4–21**. Results for the inorganic elements and the volatile organic compounds were all below any published ambient or occupational exposure limits. More information about this ambient monitoring program can be found in the report entitled *Nonradioactive Ambient Air Monitoring at Los Alamos National Laboratory 2001-2002* (LANL 2004e).

Table 4–21 2005 Ambient Air Monitoring for Particulate Matter

Station Location	*Constituent*	*Annual Mean Monitored Value (micrograms per cubic meter)*	*NAAQS Primary Annual Standard (micrograms per cubic meter)*	*Maximum 24-Hour Monitored Value (micrograms per cubic meter)*	*NAAQS 24-Hour Standard (micrograms per cubic meter)*
48th Street, Los Alamos	PM_{10}	12	50	34	150
	$PM_{2.5}$	7	15	20	65
Los Alamos Medical Center	PM_{10}	15	50	55	150
	$PM_{2.5}$	8	15	27	65
White Rock Fire Station	PM_{10}	13	50	34	150
	$PM_{2.5}$	7	15	20	65

NAAQS = National Ambient Air Quality Standards, PM_n = Particulate matter less than n microns in aerodynamic diameter.
Source: LANL 2006h.

As part of the Title V operating permit application, NMED requested that the management and operating contractor at LANL provide a facility-wide air quality impacts analysis. The purpose of the analysis was to ensure that the emission limits requested in the Title V permit application would not cause exceedances of any NAAQS or New Mexico Ambient Air Quality Standards. The analysis also demonstrated that simultaneous operation of all regulated air emission units described in the Title V permit application, being operated at their maximum requested permit limits, would not result in exceedances of any ambient air quality standards (Jacobson, Johnson, and Rishel 2003).

4.4.3 Radiological Air Quality

Individuals are continuously exposed to airborne radioactive materials. These materials come primarily from natural resources, such as the short-lived decay products of radon, found worldwide. However, airborne radioactive materials can also be emitted by manmade operations. Some LANL operations may result in the release of radioactive materials to the air from point sources such as stacks or vents or from nonpoint (area) sources such as the radioactive materials in contaminated soils. The concentrations of radionuclides in point-source releases are continuously sampled or estimated based on knowledge of the materials used and the activities performed. Nonpoint-source emissions are directly monitored or sampled or estimated from airborne concentrations outdoors. The radiological air quality at LANL described in the *1999 SWEIS* is based on data collected from 1991 through 1996. The sections below discuss radiological air quality on the basis of data collected between 1999 and 2005. Radiation doses from LANL airborne emissions and radiological emission standards are discussed in Section 4.6 of this *SWEIS*.

4.4.3.1 Radiological Monitoring

The LANL radiological air-sampling network, referred to as AIRNET, measures environmental levels of airborne radionuclides, such as plutonium, americium, uranium, tritium, and activation products that could be released from LANL operations. Most regional airborne radioactivity comes from the following sources: (1) natural radioactive constituents in particulate matter (such as uranium and thorium), (2) terrestrial radon diffusion out of the Earth and its subsequent decay products, (3) material formation from interaction with cosmic radiation, and (4) fallout from past atmospheric nuclear weapons tests conducted by several countries. **Table 4–22** summarizes regional levels of radioactivity in the atmosphere over the period 1999 to 2005.

In 2005, 28 stacks were continuously monitored for the emission of radioactive material to the ambient air. LANL staff categorizes these radioactive stack emissions into four types: (1) particulate matter, (2) vaporous activation products, (3) tritium, and (4) gaseous mixed activation products. Measurements of LANL stack emissions during 2005 totaled approximately 19,100 curies. Of this total, tritium emissions composed approximately 704 curies, and air activation products from Los Alamos Neutron Science Center (LANSCE) stacks contributed nearly 18,400 curies. Combined airborne materials such as plutonium, uranium, americium, and thorium were less than 0.00002 curies. Emissions of particulate/vapor activation products totaled less than 0.02 curies (LANL 2006h). **Table 4–23** provides further detailed emissions data for buildings with sampled stacks in the years 1999 through 2005. Overall, radiological air emissions at LANL tend to be dominated by emissions from LANSCE stacks and tritium.

Table 4–22 Annual Average Background Concentration of Radioactivity in the Regional Atmosphere

	Units [a]	*EPA Concentration Limit* [b]	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Gross Alpha	fCi/m^3	NA	1	1	0.8	0.8	0.8	1.1	0.9
Gross Beta	fCi/m^3	NA	13.4	13	13.9	13.3	13.7	18.3	16.3
Tritium	pCi/m^3	1,500	0.5	0.8	NM	NM	NM	0.1	0.1
Strontium-90	aCi/m^3	19,000	NA	NA	NA	4	11	NA	NA
Plutonium-238	aCi/m^3	2,100	NM	0	0	0	NM	0.09	0
Plutonium-239 and Plutonium-240	aCi/m^3	2,000	0.1	0	0.1	0.3	NM	NM	0.1
Americium-241	aCi/m^3	1,900	NM	0.3	NM	0.3	NM	NM	0.1
Uranium-234	aCi/m^3	7,700	16.1	17.1	17.9	21.7	20.9	17.4	12.4
Uranium-235	aCi/m^3	7,100	1.2	0.9	1.3	2.4	1.8	1.17	1.2
Uranium-238	aCi/m^3	8,300	15.2	15.9	17.7	21.8	20.1	17.0	13.2

EPA = U.S. Environmental Protection Agency, NA = not available, NM = not measurable.

[a] m^3 = cubic meters, pCi = picocurie = 10^{-12} curie, fCi = femtocurie = 10^{-15} curie, aCi = attocurie = 10^{-18} curie.

[b] Each EPA limit corresponds to 10 millirem per year.

Source: LANL 2004d, 2005h, 2006h.

4.4.4 Visibility

In accordance with the Clean Air Act, as amended, and New Mexico regulations, the Bandelier National Monument and Wilderness Area have been designated as a Class I area (defined as wilderness areas that exceed 10,000 acres [4,047 hectares]) where visibility is considered to be an important value [40 CFR 81.421, NMAC 20.2.74] and requires protection). Visibility is measured according to a standard visual range, how far an image is transmitted through the atmosphere to an observer some distance away. Visibility has been officially monitored by the National Park Service at the Bandelier National Monument since 1988. **Table 4–24** reflects average visibility from 1993 through 2002 from approximately 79 to 113 miles (127 to 182 kilometers) (LANL 2004c). This would represent a reduction in the visual range of 2 to 31 percent compared to the estimated natural median visual range for the western states of 110 to 115 miles (177 to 186 kilometers) (Malm 1999).

4.4.5 Noise, Air Blasts, and Vibration Environment

Noise (considered to be unpleasant, loud, annoying or confusing sounds to humans), air blasts (also known as air pressure waves or over pressures), and ground vibrations are intermittent aspects of the LANL area environment. Although the receptor most often considered for these environmental conditions is human, sound and vibrations may also be perceived by animals in the LANL vicinity. Little is known about how different wildlife species may process these sensations, or how certain species may react to them. The vigor and well being of area wildlife and sensitive, federally protected bird populations suggests that these environmental conditions are present at levels within an acceptable tolerance range for most wildlife species and sensitive nesting birds found along the Pajarito Plateau (DOE 1999a). Ecological resources are discussed in more detail in Section 4.5.

Table 4–23 Range of Annual Airborne Radioactive Emissions from Los Alamos National Laboratory Buildings with Sampled Stacks from 1999 through 2005 (curies)

TA Building	*Tritium* [a]	*Americium-241*	*Plutonium* [b]	*Uranium* [c]	*Thorium* [d]	*P/VAP* [e]	*G-MAP* [f]	*Strontium-90*
TA-3-029	–	1.3×10^{-7} - 2.6×10^{-6}	2.1×10^{-6} - 2.1×10^{-5}	2.8×10^{-6} - 9.8×10^{-6}	1.3×10^{-7} - 1.3×10^{-6}	2.2×10^{-5} [g]	–	2.1×10^{-7} - 3.9×10^{-7}
TA-3-102	–	1.0×10^{-10} [h]	3.9×10^{-10} [i]	4.4×10^{-9} - 3.3×10^{-7}	8.0×10^{-10} - 7.2×10^{-9}	–	–	–
TA-16-205	140-7900 [j]	–	–	–	–	–	–	–
TA-21-155	66-520	–	–	–	–	–	–	–
TA-21-209	61-760	–	–	–	–	–	–	–
TA-48-001	–	–	1.7×10^{-9} [i]	6.1×10^{-10} - 6.5×10^{-9}	1.1×10^{-9} [h]	0.00023-0.017	–	–
TA-50-001	–	6.9×10^{-9} - 1.3×10^{-7}	7.4×10^{-9} - 5.1×10^{-8}	2.5×10^{-8} [i]	3.7×10^{-8} - 7.0×10^{-8}	–	–	–
TA-50-037	–	5.8×10^{-10} [i]	8.9×10^{-10} [i]	1.9×10^{-8} [k]	3.4×10^{-9} [h]	–	–	3.4×10^{-9} [h]
TA-50-069	–	5.8×10^{-11} - 7.6×10^{-10}	9.9×10^{-11} - 5.3×10^{-9}	–	1.2×10^{-10} - 1.2×10^{-9}	–	–	–
TA-53-003	0.57-1.8	–	–	–	–	3.5×10^{-10} [h]	1.7- 8.4	–
TA-53-007	0.45-7.2	–	–	–	–	0.016-60	300-18,400	–
TA-55-004	1.8-61	6.2×10^{-9} - 5.9×10^{-7}	4.3×10^{-8} - 2.5×10^{-6}	7.1×10^{-8} - 2.3×10^{-7}	3.4×10^{-8} - 1.5×10^{-7}	–	–	5.6×10^{-8} [h]

TA = technical area.
[a] Includes both gaseous and oxide forms of tritium.
[b] Includes plutonium-238, plutonium-239, and plutonium-240.
[c] Includes uranium-234, uranium-235, and uranium-238.
[d] Includes thorium-228, thorium-230, and thorium-232.
[e] P/VAP - Particulate and vapor activation products.
[f] G-MAP - Gaseous mixed activation products.
[g] Only emitted during 2005.
[h] Only emitted during 2003.
[i] Only emitted during 2002.
[j] The 7,900 curies were an unanticipated one-time release in 2001.
[k] Only emitted during 1999.
Sources: LANL 2004d, 2005h, 2006h.

Table 4–24 Average Visibility Measurements at Bandelier National Monument (1993 to 2002) [a]

Season	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
Winter	94	99	104	113	108	102	106	113	105	111
Spring	96	95	110	84	100	91	96	82	102	91
Summer	87	87	86	92	84	79	93	86	100	88
Fall	93	103	101	106	105	87	91	104	104	104

[a] Distance in miles.
Note: To convert miles to kilometers, multiply by 1.6093.
Source: LANL 2004c.

"Public noise" is the noise present outside LANL site boundaries. It is from the combined effect of the existing LANL traffic and site activities and the noise generated by activities around the Los Alamos and White Rock communities. "Worker noise" is the noise generated by DOE activities within LANL boundaries. Air blasts consist of a higher frequency portion of air pressure waves that are audible and that accompany an explosives detonation. This noise can be heard by both workers and the area public. The lower frequency portion of air pressure waves is not audible, but may cause a secondary and audible noise within a testing structure that may be heard by workers. Air blasts and most ground vibrations generated at LANL result from testing activities involving aboveground explosives research (DOE 1999a).

The forested condition of much of LANL (especially where explosives testing areas are located), the prevailing area atmospheric conditions, and the regional topography that consists of widely varied elevations and rock formations all influence how noise and vibrations can be both attenuated (lessened) and channeled away from receptors. These regional features are jointly responsible for there being little environmental noise pollution or ground vibration concerns to the area resulting from DOE operations. Sudden loud "booming" noises associated with explosives testing are similar to the sound of thunder and may occasionally startle members of the public and LANL workers alike. The human startle response is usually related to the total amounts of explosives used in the test, the prevailing atmospheric conditions, and the receptor's relative location to the source location and to channeling valleys. Although these noises are sporadic or episodic in nature, they contribute to the perception of noise pollution in the area (DOE 1999a).

Loss of large forest areas from the Cerro Grande Fire in 2000 has had an adverse effect on the ability of the surrounding environment to absorb noise. However, types of noise and noise levels associated with LANL and from activities in surrounding communities have not changed significantly as a result of the fire (DOE 2000f).

Concerns for damage that may be caused by ground vibrations as a result of explosives testing are primarily related to sensitive architectural receptors, such as the many archeological sites and historic buildings near the LANL firing ranges. The low masonry adobe or rock walls at prehistoric sites, and the nonrobust walls of what were expected to be temporary or short-term use buildings when originally constructed, could be speculated to suffer from subtle structural deterioration (fatigue damage) over time. However, field observations of eight prehistoric archeological sites in the vicinity of the firing ranges determined that none of the sites exhibited deterioration other than natural weathering (DOE 1999a).

Limited data currently exist on the levels of routine background ambient noise levels, air blasts, or ground vibrations produced by LANL operations that include explosives detonations. The following discussions of noise level limitations are provided to identify applicable regulatory limits or administrative controls regarding LANL's noise, air blast, and vibration environment; there are no regulatory, worker health protective, or maximum permissible level limitations for air blasts or ground vibrations. Available LANL noise and vibration information from specific activities is also summarized and presented (DOE 1999a).

4.4.5.1 Noise Level Regulatory Limits and Los Alamos National Laboratory Administrative Requirements

Noise generated by operations at LANL, together with the audible portions of explosives air blasts, is regulated by county ordinance and worker protection standards. The standard unit used to report sound pressure levels is the decibel (dB); the A-weighted frequency scale (db[A] or dBA) is an expression of adjusted pressure levels by frequency that accounts for human perception of loudness. Los Alamos County has promulgated a local noise ordinance that establishes noise level limits for residential land uses. Noise levels that affect residential receptors are limited to a maximum of 65 dBA during daytime hours and 53 dBA during nighttime hours (that is 9 p.m. and 7 a.m.). Between 7 a.m. and 9 p.m. the permissible noise level can be increased to 75 dBA in residential areas, provided that noise is limited to 10 minutes in any one hour. Activities that do not meet the noise ordinance limits require a permit (LANL 2004c).

Noise standards related to protecting worker hearing at LANL includes an occupational exposure limit for steady-state noise, defined in terms of accumulated daily (8-hour) noise exposure that allows for both exposure level and duration of 85 dBA (LANL 2003g). When a worker is exposed for a shorter duration, the permitted noise level is increased. LANL Administrative Requirements also limit worker impulse impact noise exposures that consist of a sharp rise in sound pressure level (high peak) followed by a rapid decay less than 1 second in duration and greater than 1 second apart. No Exposure of an unprotected ear in excess of a C-weighted peak of 140 dB is permitted (LANL 2004c).

4.4.5.2 Existing Los Alamos National Laboratory Noise, Air Blast, and Vibration Environment

Existing LANL-related publicly detectable noise levels are generated by a variety of sources, including truck and automobile movements to and from site TAs, high explosives testing, and security guards' firearms practice activities. Noise levels within Los Alamos County unrelated to LANL are generated predominately by traffic movements and, to a much lesser degree, other residential-, commercial-, and industrial-related activities within the county's communities and surrounding areas. Noise and vibration sources at LANL and noise measurements are discussed in the *1999 SWEIS* (DOE 1999a).

Although the workforce has been above the Record of Decision (ROD) projections since 1997, reaching 13,504 at the end of 2005, or about 19 percent above the projected level (LANL 2006g), the resulting increase in traffic noise levels would be less than 1 dBA and would not be expected to result in increased annoyance to the public.

Construction is an ongoing activity at LANL and there have been temporary increases in construction traffic since 1999. These increases in noise levels from construction activity and traffic at LANL have not been reported to result in increased annoyance to the public. Operation of new and modified facilities has not been reported to result in increased annoyance to the public from offsite noise impacts.

In July 1999, with the appropriate DOE authorization, the DARHT Project Office initiated DARHT facility (a High Explosive Facility) operations on the DARHT first axis. In late fall of 2000, the first major hydrotest using the DARHT first axis was completed and testing has continued. As part of the DARHT Mitigation Action Plan, DOE has undertaken a long-term monitoring program at the ancestral pueblo of Nake'muu to assess the impact of these LANL mission activities on cultural resources. Nake'muu is the only pueblo at LANL that still contains its original standing walls. It dates circa A.D. 1200 to 1325 and contains 55 rooms, with walls standing up to 6 feet (1.8 meters) high. Over the six-year monitoring program, the site has witnessed a 0.6 percent displacement rate of chinking stones and 0.2 percent displacement of masonry blocks. The annual loss rate ranges from 0.5 to 2.0 percent for the chinking stones and 0.05 to 1.3 percent for the masonry blocks. Statistical analyses indicate that these displacement rates are significantly correlated with annual snowfall, but not with annual rainfall or shots from the DARHT Facility (LANL 2004c).

4.5 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and protected and sensitive species. Each of these areas, as well as biodiversity is addressed separately below. Field investigations are an important element in the evaluation of ecological conditions at LANL. Such studies, which are conducted by LANL staff and may involve handling animals in the field, help determine species present, seasonality, density, and overall health. Special ecological studies, such as the evaluation of site wetlands, may be undertaken by outside experts.

4.5.1 Terrestrial Ecology

LANL is located in a region of diverse landform, elevation, and climate. The combination of these features, including past and present human use, has given rise to correspondingly diverse, and often unique, biological communities and ecological relationships at LANL and the region as a whole (DOE 1999a, LANL 2004c).

Five vegetation zones have been identified within LANL (see **Figure 4–25**). In general these zones result from changes in elevation, temperature, and moisture along the approximately 12-mile (19-kilometer) wide, 5,000-foot (1,500-meter) elevational gradient from the Rio Grande to the western edge of the site. The five zones include: Juniper (*Juniperus monosperma* [Engelm.] Sarg.) Savannas; Pinyon (*Pinus edulis* Engelm.)-Juniper Woodlands; Grasslands; Ponderosa Pine (*Pinus ponderosa* P. & C. Lawson) Forests; and Mixed Conifer Forests (Douglas fir [*Pseudotsuga menziesii* (Mimel) Franco], ponderosa pine, and white fir [*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.]). While Mixed Conifer Forests are prevalent at higher elevations to the west of LANL, within the site this vegetation zone is restricted to cooler north-facing canyons walls. This diversity in vegetative communities has resulted in the presence of over 900 species of vascular plants. There is a comparable diversity in regional wildlife with 57 species of mammals, 200 species of birds, 28 species of reptiles, 9 species of amphibians, and over 1,200 species of arthropods having been identified (DOE 1999a, LANL 2004c).

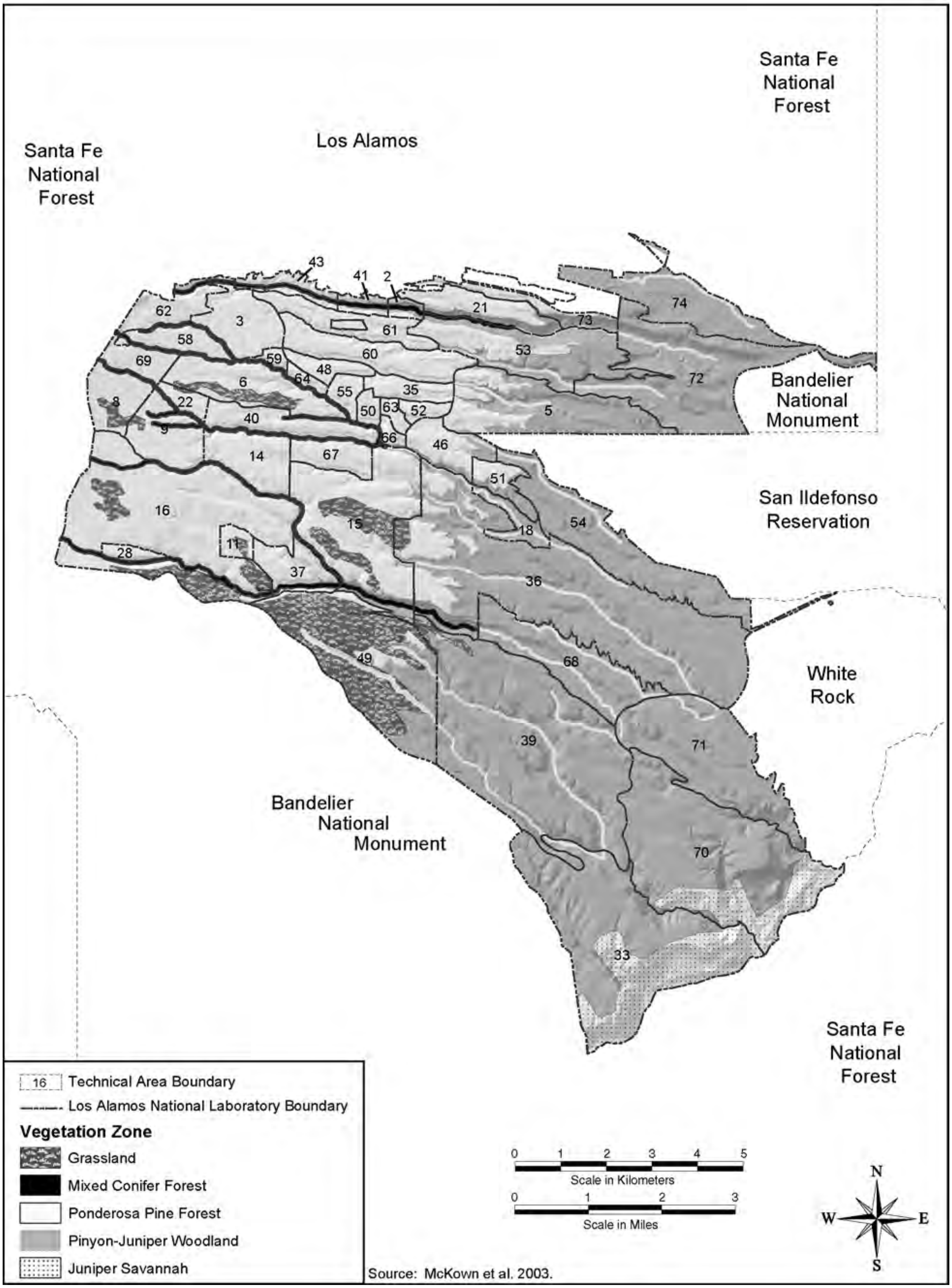


Figure 4–25 Los Alamos National Laboratory Vegetation Zones

Impacts to site terrestrial resources since publication of the *1999 SWEIS* have resulted from construction of new facilities, the Cerro Grande Fire, a bark beetle outbreak, and the conveyance and transfer of land. Major construction projects conducted between 1998 and 2003 have affected somewhat less than 100 acres (40 hectares) of previously undeveloped land. Impacts associated with this development include the loss of habitat and associated wildlife. In 2000, the Cerro Grande Fire burned 43,000 acres (17,400 hectares), including about 7,700 acres (3,110 hectares) on LANL (Balice, Bennett, and Wright 2004). Direct impacts on terrestrial resources included a reduction in habitat and the loss of wildlife (DOE 2000f). Fire mitigation work, such as flood retention facilities, affected about 50 acres (20 hectares) of undeveloped land (LANL 2005f). Additionally, about 9,950 acres (4,027 hectares) of forest have been thinned between 1997 and 2005 to reduce future wildfire potential (LANL 2006a). Thinning also creates a forest that appears more park-like with an increase in the diversity of shrubs, herbs, and grasses in the understory (Loftin 2001). An Interagency Wildfire Management Team, established in the late 1990s addresses continuing wildfire management and mitigation issues such as placement of fuel fire roads and breaks across the Pajarito Plateau (Webb and Carpenter 2001). There has been a decrease in elk (*Cervus elaphus*)-vehicle collisions since the fire. This is likely related to the amount of forage in burned areas west of LANL, as well as a lack of snowfall during the drought period. These factors have resulted in elk remaining at higher elevations away from major roadways (Sherwood, Biggs, and Hansen 2004).

Within two years of the Cerro Grande Fire a bark beetle outbreak occurred that resulted in 95 percent mortality of pinyon pine trees and 12 percent mortality of ponderosa pine trees across the Pajarito Plateau by the end of 2004. At lower elevations of the Mixed Conifer Forest Vegetation Zone on north-facing slopes of the canyons, up to 100 percent of the Douglas fir trees were also killed by the drought. The infestation could result in an increase in runoff, herbaceous growth, and the potential for wildfire. It would also be expected to impact wildlife populations. While at least partially the result of the fire, the bark beetle outbreak appears to be more a consequence of stress resulting from drought conditions and historical overstocking (LANL 2005f). Although precipitation was above average during much of 2005, there was a return to drought conditions toward the end of the year (LANL 2006h).

As noted in Section 4.1.1, approximately 2,259 acres (914 hectares) have been conveyed to Los Alamos County or transferred to the Department of the Interior to be held in trust for the Pueblo of San Ildefonso (LANL 2004c). This has reduced the size of LANL to about 25,600 acres (10,360 hectares). Much of the transferred land is in a natural state and falls within the Pinyon-Juniper Woodland and Ponderosa Pine Forest Vegetation Zones. To date, little of this land has been developed, although future development could result in both direct and indirect impacts to terrestrial habitats and species.

4.5.2 Wetlands

Wetlands are defined as, "Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Specific diagnostic criteria used by the U.S. Army Corps of Engineers to identify wetlands include vegetation, soil, and hydrology; these are spelled out in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

Approximately 34 acres (13.8 hectares) of wetlands have been identified within LANL boundaries during a survey in 2005 with 45 percent of these located in Pajarito Canyon. Dominant wetland plants found in site wetlands include reed canary grass (*Phalaris arundinacea* L.), narrow-leaf cattail (*Typha angustifolia* L.), coyote willow (*Salix exigua* Nutt.), Baltic rush (*Juncus balticus* Wildl.), wooly sedge (*Carex lanuginose* Michx.), American speedwell (*Veronica americana* Schwein. ex Benth.), common spike rush (*Eleocharis macrostachya* Britt.), and curly dock (*Rumex crispus* L.) (ACE 2005). Wetlands in the LANL region are primarily associated with canyon stream channels or are present on mesas, often in association with springs, seeps, or effluent outfalls. Cochiti Lake and the area near the LANL Fenton Hill site (TA-57) support lake-associated wetlands. There are also some springs within White Rock Canyon that support wetlands. Wetlands in the general LANL region provide habitat for reptiles, amphibians, and invertebrates, and potentially contribute to the overall habitat requirements of a number of species, including sensitive species (LANL 2004c, DOE 1999a).

The *1999 SWEIS* reported that there were 50 acres of wetlands on LANL. However, many of the outfalls with which these wetlands were associated have been closed or re-routed and the wetlands no longer exist. A further explanation for the difference in wetland acreage found in 1999 is that the methodology used in the past included as wetlands waters of the United States (ACE 2005). These channel areas were not delineated in the present survey as wetlands since they do not meet the criteria of the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

During the Cerro Grande Fire, 16 acres (6.5 hectares) of the wetlands on LANL were burned at a low or moderate intensity. No wetlands within LANL were severely burned. Some riparian areas along the drainages also burned during the fire; however, these are not wetlands and are not included in the total acres of wetland. In addition to direct impacts from the fire, wetlands could receive increased sediment from stormwater runoff. While small amounts of sediment from the burned areas would enhance wetland growth, large amounts of deposited sediment could permanently alter the condition of existing wetlands and destroy them. The effects of the Cerro Grande Fire on LANL wetlands have yet to be fully assessed (DOE 2000f).

Fire suppression did not result in any direct impacts to wetlands since fire roads or breaks were not placed in wetlands. While construction of stormwater control projects following the fire resulted in minor impacts to wetlands (for example, culvert cleaning downstream from TA-18), these actions will protect downstream wetlands from erosion (DOE 2000f). Water retention structures built in drainages following the fire could develop wetland characteristics over time; however, with the ongoing drought, they have not yet been defined as wetlands (LANL 2006a).

To date, all or portions of 8 tracts have been conveyed or transferred to Los Alamos County and the Department of the Interior to be held in trust for the Pueblo of San Ildefonso (see Table 4–2). These tracts contain a total of about 9 acres (3.6 hectares) of wetlands, including stream channels. Although these wetlands are still protected by Federal and state regulations, they are no longer under the control of DOE. To date, there has been no change in the status of these wetlands because development has not taken place; however, future development could result in a direct loss of wetland structure and function and a potential increase in downstream and offsite sedimentation (DOE 1999d).

4.5.3 Aquatic Resources

The watersheds draining the Jemez Mountains and the Pajarito Plateau are tributary to the Rio Grande, the fifth largest watershed in North America. Approximately 11 miles (18 kilometers) of the eastern boundary of LANL border the rim of White Rock Canyon or descend to the Rio Grande. The riverine, lake, and canyon environment of the Rio Grande as it flows through White Rock Canyon makes a major contribution to the biological resources and significantly influences ecological processes of the LANL region. The construction of Cochiti Dam at the mouth of White Rock Canyon for flood and sediment control, recreation, and fish and wildlife purposes in the late 1960s, has significantly changed the features of White Rock Canyon and introduced new ecological components and processes. Twelve species of fish (found in the Rio Grande, Cochiti Lake, and the Rito de los Frijoles) have been identified in the LANL region (DOE 1999a, LANL 2004c).

While the Rio Grande and Rito de los Frijoles in Bandelier National Monument are the only truly perennial streams in the immediate vicinity, many canyon floors contain reaches of perennial surface water, such as the streams draining LANL property from lower Pajarito and Ancho Canyons to the Rio Grande. No fish species have been found within LANL boundaries (DOE 1999a, LANL 2004c). Actions taken since publication of the *1999 SWEIS* have not affected site aquatic resources.

4.5.4 Protected and Sensitive Species

The presence and use of LANL by protected and sensitive species is influenced not only by the actual presence and operation of the facility, but by management of contiguous lands and resources, and, importantly, by years of human use. A number of special status species have been documented on LANL or in the immediate vicinity (see **Table 4–25**). Federally listed wildlife includes 2 endangered species, 2 threatened species, 1 candidate, and 8 species of concern. New Mexico protected and sensitive plants and animals include 3 endangered species, 7 threatened species, 2 species of concern, and 14 sensitive species. Additionally, 18 species of birds are listed as birds of conservation concern. Information related to the occurrence of these species within the LANL region is included in the table. Changes that have occurred in the number of protected and sensitive species since publication of the *1999 SWEIS* have resulted from changes in the Federal and state lists and more complete data on species occurrence acquired by LANL biologists.

Table 4–25 Protected and Sensitive Species

Common Name	*Scientific Name*	*Status* [a]		*Notes*
		Federal	*State*	
Plants				
Sapello Canyon larkspur	*Delphinium sapellonis* (Tidestrom)		Species of Concern	
Springer's blazing star	*Mentzelia springeri* (Standley) Tidestrom		Species of Concern	
Wood lily (Mountain lily)	*Lilium philadelphicum* L. var. *anadinum* (Nutt.) Ker		Endangered	Observed on Los Alamos County, Bandelier National Monument, and Santa Fe National Forest lands
Yellow lady's slipper orchid	*Cyprepedium calceolus* L. var. *pubescens* (Willd.) Correll		Endangered	Observed on Bandelier National Monument lands
Insects				
New Mexico silverspot butterfly	*Speyeria nokomis nitocris*	Species of Concern		
Fish				
Rio Grande chub	*Gila pandora*		Sensitive	
Amphibians				
Jemez Mountain salamander	*Plethodon neomexicanus*	Species of Concern	Threatened	Permanent resident, Los Alamos County, Bandelier National Monument, and Santa Fe National Forest lands
Birds				
American peregrine falcon	*Falco peregrinus anatum*	Species of Concern, Conservation Concern	Threatened	Forages on LANL, nests and forages on adjacent lands
Arctic peregrine falcon	*Falco peregrinus tundrius*	Species of Concern, Conservation Concern	Threatened	
Bald Eagle	*Haliaeetus leucocephalus*	Threatened	Threatened	Observed as a migratory and winter resident along Rio Grande and adjacent LANL lands
Bendire's thrasher	*Toxostoma bendirei*	Conservation Concern		
Black-throated gray warbler	*Dendroica nigrescens*	Conservation Concern		
Crissal thrasher	*Toxostoma crissale*	Conservation Concern		
Feruginous hawk	*Buteo regalis*	Conservation Concern		Considered accidental or transient on Bandelier National Monument
Flammulated owl	*Otus flammeolus*	Conservation Concern		Permanent resident on LANL
Graces's warbler	*Dendroica graciae*	Conservation Concern		

Common Name	Scientific Name	Status [a]		Notes
		Federal	State	
Golden eagle	*Aquila chrysaetos*	Conservation Concern		Has been known to nest in the Los Alamos area, but not found every year
Gray vireo	*Vireo vicinior*	Conservation Concern	Threatened	Considered accidental or transient on Bandelier National Monument
Lewis's woodpecker	*Melanerpes lewis*	Conservation Concern		Breeding resident on LANL
Loggerhead shrike	*Lanius ludovicianus*		Sensitive	Considered accidental or transient on Bandelier National Monument
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Sensitive	Breeding resident on LANL, Los Alamos County, Bandelier National Monument, and Santa Fe National Forest lands; critical habitat designated on Santa Fe National Forest lands
Northern goshawk	*Accipiter gentilis*	Species of Concern	Sensitive	Observed as a breeding resident on Los Alamos County, LANL, Bandelier National Monument, and Santa Fe National Forest lands
Northern harrier	*Circus cyaneus*	Conservation Concern		Considered rare or occasional on Bandelier National Monument
Pinyon jay	*Gymnorhinus cyanocephalus*	Conservation Concern		Breeding resident on LANL
Prairie falcon	*Falco mexicanus*	Conservation Concern		
Sage sparrow	*Amphispiza belli*	Conservation Concern		Breeding resident on LANL
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	Endangered	Present on LANL and White Rock Canyon, Jemez Mountains, and near Española; potential nesting area on LANL
Virginia's warbler	*Vermivora virginiae*	Conservation Concern		Breeding resident on LANL
Williamson's sapsucker	*Sphyrapicus thyroideus*	Conservation Concern		Breeding resident on LANL
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate, Conservation Concern	Sensitive	Has been recorded along Rio Grande, adjacent to LANL
Mammals				
Big free-tailed bat	*Nyctinomops macrotis*		Sensitive	Migratory visitor on Bandelier National Monument and Santa Fe National Forest lands; breeding resident on Los Alamos County
Black-footed ferret	*Mustella nigripes*	Endangered		
Fringed myotis	*Myotis thysanodes*		Sensitive	Breeding resident on LANL

Common Name	Scientific Name	Status [a]		Notes
		Federal	State	
Goat Peak pika	*Ochotona princeps nigrescens*	Species of Concern	Sensitive	Observed on Los Alamos County and Bandelier National Monument lands
Long-eared myotis	*Myotis evotis*		Sensitive	Breeding resident on LANL
Long-legged myotis	*Myotis volans*		Sensitive	Breeding resident on LANL
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*	Species of Concern	Threatened	Permanent resident on Bandelier National Monument and Santa Fe National Forest lands; overwinters by hibernating
Ringtail	*Bassariscus astutus*		Sensitive	Observed in Los Alamos County
Spotted bat	*Euderma maculatum*		Threatened	Seasonal resident on LANL, Bandelier National Monument, and Santa Fe National Forest lands
Townsend's big-eared bat	*Plecotus townsendii*	Species of Concern	Sensitive	Seasonal resident on LANL
Western small-footed myotis	*Myotis ciliolabrum*		Sensitive	Seasonal resident on LANL
Yuma myotis	*Myotis yumanensis*		Sensitive	Summer resident on LANL, Los Alamos County, and Santa Fe National Forest lands

[a] Status:

Endangered:

Federal – in danger of extinction throughout all or a significant portion of its range.

State – Animal: any species or subspecies whose prospects of survival or recruitment in New Mexico are in jeopardy.

– Plant: a taxon listed as threatened or endangered under provision of the Federal Endangered Species Act, or is considered proposed under the tenets of the Act, or is a rare plant across its range within the State, and of such limited distribution and population size that unregulated taking could adversely impact it and jeopardize its survival in Mexico.

Threatened:

Federal – likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

State – Animal: any species or subspecies that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico.

– Plant: New Mexico does not list plants as threatened.

Candidate: Substantial information exists in U.S. Fish and Wildlife Service files on biological vulnerability to support proposals to list as endangered or threatened.

Conservation Concern: Migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act.

Sensitive: Those taxa that, in the opinion of a qualified New Mexico Department of Game and Fish biologist, deserve special consideration in management and planning, and are not listed as threatened or endangered by the State of New Mexico.

Species of Concern:

Federal – conservation standing is of concern, but status information is still needed; they do not receive recognition under the Endangered Species Act.

State – a New Mexico plant species, which should be protected from land use impacts when possible because it is a unique and limited component of the regional floral.

Sources: LANL 2004c, 2006a, NMAC 19.21.2, NMDGF 2004a, 2004b, NMNHP 2004, NMSF 2004, USFWS 2002, 2004a, 2004b.

A brief summary discussion of the Federal and state endangered and threatened species is provided below. The reader is referred to the *1999 SWEIS* for more detailed information on these and other species presented in Table 4–25. DOE coordinates with the New Mexico Department of Game and Fish and the U.S. Fish and Wildlife Service to locate and conserve protected and sensitive species.

LANL's Habitat Management Plan Summary

The LANL *Threatened and Endangered Species Habitat Management Plan* was developed to provide protection for threatened and endangered species that may reside on or use LANL property, as well as facilitating the implementation of DOE's mission at LANL. The three goals of the Plan are to: 1) develop a comprehensive management plan that protects undeveloped portions of LANL that are suitable or potentially suitable habitat for threatened and endangered species, while allowing current operations to continue and future development to occur with a minimum of project or operational delays or additional costs related to protecting species or their habitats; 2) facilitate DOE compliance with the Endangered Species Act and related Federal regulations by protecting and aiding in the recovery of threatened and endangered species; and 3) promote good environmental stewardship by monitoring and managing threatened and endangered species and their habitats using sound scientific principles. The Plan consists of Areas of Environmental Interest, Site Plans, and Monitoring Plans. Areas of Environmental Interest consist of a core area that contains important breeding or wintering habitat for a specific species and a buffer area around the core area. The Site Plans contain descriptions of individual species, the Area of Environmental Interest for that species, and current impacts in the Area Environmental Interest. Monitoring Plans describe the methodology used to determine if Federally listed species are present at LANL and may be designed to estimate reproduction, abundance, and distribution of the species at LANL.

The wood lily (*Lilium philadelphicum* L. var. *anadinum* (Nutt.) Ker) and yellow lady's slipper orchid (*Cyprepedium calceolus* L. var. *pubescens* (Willd.) Correll) are both listed as endangered in New Mexico. The wood lily grows in ponderosa pine, mixed-conifer, and spruce-fir forests and requires riparian areas. This plant has been observed on Los Alamos County, Bandelier National Monument, and Santa Fe National Forest lands. The yellow lady's slipper orchid, which grows in mixed-conifer forests, also requires riparian areas with moist soil conditions. It has been observed within the Bandelier National Monument (DOE 1999a).

The southwestern willow flycatcher (*Empidonax traillii extimus)* (federally and state-listed as endangered) occurs in riparian habitats along rivers, streams, or wetlands. Potential suitable nesting for this habitat species is present on LANL but is limited to a single canyon area. The southwestern willow flycatcher has been observed at higher elevations in the Jemez Mountains west of LANL and at lower elevations along the Rio Grande in the vicinity of Española. A migrant willow flycatcher was identified by song on LANL once during May 1997 and 2005. However, the willow flycatcher discovered on LANL cannot be confirmed to belong to the southwestern race (DOE 1999a, LANL 2006a).

The black-footed ferret (*Mustella nigripes*), which is listed as endangered by the U.S. Fish and Wildlife Service, was last reported in New Mexico in 1934. This species, which requires greater than 80 acres (32 hectares) of prairie dog towns (for its prey base), has a low potential of occurrence on LANL since no large prairie dog towns occur on the site (Keller and Koch 2001).

The Jemez Mountain salamander (*Plethodon neomexicanus*) is listed as threatened in New Mexico. It can be found in mixed-conifer forests and requires north-facing moist slopes. It is a permanent resident in Los Alamos County, Bandelier National Monument, and Santa Fe National Forest (DOE 1999a).

Two federally threatened birds, the bald eagle (*Haliaeetus leucocephalus*) and Mexican spotted owl (*Strix occidentalis lucida*), are found in the LANL region. State-listed threatened birds found in the area include the peregrine falcon (*Falco peregrinus*) (both subspecies), bald eagle, and gray vireo (*Vireo vicinior*). The bald eagle has been observed as a migratory and winter resident along the Rio Grande and on adjacent LANL lands. The Mexican spotted owl prefers tall, old-growth forest in canyons and moist areas for breeding. It is found in mixed conifer and ponderosa forests and is a breeding resident on LANL, Los Alamos County, Bandelier National Monument, and Santa Fe National Forest lands (DOE 1999a). Mexican spotted owls were recorded breeding on LANL from 1994 through 1999 and in 2005. Although adult birds were seen, there was no recorded breeding between 2000 and 2004 after the Cerro Grande fire. In 2004, a resident Mexican spotted owl was confirmed in the north-central part of LANL; however the nesting status of this bird was not determined. In 2005, a second occupied territory in the southwestern portion of LANL was confirmed to have a nesting pair and three young were fledged (LANL 2006a). The peregrine falcon, which requires cliffs for nesting, has been found within juniper savannah and pinyon-juniper, ponderosa pine, and mixed-conifer forests. It forages on LANL and nests and forages on adjacent lands. The gray vireo uses riparian areas in juniper savannah and pinyon-juniper forests. It has been observed on Bandelier National Monument.

Two state-threatened mammals have been found in the LANL area. These include the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) and spotted bat (*Euderma maculatum*). The former is found in mixed-conifer and spruce-fir forests and requires riparian areas. It is a permanent resident on Los Alamos County and Santa Fe National Forest lands. The spotted bat is found in pinyon-juniper woodland, ponderosa pine forest, and spruce-fir forest. It roosts in cliffs near water. This species is a seasonal resident on Bandelier National Monument and Santa Fe National Forest; it is a seasonal resident on LANL (DOE 1999a).

Habitat that is either occupied by federally protected species or that is potentially suitable for use by these species in the future has been delineated within LANL; occupied habitat is protected as if it were critical habitat[4] for the species. The *Los Alamos Threatened and Endangered Species Habitat Management Plan*, implemented in 1999, identifies Areas of Environmental Interest for various federally listed threatened or endangered species. In general, an Area of Environmental Interest consists of a core area that contains important breeding or wintering habitat for a specific species and a buffer area around the core area. The buffer protects the core area from disturbances that would degrade its value. Areas of Environmental Interest have been established at LANL for the Mexican spotted owl, bald eagle, and southwestern willow flycatcher (LANL 1998c). Recently, changes in the boundaries for all Mexican Spotted Owl Area of Environmental Interest have been approved by the U.S. Fish and Wildlife Service. These changes, which were made in response to implementation of a new habitat model, resulted in the removal of some areas from the Areas of Environmental Interest and the addition of other areas.

---

[4] *Critical habitat = specific areas occupied by a species on which are found those physical and biological features essential to its conservation and which may require special management consideration or protection. These areas are designated by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973.*

Areas of Environmental Interest have not been established for the black-footed ferret, since suitable habitat for this species does not occur at LANL (DOE 2003d).

Although many of the Mexican spotted owl Areas of Environmental Interest received moderate- and low-severity burns, part of the Sandia-Mortandad Area of Environmental Interest was severely burned during the Cerro Grande Fire. Habitat within the southwestern willow flycatcher and bald eagle Area of Environmental Interest did not burn (DOE 2000f). There is no evidence that the fire caused a long-term change to the overall number of federally listed threatened or endangered species inhabiting the region. LANL's species of greatest concern, the Mexican spotted owl, was seen within weeks of the fire and in all subsequent breeding seasons; however, there was no recorded breeding between 2000 and 2004. It was not until 2005 that a nested pair was observed. Some State-listed species, including the Jemez Mountain salamander (*Plethodon neomexicanus*), have undoubtedly been less fortunate and recovery of the species to pre-fire levels may take a long time (LANL 2003h, 2006a).

As noted above (see Section 4.1.1), 2,259 acres (914 hectares) have been conveyed to Los Alamos County and transferred to the Department of the Interior to be held in trust for the Pueblo of San Ildefonso. Some of the areas that have been turned over to these two entities have Areas of Environmental Interest for the Mexican spotted owl. However, the *LANL Threatened and Endangered Species Habitat Management Plan* (LANL 1998c), under which the Areas of Environmental Interest are designated, is no longer in effect for conveyed or transferred land (DOE 1999d).

4.5.5 Biodiversity

Biodiversity refers to the variety and variability among living organisms and the ecological complexes in which they occur (EPA 2005c). The major human-caused disturbance factors, which are addressed in detail in the *1999 SWEIS* and identified by the Council on Environmental Quality as responsible for the decline in biodiversity at multiple scales, including global, regional, and site-specific scales, are the following:

- Physical alteration of the landscape,
- Over harvesting,
- Disruption of natural processes, such as flooding and fires,
- Introduction of nonnative (exotic) species,
- Pollution, and
- Global climate change (which is considered outside the scope of this analysis).

Since publication of the *1999 SWEIS*, development at LANL, the Cerro Grande Fire, the conveyance and transfer of land, the drought, and the bark beetle outbreak have all had (or have the potential to have) an effect on biodiversity. For example, development has reduced available habitat and fragmented the environment, thereby altering the composition of wildlife populations present on the site. Further, these factors may have broad scale detrimental impacts on soil erosion. The introduction of non-native plant species (also called exotic plants) can result from the elimination of native species through land disturbance. Presently there are 150 exotic plants growing at LANL. Certain actions initiated at LANL and at other land-management area across the Pajarito Plateau could act to positively affect the environment. For example, the thinning of forests will create a woodland environment closer to the one that existed prior to the advent of fire suppression activities in the 1890s, which may serve to attract a more diverse animal population back into the area.

Pollution impacts on ecosystems include direct lethal, sub-lethal, and reproductive effects (including those resulting from bioaccumulation) and degradation of habitat. Sub-lethal effects of environmental contamination may indirectly cause mortality at widely varying temporal scales and on widely varying levels of ecological organization. Possible mechanisms include immunological effects enhancing susceptibility to disease, alteration of nutrient cycles through effects on bioavailability or uptake mechanisms, metabolic effects, and behavior modification affecting ability to feed, hunt, avoid predation, or breed. The contribution of pollutants to environmental media by LANL operations is due primarily to past practices. Long-term monitoring of soils, sediment, water, and air, as well as biomonitoring, have not demonstrated levels of contaminants that would pose a health risk, nor have there been obvious toxic effects observed. There is no evidence of any contaminants originating at LANL that would pose a risk to recreational fishing in the Rio Grande and downstream of Cochiti Lake (LANL 2004c). Monitoring data for a variety of environmental media are published annually in the site Environmental Surveillance Reports (LANL 2002d, 2004a, 2004d, 2005h, 2006h).

4.6 Human Health

The following sections summarize current information on public and worker health in and around LANL. The methods that are in place to monitor and reduce the risks to the public and workers from all hazards are described in the *1999 SWEIS* (see Chapter 4, Sections 4.6.1 and 4.6.2).

4.6.1 Public Health in the Los Alamos National Laboratory Vicinity

4.6.1.1 Cancer Incidence and Mortality in the Los Alamos Region

The *1999 SWEIS* presented a detailed discussion of cancer incidence and mortality in the Los Alamos region, based on national and regional statistics through about 1995. The *1999 SWEIS* summarized National Cancer Institute data for the State of New Mexico and its counties, as well as the results of independent studies conducted to investigate reported increased incidence of specific cancers in Los Alamos County and the surrounding communities. This section presents a summary of cancer incidence and mortality figures for the Los Alamos region as derived from the most recent data made available by the National Cancer Institute (through 2003).

Table 4–26 presents a summary of total cancer mortality, incidence of all cancers, and incidence of selected cancer types for the State of New Mexico, as well as Los Alamos, Santa Fe, Sandoval, and Rio Arriba Counties, for the period 1999 through 2003. During that period, the overall cancer incidence (412.2) and death rates (171.1) for the State of New Mexico were somewhat below the national average (462.2 and 195.7, respectively). Total cancer incidence in Los Alamos County (434.9) and two of the three contiguous counties exceeded the State average, although the rates in all four counties were below the national averages. As reported in the 1993

Los Alamos Cancer Rate Study (Athas and Key 1993), the incidence rates of melanoma of the skin, prostate cancer, and female breast cancer remain elevated in Los Alamos County with respect to the State averages. The rate of thyroid cancer also exceeded the State average for the period. Cancers of the lung, colon, and rectum occurred at rates below the State averages. Due to the small number of reported cases and resulting statistical unreliability of the data, the rates of non-Hodgkin's lymphoma, ovarian cancer, brain cancer, leukemia, and stomach cancer in Los Alamos County were not reported by the National Cancer Institute (NCI 2006).

Table 4–26 Five-Year Profile of Cancer Mortality and Incidence in the United States, New Mexico, and Los Alamos Region, 1999 through 2003 [a]

Statistic	*United States* [b]	*New Mexico*	*Los Alamos County*	*Santa Fe County*	*Sandoval County*	*Rio Arriba County*
Average Deaths Per Year	554,165	2,966	25	178	140	60
Annual Death Rate (per 100,000)	195.7 (195.5, 196.0)	171.1 (168.4, 173.9)	132.3 (109.5, 160.1)	147.7 (138.0, 158.0)	169.2 (156.9, 182.3)	163.4 (145.3, 183.3)
Annual Incidence Rate (per 100,000)						
All sites [c]	462.2 (461.4, 463.0)	412.2 (408.0, 416.5)	434.9 (394.0, 480.4)	478.1 (461.1, 495.5)	444.8 (424.9, 465.4)	337.0 (311.4, 364.3)
Brain and Other Nervous System	6.5 (6.4, 6.6)	5.6 (5.1, 6.1)	NA [d]	6.0 (4.3, 8.3)	4.7 (2.9, 7.3)	NA [d]
Breast (female)	124.9 (124.4, 125.5)	115.0 (112.0, 118.1)	127.2 (98.7, 165.7)	155.4 (142.9, 168.8)	123.6 (109.8, 138.7)	89.0 (72.0, 109.0)
Colon and Rectum	52.0 (51.7, 52.3)	42.9 (41.5, 44.3)	39.8 (28.0, 56.8)	44.2 (39.0, 49.8)	50.8 (44.2, 58.1)	40.6 (32.0, 50.9)
Leukemia	11.3 (11.2, 11.4)	12.5 (11.7, 13.2)	NA [d]	19.7 (16.3, 23.5)	13.3 (10.0, 17.3)	7.8 (4.4, 12.9)
Lung and Bronchus	67.5 (67.2, 67.8)	46.9 (45.5, 48.4)	28.5 (18.8, 43.7)	42.0 (36.9, 47.6)	48.1 (41.7, 55.4)	32.4 (24.6, 42.0)
Melanoma of Skin	16.6 (16.4, 16.7)	17.3 (16.4, 18.2)	29.6 (20.0, 44.4)	23.6 (20.0, 27.7)	19.1 (15.2, 23.6)	NA [d]
Non-Hodgkin's Lymphoma	18.4 (18.2, 18.5)	15.6 (14.7, 16.4)	NA [d]	19.8 (16.4, 23.7)	17.9 (14.0, 22.5)	12.6 (8.0, 19.1)
Ovary	13.1 (12.9, 13.2)	13.0 (12.0, 14.1)	NA [d]	15.3 (11.5, 20.1)	12.1 (8.1, 17.5)	NA [d]
Prostate	161.2 (160.4, 161.9)	152.2 (148.3, 156.1)	244.7 (202.4, 296.6)	198.3 (182.0, 216.1)	158.0 (140.3, 177.7)	151.4 (126.6, 180.2)
Stomach	7.1 (7.0, 7.2)	7.1 (6.5, 7.7)	NA [d]	7.1 (5.1, 9.7)	7.3 (5.0, 10.4)	12.1 (7.6, 18.6)
Thyroid	8.2 (8.1, 8.3)	10.2 (9.5, 10.9)	19.5 (11.3, 33.5)	10.8 (8.4, 13.6)	13.7 (10.5, 17.6)	12.6 (8.1, 18.9)

NA = not available.
[a] Age-adjusted incidence rates. 95 percent confidence interval in parentheses.
[b] The U.S. average number of deaths and annual death rate reported by the National Cancer Institute are for the entire 1999 through 2003 rate period. The U.S. annual incidence rates reported by the National Cancer Institute are for the year 2002.
[c] All cancers, all races, both sexes.
[d] Data not available. When the number of reported cases is small, some data are suppressed in National Cancer Institute reports to ensure confidentiality and stability of rate estimates.
Source: NCI 2006.

In a study entitled *Public Health Assessment, Final, Los Alamos National Laboratory*, the ATSDR of the U.S. Department of Health and Human Services Public Health Service reported on its review of possible public exposures to radioactive materials and other toxic substances in the environment near LANL (ATSDR 2006). The study also examined the results of the *Los Alamos Cancer Rate Study* (Athas and Key 1993), and a related work entitled *Investigation of Excess Thyroid Cancer Incidence in Los Alamos County* (Athas 1996), and determined that there were no data to link environmental factors, other than naturally occurring ultraviolet light from the sun, with the observed incidence of any cancer in Los Alamos County. The ATSDR report concluded that, “Overall, cancer rates in the Los Alamos area are similar to cancer rates found in other communities. In some time periods, some cancers will occur more frequently and others less frequently than seen in reference populations. Often, the elevated rates are not statistically significant.”

4.6.1.2 Radiation in the Environment around Los Alamos National Laboratory

Radiation in the environment around LANL is attributed to external, naturally-occurring radiation and from past and present operations at LANL. External radiation comes from two sources that are approximately equal: cosmic radiation from space and terrestrial gamma radiation from radionuclides naturally in the environment. Doses from cosmic radiation range from 50 millirem per year at lower elevations near the Rio Grande to about 90 millirem per year in the mountains. Doses from terrestrial radiation range from 50 to 150 millirem per year depending on the amounts of natural uranium, thorium, and potassium in the soil.

The largest dose from radioactive material is from the inhalation of naturally occurring radon and its decay products, which contribute about 200 millirem per year. An additional 40 millirem per year results from naturally-occurring radioactive materials in the body, primarily potassium-40, which is present in all food and in all living cells.

In addition, members of the U.S. population receive an average dose of 50 millirem per year from medical and dental uses of radiation, 10 millirem per year from manmade products such as stone and adobe walls, and less than 1 millirem per year from global fallout from nuclear weapons tests. Because of the above factors, published estimates of the background doses received by people in the area around LANL generally give a range of rounded values, from a low of about 300 to a high of about 500 millirem per year (LANL 2006h). For this reason, the background dose varies and, for the purpose of this SWEIS, the typical LANL area resident is assumed to receive a dose near the middle of this range (approximately 400 millirem per year) from background sources.

Radiological Emissions Standards

Federal Government standards limit the dose that the public may receive from LANL operations. The DOE public dose limit to any individual from LANL operations is 100 millirem per year received from all pathways (that is, all ways in which people can be exposed to radiation, such as inhalation, ingestion, and direct radiation). The dose received from airborne emissions of radionuclides is further restricted by the EPA dose standard of 10 millirem per year (40 CFR Part 61). These doses are in addition to exposures from natural background, consumer products, and medical and dental radiation.

Radiological Dose Assessment

The LANL Environmental Surveillance and Compliance Program oversees the monitoring of the site and surrounding region foodstuffs, air, water, and soil for radiation, radioactive materials, and hazardous chemicals. The information is used for continually determining time trends and to assess potential risks to human health and the environment. The information is published annually in the LANL environmental surveillance report.

The *1999 SWEIS* provided a dose assessment as reported in the LANL *Environmental Surveillance and Compliance at Los Alamos During 1996* (LANL 1997c). The dose assessment provided below was reported in *Environmental Surveillance at Los Alamos During 2005* (LANL 2006h).

Doses, calculated and reported in the LANL Environmental Surveillance and Compliance Reports are incremental (above background) doses caused by operations at LANL. Annual radiation doses to the public are evaluated for three principal exposure pathways: inhalation, ingestion, and direct (external) radiation. Doses for the following cases are calculated:

- The entire population within 50 miles (80 kilometers) of the site,
- The maximally exposed individual (MEI) who is not on LANL or DOE property (referred to as the offsite MEI),
- Residents in the Los Alamos Townsite and White Rock.

The doses from the first two cases above, for the past 13 years, are shown in **Figures 4–26** and **4–27**. The two graphs are similar because LANSCE is the major contributor to both. Generally, the year-to-year fluctuations are the result of variations in the number of hours that LANSCE operates, whereas the downward trend is the result of efforts to reduce LANSCE emissions by installing delay lines and fixing small leaks. The increase in 2005 occurred because LANSCE operational time was over twice the 2004 level and a valve in the LANSCE emissions control system was defective.

In addition, offsite doses to individuals from water ingestion, food ingestion, and direct exposure from soil contamination are calculated based on measurements of radionuclide concentrations in groundwater, surface water, sediments, surface soil, and radioactive content of foods.

Population within 50 Miles (80 kilometers)

The distribution of population has changed since the *1999 SWEIS*. Details are shown in **Table 4–27**. There is an increase in the total population within a 50-mile (80-kilometer) radius of LANSCE (TA-53). The effects on the population dose and accident analyses of the shift in population will vary based on the meteorology of the area and which radionuclides are dominating the assessment.

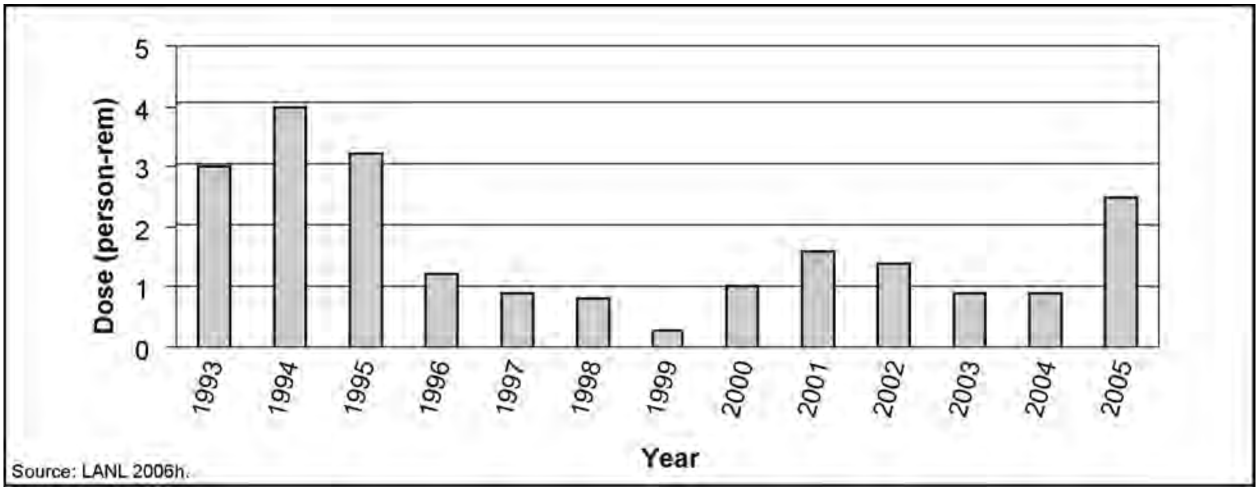


Figure 4–26 Annual Collective Dose (person-rem) to the Population within 50 Miles (80 kilometers) of Los Alamos National Laboratory

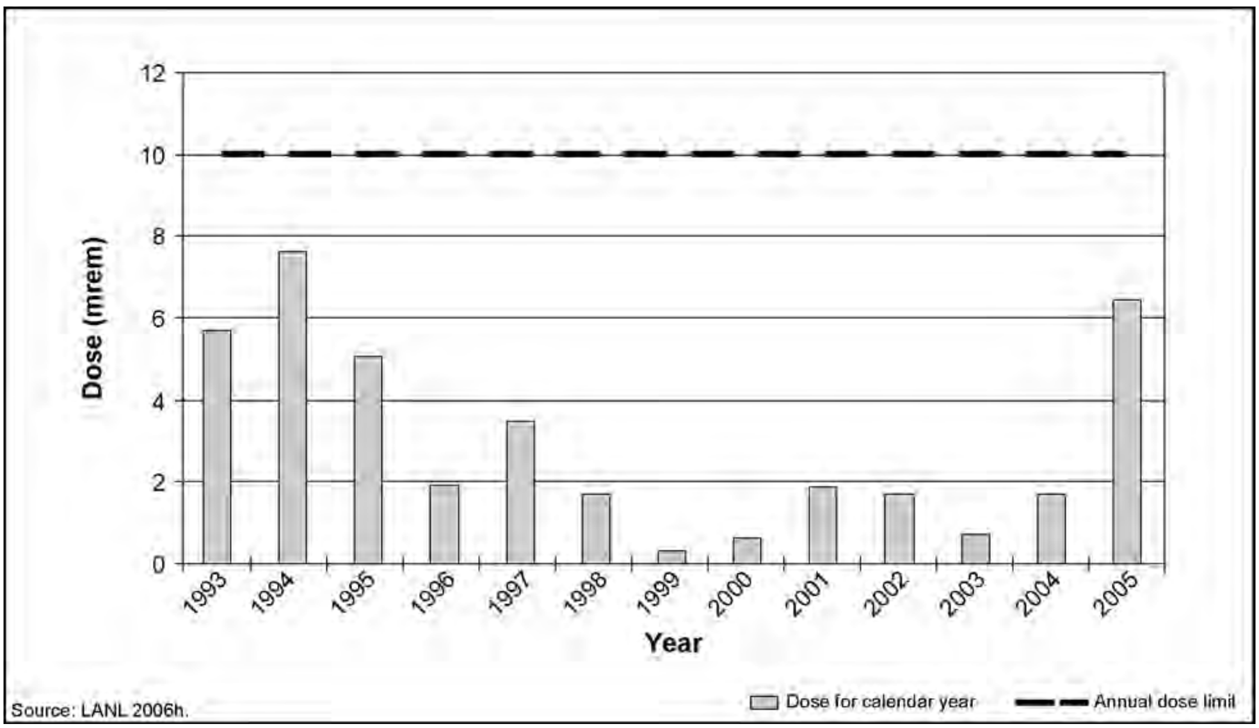


Figure 4–27 Annual Dose (millirem) to the Maximally Exposed Individual Offsite

Table 4–27 Changes in Population Distribution Since the *1999 SWEIS*

Miles from LANL [a]	*0 to 10*	*10 to 20*	*20 to 30*	*30 to 40*	*40 to 50*	*Total*	*Percent Increase*
1999 SWEIS	19,919	50,046	85,602	30,563	56,175	242,305	–
Current SWEIS	19,646	48,081	101,113	26,481	80,192	275,513	14 (33,208)

[a] Centered at the Los Alamos Neutron Science Center (TA-53).
Note: To convert miles to kilometers, multiply by 1.6093.
See Appendix C for further details.

The 2005 collective population dose attributable to LANL operations to persons living within 50 miles (80 kilometers) of the site was 2.46 person-rem. Tritium contributed about 17 percent of the dose, and short-lived air activation products such as carbon-11, nitrogen-13, and oxygen-15 from LANSCE contributed about 83 percent. This increase in the 2005 collective population dose was due to a longer beam time (over twice that of 2004) at LANSCE and a malfunction in the air emissions control system that was later fixed. Until 2005, population doses had declined from a high of about 4 person-rem in 1994 to less than 1 person-rem in 2004. As of November 2006, the collective population dose was expected to decrease in 2006 to the 2004 level.

Offsite Maximally Exposed Individual

The offsite MEI is a hypothetical member of the public who, while not on LANL property, would receive the largest dose from LANL operations. During 2005, two potential MEI locations were analyzed. One was at East Gate along NM 502, at the east side of Los Alamos County. East Gate is normally the location of greatest exposure because of its proximity to LANSCE. The total dose to the MEI at the East Gate in 2005 was estimated at 6.46 millirem, of which approximately 6.31 millirem would come from LANSCE. Emissions from LANSCE stacks were greatly elevated during 2005 due to longer beam operating time (almost 10 months in 2005 versus 4 months in 2004) and a malfunction in the air emissions control system. As of November 2006, the emissions were expected to return to the 2004 rates as a result of the system's repair and additional controls implemented in 2005.

The second location evaluated as a potential MEI in 2005 was the boundary of the Pueblo de San Ildefonso Sacred Area north of Area G. The dose at this location was calculated to be approximately 0.9 millirem per year, less than the MEI dose at the East Gate. The MEI dose of 6.46 millirem is below the 10 millirem per year airborne emissions dose limit for the public (40 CFR Part 61). The year-to-year fluctuations in the emission rate from LANSCE are the result of variations in the number of hours that LANSCE runs. The downward trend indicated in recent years resulted from installing delay lines and fixing small leaks.

Onsite Maximally Exposed Individual

The onsite MEI is a member of the public who would receive a radiological dose from LANL operations while onsite. This MEI had been evaluated in previous years, but because of increased security restrictions, members of the public are prevented from accessing many of the technical areas. This change, combined with the relocation of significant radiation sources, makes an onsite MEI no longer applicable.

Doses in Los Alamos Townsite and White Rock

Los Alamos Townsite. During 2005, the measurable contributions to the dose at an average Los Alamos residence were as follows: 0.08 millirem from radionuclides produced at LANSCE and 0.01 millirem from tritium. Other nuclides contribute less than 0.02 millirem. These doses add up to 0.11 millirem.

White Rock. During 2005, the measurable contributions to the dose at an average White Rock residence were as follows: 0.04 millirem from emissions at LANSCE and 0.01 millirem from tritium. Other nuclides each contribute less than 0.01 millirem. These add up to 0.06 millirem.

Water (Ingestion Pathway)

The majority of radionuclides detected in groundwater samples collected during 2005 resulted from the presence of natural radioactivity in these sources. Tritium was the only radionuclide detected in these groundwater samples that could possibly be attributed to LANL operations. The highest concentration of tritium from a known or potential drinking water source (349 picocuries per liter) was measured in a sample from an alluvial spring in Upper Los Alamos Canyon, which is not a recognized drinking water supply. This concentration was far below the EPA maximum contaminant level of 20,000 picocuries per liter and results in a dose less than 0.1 millirem per year (LANL 2006h).

Soil (Direct Exposure Pathway)

Soil samples were collected on the perimeter of San Ildefonso Pueblo land within Mortandad Canyon, downwind of Area G. No samples had radionuclide concentrations above the Regional Statistical Reference Levels. As the strontium-90 and cesium-137 soil concentrations at the sample location were less than the Regional Statistical Reference Levels for both radionuclides, the doses from cesium-137 and strontium-90 concentrations in soil are most likely from global fallout, not LANL. The tritium could mainly come from three sources: cosmic rays, nuclear weapons testing, and LANL; however, the total dose from tritium in soil was virtually nonexistent. Similarly, transuranics (such as plutonium) may include a small contribution from LANL, but the dose would be less than 0.1 millirem per year. Finally, the isotopic mixture of uranium was consistent with natural uranium. Therefore, the LANL contribution to dose from soil is less than 0.1 millirem per year, and the majority of the radionuclides detected are primarily due to fallout (LANL 2006h).

Food (Ingestion Pathway)

Over the years, LANL staff has collected a variety of foodstuff samples (fruits, vegetables, grains, fish, milk, eggs, honey, herbal teas, mushrooms, pinyon nuts, domestic animals, and large and small game animals) from the surrounding area and communities to determine the impacts of LANL operations on human health via the human food chain. During 2005, predator and bottom-feeding fish were caught at Abiquiu and Cochiti Reservoirs and purslane (*Portulaca* species), a wild edible plant, was collected on the perimeter of San Ildefonso Pueblo within Mortandad Canyon, downwind of Area G. Fish caught at Abiquiu Reservoir serve as a background population that is essentially removed from the influence of LANL because the reservoir is upstream of the site. Cochiti Reservoir is downstream of LANL and fish caught there are potentially impacted by LANL operations. A review of the radionuclide concentrations indicated that the dose received from consuming predator and bottom-feeding fish caught at Cochiti Reservoir would be much less than 0.1 millirem per year.

Purslane was again chosen for analysis in 2005 to better define the reasons for slightly higher levels of some radionuclides in wild edible plants in 2004. The analyses of the nine radionuclides in purslane plants collected from Mortandad Canyon on San Ildefonso Pueblo lands showed that strontium-90 was the only radionuclide detected in concentrations above the Regional Statistical Reference Level. The highest level of strontium-90 in purslane plants from Mortandad Canyon was below the screening level of 1 picocurie per gram. Assuming consumption of approximately 30 pounds of purslane per year, a total dose of approximately 0.1 millirem would be received from the consumption of wild purslane. The LANL contribution to the dose from consuming foodstuffs would be on the order of 0.1 millirem per year if wild foodstuffs were collected and consumed. In summary, the total annual dose to an average resident from ingestion of fish and wild purslane was approximately 0.1 millirem.

4.6.1.3 Radionuclides and Chemicals in the Environment Around Los Alamos National Laboratory

The risk to the public health from ingestion of water, foodstuffs, and from incidental ingestion of soils and sediments was estimated in the *1999 SWEIS* from environmental surveillance data within and surrounding LANL. As indicated in the *1999 SWEIS*, the risk of toxicity and carcinogenicity continues to be dominated by existing concentrations of radionuclides and chemicals in environmental media due to naturally occurring materials, global fallout, and other anthropogenic sources affecting the region, and historical operations (including emissions and effluents, and accidental spills and releases).

Estimates of dose and risk from radioactive and nonradioactive contaminants potentially ingested by residents, recreational users of LANL lands, and via special pathways are evaluated in Appendix D of the *1999 SWEIS* based on contaminant data published in *Environmental Surveillance Reports* for the period between 1991 and 1997. According to the *1999 SWEIS*, the total worst-case ingestion doses for the offsite resident of Los Alamos County and Non-Los Alamos County resident would be 11 and 17 millirem per year, respectively. If this person is also a recreational user of the Los Alamos canyons, drinking canyon water and ingesting canyon sediments, the worst-case additional dose would range up to 1 millirem per year. If the individual has traditional American Indian or Hispanic lifestyles, the worst-case additional dose would be 3 millirem per year (DOE 1999a). Thus the worst-case individual could receive 15 and 21 millirem per year. The associated excess latent cancer fatality risk for the offsite resident would be in the range of 9 to 13 in one million (using a conversion risk factor of 0.0006 excess latent cancer fatalities per rem).

Estimates were also made in the *1999 SWEIS* of the potential health risk from nonradioactive contaminants in groundwater, surface water, soils, and sediments, vegetables, fruit, and fish. According to the *1999 SWEIS*, the hazard indices for all detectable metals were generally less than 1 (a Hazard Index of 1 or greater than 1 is considered indicative of a potential health hazard to the exposed individual) and the latent cancer fatality risk less than one in one million per year.

Appendix C, of this *SWEIS*, re-examines the potential health risk to specific receptors from contaminants in the environment around LANL. Dose and risk were estimated using environmental surveillance data reported over several years. The reported concentrations were averaged and a 95 percent upper confidence level (95 percent upper confidence limit) concentration was determined for each contaminant in each of several foodstuffs and environmental media. Using published guidelines, consumption rates for specific foodstuffs and environmental media were selected to depict the exposure of residents to environmental contaminants. Exposures were calculated for typical (average) and high levels of consumption. As represented by the Appendix C calculations, the "Offsite Resident" is a person who depends heavily on locally acquired foodstuffs (including some fish, game, and other wild foods) and whose living habits and diet result in higher-than-average exposure to radionuclides and chemicals in the environment. Additional pathway components were analyzed to account for exposures to an avid recreational user of wildlands at LANL (the "Recreational User"). Finally, several additional diet items ("Special Pathways") were analyzed to assess the potential added impacts to Native American, Hispanic, and other residents with traditional living habits and diets. Where appropriate, updated exposure pathway parameters and risk factors were used to estimate the dose and risk from radioactive and nonradioactive contaminants in the environment.

The results of these analyses are not much different from those presented in the *1999 SWEIS*. As represented by the sum of all the analyzed pathway components, the worst-case individual (an "Offsite Resident" who is also a "Recreational User" and consumes the "Special Pathways" diet items) would receive a radiation dose of 11 millirem per year and the associated excess latent cancer fatality risk would be 6.6 in one million. With the exception of several naturally-occurring metals, the hazard indices for all nonradioactive contaminants are again found to be generally less than 1 and the latent cancer fatality risk less than 1 in one million per year. The findings of the *1999 SWEIS* regarding exposure of Los Alamos County residents to naturally-occurring arsenic and beryllium are confirmed in Appendix C.

Arsenic and vanadium were identified as having a Hazard Index above 1 in groundwater that supplies Los Alamos County and San Ildefonso Pueblo. Excess latent cancer fatality risk from arsenic greater than 1 in one million per year was also estimated for consumption of soils, sediments, and surface water, by some residents and recreational users of LANL. While the risk associated with arsenic ingestion was greater than 1 in one million per year, the arsenic was not associated with discharges at LANL. Arsenic and vanadium are endemically present in the rocks, soils, groundwater, and surface waters in the region in which New Mexico is located (DOE 1999a).

Beryllium has no Hazard Index for ingestion exceeding 1. However, excess latent cancer fatality rates greater than 1 in one million are estimated in several pathways. Beryllium concentrations in waters, soils, and sediments are typical of those in background readings in the northern New Mexico region. Based on the environmental surveillance data from LANL, the portion of beryllium associated with LANL operations is not a significant contributor to beryllium concentrations in the immediate area of LANL (DOE 1999a).

Radionuclide and chemical concentrations in the environment around LANL are not expected to change significantly over time. If anything, they are expected to diminish with the radioactive decay of the radionuclide constituents. An event, however, with a potential for redistribution of radionuclide and chemical constituents in the vicinity of LANL was the Cerro Grande fire that occurred in May 2000. The Cerro Grande Fire burned areas that were known or suspected to be contaminated with radionuclides and chemicals, which raised concerns about health effects to the public offsite. Studies were conducted to determine radiological and nonradiological effects in the vicinity of LANL after the fire (RAC 2002, LANL 2002g).

The LANL study considered the possibility that the fire enhanced flooding in watersheds that have residual contamination from early LANL operations (LANL 2002g). The objective was to estimate potential radiological and nonradiological effects from the fire that might have been experienced by receptors most affected during calendar year 2000. Observations and sampling showed that the aftereffects of the Cerro Grande Fire resulted in increased concentrations of radioactive and chemical contaminants in runoff and in sediments deposited during 2000. The predominance of these effects was caused by the increased mobilization of locally deposited worldwide fallout or of naturally-occurring substances that were concentrated by the fire. The study concluded that none of the receptors most affected (residents of Totavi or direct and indirect users of Rio Grande water) was likely to have experienced health effects as a result of exposures to radioactive and nonradioactive contaminants during calendar year 2000.

The study performed by the Risk Assessment Corporation (RAC 2002), was performed at the request of the NMED and was funded by DOE. It was an independent assessment of public health risks from radionuclides and chemicals associated with LANL releases as a result of the fire. The assessment covered releases to the air and to surface waters.

With regard to air releases, the Risk Assessment Corporation assessment indicated that "exposure to LANL-derived chemicals and radionuclides released to the air during the Cerro Grande Fire did not result in a significant increase in health risk over the risk from the fire itself" (RAC 2002). The risk of cancer from exposure to radionuclides and carcinogenic metals released from vegetation that burned was greater than that from radionuclides and chemicals released from contaminated sites at LANL. All cancer risks were below the EPA established range acceptable risks of 1 in one million to 1 in 10,000. "Potential intakes of noncarcinogenic LANL-derived chemicals exceeded acceptable intakes established by EPA at some locations on LANL property" (RAC 2002). However, the estimated intakes were conservative, and the actual risks were likely overestimated.

Cancer risks from exposure to LANL-derived radionuclides and carcinogenic chemicals released to the surface water as a result of the Cerro Grande Fire were within acceptable limits established by the EPA. Estimated intakes of noncarcinogenic LANL-derived chemicals were also less than acceptable limits established by EPA. Of the exposure scenarios considered, the estimated health risks were highest for the hypothetical resident living year round on the bank of the Rio Grande near the confluence of Water Canyon. The most important type of exposure in terms of risk was eating fish. The potential annual cancer risk for that individual was calculated to be less than 3 in one million. For comparison, this *SWEIS* (Appendix C) estimates a worst case ingestion pathway dose of 0.0011 rem, which corresponds (using the current risk conversion factor of 0.0006 excess latent cancer fatalities per rem) to an excess latent cancer fatality risk of 6.6 in one million.

In the *Public Health Assessment* (ATSDR 2006), ATSDR reviewed environmental monitoring data from 1980 to 2001 and assessed past, current, and potential future human exposure situations. Based on the observed levels of various contaminants in the environment and the potential exposure pathways, the ATSDR concluded that no harmful exposures due to chemical or radioactive contamination detected in groundwater, surface soil, surface water and sediment, air or biota are occurring or expected to occur in the future. The data considered in the ATSDR assessment included at least one full year of environmental monitoring results from the period following the Cerro Grande fire. Retrieval of documents and data from the pre-1980 period is continuing. Based on the results of that retrieval effort, the ATSDR will determine if additional actions need to be taken to evaluate pre-1980 potential exposures.

In 1999, the Centers for Disease Control and Prevention began the Los Alamos Historical Document Retrieval and Assessment Project to systematically identify the information available concerning past releases of chemicals and radionuclides from the site between 1943 and the present. In January 2006, the project team issued an interim report summarizing historical operations at Los Alamos, materials that were used, materials that were likely released offsite, development of residential areas around Los Alamos, and the relative importance of identified releases in terms of potential health risks. The results of efforts to use plutonium measurements in soil around LANL to gain information about the potential magnitude of historical plutonium releases were also presented. The project is ongoing and the Centers for Disease Control and Prevention has expressed its intent to work with stakeholders to evaluate whether historical releases of radionuclides or other toxic materials from Los Alamos operations warrant more detailed evaluation (CDC 2006).

4.6.2 Los Alamos National Laboratory Worker Health

This section summarizes operational health risk experience at LANL, including exposure of workers to radioactive materials and hazardous materials resulting in intakes and recordable incidents due to exposure or physical injuries from workplace hazards. The *1999 SWEIS* contained a summary of radiological and chemical exposure and physical hazard incidents affecting worker health at LANL during the 1990s. It also included a summary of worker health-related studies at LANL as well as a description of all LANL worker health programs. This section provides information concerning worker safety, updated for the years 1999 to 2004.

Worker conditions at LANL have remained essentially the same as those identified in the *1999 SWEIS*. More than half the workforce remains routinely engaged in activities that are typical of office and computing industries. Much of the remainder of the workforce is engaged in light industrial and bench-scale research activities. Approximately one-tenth of the general workforce at LANL continues to be engaged in production, services, maintenance, and research and development within nuclear and moderate hazard facilities (LANL 2003h).

4.6.2.1 Worker Exposures to Ionizing Radiation

Occupational radiation exposures for workers at LANL from 1999 to 2005 are summarized in **Table 4–28**. The collective total effective dose equivalent (TEDE) for the LANL workforce during 2005 was 156 person-rem, considerably lower than the workforce dose of 704 person-rem projected in the *1999 SWEIS* ROD (LANL 2006h).

Table 4–29 summarizes the highest individual dose data for 1999 through 2005. The highest individual doses in 2005 were 2.051, 1.603, 1.398, 1.285, and 1.146 rem. There were no doses that exceeded DOE’s 5 rem per year Radiation Protection Standard. With one exception, all worker doses were below the 2 rem per year performance goal set by the as low as reasonably achievable Steering Committee in accordance with LANL procedures (LANL 2006g).

Table 4–28 Radiological Exposures of Los Alamos National Laboratory Workers

Parameter	Units	1999	2000	2001	2002	2003	2004	2005
Collective TEDE (external plus internal)	person-rem	131	196	113	164	241	125	156
Number of workers with measurable dose	Number	1,427	1,316	1,332	1,696	1,989	1,710	2,169
Average measurable dose (external plus internal)	Millirem	92	149	85	96	121	73	72
Average measurable dose (external only)	Millirem	90	65	83	95	111	68	69

TEDE = total effective dose equivalent.
Source: LANL 2006g.

Table 4–29 Highest Individual Doses to Los Alamos National Laboratory Workers [a]

1999	2000	2001	2002	2003	2004	2005
1.910	1.048	1.284	2.214	3.0 [b]	1.539	2.051
1.866	1.013	1.225	1.897	1.8 [b]	1.510	1.603
1.783	0.905	1.123	1.813	1.710	1.500	1.398
1.755	0.828	1.002	1.644	1.569	1.148	1.285
1.749	0.815	0.934	1.619	1.214	1.061	1.146

[a] Units = rem.
[b] Two workers were exposed to plutonium-238 while performing pre-inventory checks at TA-55. These radiation doses are revised down from what was originally reported.
Sources: LANL 2006g.

The collective TEDE for 2005 is 75 percent of the 208 person-rem for 1993 through 1995 used as a baseline in the *1999 SWEIS* and significantly less than the 704 person-rem collective TEDE projected in the *1999 SWEIS*. Several offsetting factors can be responsible for helping keep the dose below the *1999 SWEIS* baseline. The primary factor is that pit manufacturing has not become fully operational while other factors include: (1) changes in work load and types of work, and (2) improvements in the as low as reasonably achievable program (LANL 2006g).

4.6.2.2 Non-ionizing Radiation, Chemical and Biological Exposures

Non-ionizing radiation refers to any type of electromagnetic radiation that does not carry enough energy to ionize living material, that is, to completely remove an electron from an atom. Because non-ionizing radiation has lower energy than ionizing radiation, it has fewer health risks than ionizing radiation. Technologies used at LANL that generate non-ionizing radiation include lasers, microwave-generating and radiofrequency devices, technologies that generate ultraviolet radiation, video displays and instrumentation, welding, and security-related devices. Devices that generate nonionizing radiation are regulated by the U.S. Food and Drug Administration, while worker exposures are regulated by the Occupational Safety and Health Administration. Public exposures are not expected as any non-ionizing radiation generated by site operations are localized in nature. Devices that can generate larger amounts of non-ionizing radiation, such as some lasers, can cause eye injury to anyone who looks directly into the beam or its mirror reflection, or skin burns. Worker exposures could occur because of equipment failure, improper use of equipment, or non-adherence to procedures. Mitigation measures include regular equipment maintenance and inspections, use of design measures such as interlocks that prevent laser operation unless the enclosure is secured, and administrative controls and training. Workers who operate more powerful lasers are required to have an eye examination, complete a laser safety training course, and understand and follow applicable procedures.

The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, soil through direct contact or ingestion). Section 4.4.2 of this chapter presents the atmospheric concentrations of the more prevalent chemicals. The presence of chemicals in surface and groundwater at LANL is presented in Section 4.3.1.3 and Section 4.3.2. Soil conditions are presented in Section 4.2.3.1 while chemical wastes generated by site operations are presented in Section 4.9.3.

Adverse health impacts to the public are minimized through administrative and design controls to decrease hazardous chemical releases to the environment and to achieve compliance with permit requirements. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at LANL via inhalation of air containing hazardous chemicals released to the atmosphere by LANL operations. Risks to public health from ingestion of contaminated drinking water or direct exposure are also potential pathways.

Chemical exposure pathways to LANL workers during normal operations may include inhaling the workplace atmosphere, drinking LANL potable water, and possible other contact (that would lead to absorption through the skin) with hazardous materials associated with work assignments. Workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. LANL workers are also protected by adherence to the Occupational Safety and Health Administration and EPA occupational standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals used in the operation processes, ensures that these standards are met. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at LANL are substantially better than required by standards.

LANL staff currently work with biological organisms as part of the national science and security missions of the site. Microorganisms are found naturally in the environment, yet only a very small percentage of these can cause infection and mild to severe disease in humans. Potential worker exposures to microorganisms could occur through inhalation, ingestion, or cutaneous contact with biological material generated from normal laboratory activity. In addition, other biohazardous materials with which workers may come in contact include animals and animal carcasses through wildlife management programs, and sanitary waste at the Sanitary Wastewater System, but these are considered minor sources of biological exposure as compared to the microbiological materials used in projects related to the national security missions. Work conducted in the LANL biosciences laboratories are governed by safety and security requirements for biohazardous materials as outlined in the document entitled "Biosafety in Microbiological and Biomedical Laboratories" by the Centers for Disease Control and

Prevention (see Appendix C). Worker exposure to biohazardous material is primarily regulated through the Occupational Safety and Health Administration. Laboratory safety and security measures are used to reduce or eliminate laboratory staff and the general public from potential exposures to microorganisms being researched at LANL. These mitigation measures include safety equipment, laboratory design, administrative controls, training, and containment measures for appropriate biohazardous material (see Appendix C). There have been no public health hazards attributed to LANL operations due to the use of these safety control measures for biological laboratories.

4.6.2.3 Occupational Injuries and Illness

Table 4–30 summarizes occupational injury and illness rates at LANL from 1999 through 2005. Occupational injury and illness rates for workers in 2005, although higher than some previous years, continue to be small as shown in the table. These rates correlate to reportable injuries and illnesses during the year for 200,000 hours worked or roughly 100 workers (LANL 2006g).

Table 4–30 Occupational Injury and Illness Rates at Los Alamos National Laboratory [a]

Calendar Year	1999	2000	2001	2002	2003	2004	2005
TRC [b]	2.52	1.97	1.96	2.39	2.30	2.86	2.80
DART [c]	1.37	0.94	0.91	1.46	1.26	1.35	0.99

[a] All workers, including University of California workers.
[b] Total Recordable Cases, number per 200,000 hours worked.
[c] Days away, restricted, or transferred, number of cases per 200,000 hours worked.
Source: LANL 2006g.

4.6.3 Accident History

Accidents were discussed in the *1999 SWEIS*. Since 1999, accidents at LANL have included the following. On August 5, 2003, in a storage room in TA-55 a package containing residues from plutonium-238 operations breached while being handled by two workers performing a pre-inventory check. The breach was caused by degradation of the container. The pressurized release of materials from the package resulted in confirmed intakes of plutonium by both workers. The internal doses to the workers were initially estimated to be in excess of 10 rem committed effective dose equivalent. However, based on follow-up bioassay results, the assigned doses were later revised downward to about 1.8 and 3 rem (NNSA 2003). Cleanup of the storage room, including repackaging of the nuclear materials, is ongoing with containers at risk having been removed, or repackaged or temporarily mitigated prior to final repackaging. Decontamination of the room will be completed upon completion of repackaging or removal of the nuclear materials (LANL 2006a).

On February 15, 2001, plutonium-238 was released into the air from a glovebox when the hot nuclear material caused a crack in a technician's uninsulated glove. The accident was partially a result of the failure to follow procedures for safely handling plutonium-238. DOE investigated allegations concerning this incident, along with radiological incident reports from 1999 and 2000 at TA-55. As a result, recommendations were made, accepted by DOE, and instituted in corrective actions at TA-55 (DOE 2003f).

In March 2000, a radiological release of plutonium-238 occurred near a glovebox in the Plutonium Facility at TA-55. Seven workers had confirmed intakes of plutonium-238. The source of the release was a compression fitting in a contaminated vacuum line serving the glovebox. After an investigation was completed, lessons learned from this incident were documented by DOE. As a result, DOE performed a check of over 50,000 mechanical fittings at TA-55 and corrected leak problems (DOE 2000c).

Since 1945, there have been 13 criticality accidents at LANL (LANL 2000c). The accidents occurred during processing, critical experiment setups, and operations. These accidents resulted in various levels of radiation exposure to involved workers and in no or little damage to the equipment. The early criticality accidents (prior to 1946) resulted in worker fatalities. After 1947, remote criticality experiment facilities were constructed, leading to minimum doses to workers from criticality accidents. None of the accidents resulted in any significant exposure to members of the public. Although a number of criticality accidents were experienced at LANL in the period from 1945 to the early 1980s, a review of more recent LANL annual environmental and accident reports indicates that there have been no accidents since that time that have resulted in significant adverse impacts to workers, the public, or the environment. During the review period, from 1986 to 1990, site operations were much greater than in previous years and higher than anticipated for the future (DOE 2000c).

Beginning May 4, 2000, the Cerro Grande Fire damaged or destroyed 112 structures at LANL and about 230 residential structures in the Los Alamos Townsite. By the time it was contained (16 days later), it had burned about 7,700 acres (3,110 hectares) within the boundaries of LANL. DOE is conducting an extensive environmental monitoring and sampling program to evaluate the effects of that fire at LANL. The program will identify changes from pre-fire baseline conditions that will aid in evaluating potential future impacts, especially those from any contaminants that may have been transported offsite (LANL 2000c). Effects from the fire on different environmental resources are described in the applicable sections of this chapter.

In addition to the aforementioned radiological and wildfire accidents, a number of non-radiological accidents have occurred at LANL from 2000 to 2005. On July 14, 2004, an undergraduate student working with a LANL scientist using two lasers in an experiment suffered a retinal traumatic hole in one eye caused by pulsed laser light. This accident occurred because neither experiment participant was wearing the required laser eye protection and they looked directly down the laser beam path. The employees involved further exacerbated this accident by not reporting the incident immediately and securing the scene. After this accident the LANL director temporarily suspended all operations and ordered a complete safety review of the lab (LANL 2004h, 2004i).

On May 27, 2005, a chemical accident occurred in TA-9 Building 21 resulting in injury to two involved workers. The workers were weighing a normally inert chemical material when it experienced a chemical reaction that caused the release of energy. Both employees suffered a range of wounds, none of which were fatal and were treated at the Los Alamos Medical Center. One employee was released from the center on the same day as the accident. The event was localized to the area immediately surrounding the location of the chemical handling (Delucas 2005).

In June 2005, two LANL workers were mixing hydrochloric and nitric acid to form a corrosive liquid called aqua regia. They both inhaled vapors that evolved during the mixing operation. One employee had a temporary shortness of breath while the other suffered longer-term respiratory symptoms, which eventually caused him to be hospitalized for six days. Neither employee suffered permanent injuries. LANL management was not informed of this event until after the hospitalized employee returned to work (Lenderman 2005). During the last several years, a number of incidents have occurred at TA-55 PF-4, which resulted in worker contamination and doses due to plutonium-238 uptakes. DOE investigated each incident, analyzed it for root causes, and developed a set of recommendations. The DOE Lessons Learned Database was also updated with information from these incidents. In each case, LANL staff performed specific actions in the areas of procedures, training, inspection, and component upgrading and replacement in order to address the root causes and preclude reoccurrence of the event (DOE 2000b, 2003f, 2004b, 2004d).

4.6.4 Los Alamos National Laboratory Emergency Management and Response Program

Emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations support LANL's emergency management system. LANL personnel maintain the necessary apparatus, equipment, and Emergency Operations Center to respond effectively to virtually any type of emergency, not only on the LANL site, but throughout the local community as well.

The Emergency Response and Management Program is operated out of a new two-story, 38,000-square foot (3,530-square-meter) Emergency Operations Center. Construction of the facility began in January 2002, and it became operational in December 2003. The building serves as the command center for responding agencies in an emergency and has space and resources to house up to 120 personnel, including representatives from neighboring Pueblos, the Federal Bureau of Investigation, the Federal Emergency Management Agency, DOE, U.S. Forest Service, National Park Service, National Guard, New Mexico State Police, Los Alamos County Police, Firefighters, Emergency Managers, the Red Cross, and others.

The Center's multi-faceted communications includes a multi-band radio system; a media interface and emergency broadcast system; a mobile communications van and mobile command center, to which essential functions can be transferred immediately in an emergency; fixed wing and helicopter surveillance; and emergency communications of all kinds. More than 600 telephone and high-speed data lines serve the Emergency Operations Center.. The Emergency Operations Center can receive video from fixed cameras monitoring traffic at key points throughout Los Alamos County and LANL, and can control programmable signs that advise motorists of emergency or traffic conditions on the main roads. The Emergency Operations Center information network includes a data mirror with the latest information on facility conditions, hazardous material inventories, and other updates that would aid first responders.

LANL's Emergency Response and Management Program effectively combines Federal and local emergency response capabilities. A coordinated effort to share emergency information with Los Alamos County is a cornerstone of the Emergency Management Program. LANL emergency management staff and Los Alamos County police, fire, emergency medical, and 911 dispatch personnel operate out of the LANL Emergency Operations Center. It is the United States' first Emergency Operating Center that combines Federal and local operations. A computer-aided dispatch system provides a centralized dispatch capability for the Los Alamos Police and Fire Departments. First responders from different agencies share real-time information from the same Emergency Operations Center, resulting in a more coordinated emergency response.

The construction of the new Emergency Operations Center was initiated in response to the destructive wildfires in northern New Mexico in the summer of 2000. It replaces a cramped, outdated facility that was located in TA-59, could accommodate only 16 people, and had limited communications capabilities. DOE, with assistance from the LANL Emergency Response and Management staff, is responsible for initiating, coordinating, and reviewing all written emergency response agreements. The agreements serve as the basis for communicating roles and responsibilities, dispatching mutual aid, carrying out emergency operations, and providing for treatment and care of patients during an emergency event at LANL. These agreements and memoranda of understanding are established with county and state agencies, local fire and law enforcement entities, and local emergency medical centers. Key organizations and agencies having mutual aid agreements with DOE and LANL are Los Alamos County Mutual Aid, Los Alamos Medical Center, St. Vincent Hospital Mutual Assistance, Española Hospital, and University of New Mexico Hospital. DOE subcontracts with Los Alamos County for fire department services.

There are several mechanisms to coordinate site emergency response plans and training opportunities with local offsite response agencies. Routine coordination between LANL staff and offsite agencies is primarily handled through the Los Alamos County Local Emergency Planning Committee, which meets monthly and is headed by the Los Alamos County Emergency Manager. The Planning Committee includes representatives from the Emergency Response and Management Program, various Los Alamos County and nearby county emergency response agencies, the National Forest Service, the National Park Service, and other interested parties. County personnel are heavily involved in planning efforts for most LANL exercises, including discussions on scenario selection. Conversely, if a LANL training and exercise scenario does not meet the county's needs, the county runs its own scenario with LANL staff participating as a response organization. Furthermore, LANL personnel provide training at no cost to a variety of county-associated response entities, including members of the bomb disposal and crisis negotiation teams.

Operating under the oversight of the NNSA Los Alamos Site Office, LANL's emergency management and response system is a mature program with an acceptable level of readiness. The program operates in accordance with applicable Federal requirements, including DOE Order 151.1C *Comprehensive Emergency Management System*, and encompasses five main areas:

- Emergency planning activities, including the identification of hazards and threats, hazard mitigation, development and preparation of emergency plans and procedures, and identification of personnel and resources needed for an effective response;
- Emergency preparedness activities, including the acquisition and maintenance of resources and the implementation of a training, drill, and exercise program;
- Emergency response activities, including the application of available resources to mitigate the consequences of an emergency to workers, the public, the environment, national security, and the initiation of recovery planning. Trained LANL personnel, including specialized teams such as the HazMat, Crisis Negotiation, and Hazardous Devices teams are available to respond on a 24-hour basis;
- Emergency recovery activities, including planning and actions to return site or facility operations to a normal state following termination of the emergency; and
- Emergency readiness assurance activities, including assessments, documentation, and program management plans to ensure emergency capabilities are adequate.

LANL personnel are responsible for the development of the *Wildland Fire Management Plan*. It will be integrated into the existing Fire Protection Program and implemented and administered by the Emergency Response and Management Program.

4.6.5 Los Alamos National Laboratory Security Program

LANL maintains special nuclear material inventories, classified matter, and facilities that are essential to nuclear weapons production. These security interests are protected against a range of threats that include adversarial groups, theft or diversion of special nuclear material, sabotage, espionage, and loss or theft of classified matter or government property.

LANL's physical security protection strategy is based on a graded and layered approach supported by an armed guard force trained to detect, deter, and neutralize adversary activities and backed up by local, state, and Federal law enforcement agencies. This strategy employs the concept of defensible concentric layers where each layer provides addition controls and protections.

The defense-in-depth approach begins in the airspace above LANL, which is restricted to approximately 5,000 feet (1,500 meters) above the ground surface. On the ground protection begins at the site perimeter and hardened access control points and builds inwardly to facility exteriors and designated interior zones and control points.

Both staffed and automated access control systems limit entry into areas and facilities to authorized individuals. Additional security measures include random stops and inspections of cars. Automated access control systems use booths, turnstiles, doors, and gates controlled by magnetic-stripe badge readers and hand-geometry personal identifiers. Escorting requirements provide access controls for visitors entering security areas. Access control is also provided through control of the selection, use issuance, and safeguarding of keys and cores for locks.

Entrance and exit inspections and portal systems with metal detectors, nuclear material monitors, explosives detectors, and X-ray machines are used to prevent unauthorized introduction or removal of prohibited items and security interests. The guard force also performs random roving inspections throughout the site. Additionally, handlers use highly trained explosives detection and drug detection dogs to conduct random and systematic inspections. The LANL contractor uses truck and package inspection facilities with detection equipment and canine support to segregate, inspect, and stage materials prior to delivery.

Physical security protection also includes barriers, electronic surveillance systems, and intrusion detection systems that form a comprehensive site-wide network of monitored alarms. Various types of barriers are used to delay or channel personnel, or to deny access to classified matter, special nuclear material, and vital areas. Barriers are used to direct the flow of vehicles through designated entry control portals and to deter and prevent penetration by motorized vehicles where vehicular access could significantly enhance the likelihood of a successful malevolent act. Barriers may be passive and designed to require the use of special tools and high explosives to penetrate them. Barriers may also have an active component designed to dispense an obscuration agent, viscous barrier, or sensory irritant.

Tamper-protected surveillance, intrusion detection, and alarm systems designed to detect an adversary action or anomalous behavior inside and outside LANL facilities are paired with assessment systems to evaluate the nature of the adversary action. Random patrols and visual observation are also used to deter and detect intrusions. Penetration-resistant alarmed vaults and vault-type rooms are used to protect classified materials.

Guards are stationed in mobile and fixed posts around LANL 24 hours a day, 365 days a year. They are trained and equipped to respond to alarms and adversary action in accordance with well-designed and thoroughly tested plans using specialized equipment and weapons.

4.7 Cultural Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. To fully meet the requirements of these laws, regulations, and guidelines, DOE is implementing *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006f). Implementation of this plan, which has undergone public review, involves a Programmatic Agreement between DOE, the Advisory Council on Historic Preservation, and the New Mexico State Historic Preservation Office (DOE 2006b). By carrying out the terms of the agreement, DOE will fulfill its responsibilities under Section 106 of the National Historic Preservation Act.

The three general categories of cultural resources addressed in this section are archaeological resources, historic buildings and structures, and traditional cultural properties. Archaeological resources include any material remains of past human life or activities which are of archaeological interest, including items such as pottery, basketry, bottles, weapons, rock art and carvings, graves, and human skeletal materials. The term also applies to sites that can provide information about past human lifeways. Historic buildings include buildings or other structures constructed after 1942 and LANL-era buildings that have been evaluated for eligibility to the National Register of Historic Places (NRHP). Traditional cultural properties are defined as a place of special heritage value to contemporary communities (often, but not necessarily, American Indian groups) because of their association with the cultural practices or beliefs that are rooted in the histories of those communities and are important in maintaining the cultural identity of the communities (LANL 2006f).

Occupation and use of the Pajarito Plateau began as early as 10,000 BC as foraging groups used the area for gathering and hunting large game animals. Since that time a succession of peoples have populated the area as reflected in the rich archaeological resources and historic buildings and structures that are present. The chronological sequence associated with the cultural history for the northern Rio Grande is presented in **Table 4–31**. A detailed description of each period is provided in *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006f).

LANL's Cultural Resources Management Plan

A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico (Cultural Resources Management Plan) defines the responsibilities, requirements, and methods for managing cultural resources at LANL. It provides a series of steps and procedures for complying with Federal historic preservation laws and regulations, such as the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act, as well as DOE policies and directives related to cultural resources protection.

Critical to success of the Cultural Resources Management Plan are strategies that effectively administer those cultural resources warranting long-term protection while at the same time facilitating land-use flexibility in support of the DOE mission at LANL. The Plan supports this by specifying steps for the timely integration of cultural resource concerns and reviews into program and project planning.

The initial step is notification about a proposed project by the responsible organization at LANL. Cultural resources in an area of potential effects are next identified by reviewing background information and conducting additional studies, as necessary. Approximately 800 to 1000 cultural resource reviews of projects are performed at LANL each year.

Cultural resources are then assessed to determine if adverse effects could occur and to identify ways to avoid, minimize, or resolve any anticipated consequences. Project reviews and evaluations might also involve field checks by qualified cultural resource managers. Additionally, DOE consults with State or Tribal Historic Preservation Officers, as well as other knowledgeable parties, as appropriate.

Finally, a plan is formulated to resolve any anticipated adverse effects. Actions that might be undertaken could include avoiding the cultural resource, modifying the undertaking to minimize adverse effects, completely documenting the property, and wholly or partially excavating the site. As necessary, the boundaries of a cultural resource are clearly marked prior to initiating physical work on a project to assist in avoiding any adverse effects.

Table 4–31 Culture History Chronology for Northern Rio Grande Specific to Los Alamos National Laboratory and the Pajarito Plateau

Culture Period Dates	*Culture Period Dates*	*Culture Period Dates*
Paleoindian	Clovis	9500 to 8000 BC
	Folsom	9000 to 8000 BC
	Late Paleoindian	8000 to 5500 BC
Archaic	Jay	5500 to 4800 BC
	Bajada	4800 to 3200 BC
	San Jose	3200 to 1800 BC
	Armijo	1800 to 800 BC
	En Medio	800 BC to AD 400
	Trujillo	AD 400 to 600
Ancestral Pueblo	Early Developmental	AD 600 to 900
	Late Developmental	AD 900 to 1150
	Coalition	AD 1150 to 1325
	Classic	AD 1325 to 1600
American Indian, Hispanic, and Euro-American	Early Historic Pajarito Plateau	AD 1600 to 1890
	Homestead	AD 1890 to 1943
Federal Scientific Laboratory	Manhattan Project	AD 1942 to 1946
	Cold War (Early Cold War)	AD 1956 to 1990 (AD 1946 to 1956)

Source: LANL 2006f.

Two potential National Historic Landmarks and one potential National Register Historic District have been proposed at LANL. The former includes the "Project Y" Manhattan Project and Los Alamos National Laboratory Ancestral Pueblo National Historic Landmarks. "Project Y" of the Manhattan Project lasted only four years (1942 through 1946), but represented one of the defining moments of recent world history. The main goal of "Project Y" was the immediate development and possible deployment of the world's first atomic weapon. The potential Los Alamos National Laboratory Ancestral Pueblo National Historic Landmark would consist of four discrete units totaling 132 acres (53.4 hectares) and would recognize a number of the Ancestral Pueblo archaeological sites that are especially important due to integrity of location and the nature of the resource (LANL 2006f).

The potential Los Alamos Archaeology National Register Historic District would consist of a number of sites and clusters of sites that, while not deemed of sufficient significance to be considered for inclusion in the two potential National Historic Landmarks, nevertheless are important to the State of New Mexico and to the Nation. The proposed National Register Historic District would contain a total of 10 discrete components with a combined size of 1,496 acres (605.4 hectares). Included are six complexes rich in resources dating from the Archaic Period through the Ancestral Pueblo Classic Period and four components relating to the Homestead Period (LANL 2006f).

4.7.1 Archaeological Resources

As of 2005, archaeological surveys have been conducted on approximately 90 percent of the land within LANL boundaries with 86 percent having been intensively surveyed. This represents an increase of 15 percent in the total area surveyed since publication of the *1999 SWEIS*. The majority of these surveys emphasized American Indian cultural resources. Information on these resources was obtained from the LANL cultural resources database, which is organized primarily by site type. A total of 1,915 archaeological resource sites have been identified at LANL. Of these, 1,776 are prehistoric sites related to the Paleoindian, Archaic, and Ancestral Pueblo Cultures and 139 are related to the early American Indian, Hispanic, and Euro-American Cultures. Although about 400 archaeological resource sites have been determined to be NRHP-eligible, most of the remaining sites have yet to be formally assessed and are therefore assumed to be eligible until assessed (LANL 2006f).

Following the Cerro Grande Fire, surveys identified 333 archaeological resource sites that were impacted. Of these sites, 269 were damaged by the fire, 35 by suppression activities, and 29 by rehabilitation activities. Damage included direct loss, soot staining, spalling, and cracking of stone masonry walls of Ancestral Pueblo field houses and room blocks, and exposure of artifacts from erosion. The fire offered the opportunity for rehabilitation of selected Ancestral Pueblo archaeological sites and such work, including erosion control, placing protective fences, and tree thinning (to protect sites from future fires), was conducted at 107 sites (LANL 2004c). The Cerro Grande Fire also affected a number of homestead era sites with many wooden structures being burned. The Grant and Gomez homesteads located in Water Canyon and north of Pajarito Canyon, respectively, are two examples where the fire and subsequent rehabilitation measures damaged or destroyed Homestead Period resources (LANL 2006f). Additionally, the fire, as well as the tree thinning measures taken to reduce wildfire hazard, resulted in the discovery of 447 new archaeological sites (LANL 2006a).

The conveyance and transfer of land has resulted in archaeological sites being removed from DOE protection (LANL 2002b). Archaeological protection easements are a means by which these resources may be protected. Such easements have been established on 79.5 acres (32 hectares) of TA-74, which has largely been conveyed to Los Alamos County in order to protect 31 archaeological sites. Protective easements will also be established in Rendija Canyon to protect traditional cultural properties and allow access to these properties by San Ildefonso and Santa Clara Pueblos. These easements are being set up with a private conservation trust to provide protection in perpetuity (LANL 2004c, 2004f).

Since publication of the *1999 SWEIS,* a number of actions have occurred that have affected archaeological resources at LANL. Vandalism to two sites within the Rendija Canyon Tract was caused when vehicles drove through the sites during a holiday weekend. This tract is to be conveyed to Los Alamos County. Additionally, a contractor associated with the West Jemez Road Upgrade Project drove through an archaeological site. In both cases, corrective actions were taken to prevent any recurrence (LANL 2006a).

4.7.2 Historic Buildings and Structures

In terms of the historic built environment, there are a total of 510 buildings and structures that date to the Manhattan Project and early Cold War. Of these, 31 date to the Manhattan Project. A total of 179 of these 510 buildings and structures have been evaluated for eligibility for inclusion in the NRHP, of which 98 have been determined eligible and 81 not eligible. These figures include a small number of structures younger than 50 years in age that are likely to be deemed of exceptional national significance and are thus eligible for inclusion in the NRHP despite not yet having achieved the 50-year-old age limit normally required for inclusion. These potentially exceptional structures are those identified as the 15 "SWEIS Key Facilities" in the *1999 SWEIS* (LANL 2006f).

A number of factors have served to greatly reduce the number of Manhattan Project buildings still extant as of October 2004. These include (1) the expedient initial construction of the original buildings and structures; (2) post-Manhattan Project infrastructure development particularly during the late 1950s and early 1960s, and again beginning in the late 1990s through the first decade of the 21st century; (3) the development of the Los Alamos townsite during the 1950s and 1960s; (4) the Cerro Grande Fire; and (5) contamination of some buildings by asbestos and radioactive isotopes. As of 2003, only 28 Manhattan Project buildings retained sufficient historical and physical integrity for listing on the NRHP, and only a handful are deemed suitable for long-term preservation and interpretation (LANL 2006f). Additionally, the decrease in the number of historic buildings reported in the *1999 SWEIS* is due to no longer counting temporary and modular properties, shed, and utility features associated with the Manhattan Project and Cold War Periods. These properties were removed from the count because they are exempt from review under terms of the Programmatic Agreement between DOE, the New Mexico State Historic Preservation Office, and the Advisory Council on Historic Preservation (DOE 2006b).

As a result of the conveyance and transfer of 2,259 acres (914 hectares) of land to Los Alamos County and the Pueblo of San Ildefonso, two historic buildings have been removed from DOE protection. Archaeological protection easements established within TA-74 (see Section 4.7.1) will protect one of these resources (LANL 2006a).

Since publication of the *1999 SWEIS*, two historic sites associated with the Manhattan Project have been affected by the TA-33 Remodeling Project and road construction at the TA-8 Gun Site. In the case of the TA-33 Remodeling Project, a rollup door on a Manhattan Project building was removed before consultation and documentation was carried out. Corrective action included photographic documentation of the building after the door was removed, along with the creation of archival quality negatives from digital photographs taken prior to the door removal. The Manhattan Project complex at the TA-8 Gun Site was disturbed by road construction; however, corrective actions, including restoring the parking lot area, establishing a new access road, constructing a retaining wall, and reseeding disturbed areas, have been completed (LANL 2006a). An additional Manhattan Project site, the V-site, was affected by the Cerro Grande Fire. The remaining standing building at the site is currently being stabilized as part of the "Save America Treasures" program (LANL 2006f).

4.7.3 Traditional Cultural Properties

Within LANL's boundaries there are ancestral villages, shrines, petroglyphs (carvings or line drawings on rocks), sacred springs, trails, and traditional use areas that could be identified by Pueblo and Hispanic communities as traditional cultural properties. According to the DOE compliance procedure, American Indian Tribes may request permission for visits to sacred sites within LANL boundaries for ceremonies (DOE 1999a).

When a project is proposed, LANL arranges site visits with Tribal representatives from the San Ildefonso, Santa Clara, Jemez, and Cochiti Pueblos as appropriate to solicit their concerns and to comply with applicable requirements and agreements. Provisions for coordination among these four Pueblos and DOE are contained in Accords that were entered into in 1992 for the purpose of improving communication and cooperation among Federal and Tribal Governments (DOE 1999a).

During preparation of the *1999 SWEIS*, consultations were conducted with 19 American Indian Tribes and two Hispanic communities to identify cultural properties important to them in the LANL region. All of the consulting groups stated that they had at least some traditional cultural properties present on or near LANL. Categories and numbers of traditional cultural properties identified included 15 ceremonial and archaeological sites, 14 natural features, 10 ethonobotanical sites, 7 artisan material sites, and 8 subsistence features. Although these resources were stated as being present throughout LANL and adjacent lands; no specific features or locations were identified that would permit formal evaluation and recognition as traditional cultural properties. In addition to physical cultural entities, concern has been expressed that "spiritual," "unseen," "undocumentable," or "beingness" aspects can be present at LANL that are an important part of American Indian culture (DOE 1999a).

A "Comprehensive Plan for the Consideration of Traditional Cultural Properties and Sacred Sites at Los Alamos National Laboratory, New Mexico" was sent by DOE to 26 different Tribes to help complete the traditional cultural properties identification and evaluation process begun in the *1999 SWEIS*. As of September 30, 2005, this process had narrowed the number of Tribes with active traditional cultural properties concerns on LANL to the Pueblo of San Ildefonso, the Pueblo of Santa Clara (Rendija Canyon), and possibly the Pueblo of Cochiti. DOE maintains ongoing discussions with these pueblos. Such discussions with the Pueblo of San Ildefonso have identified one traditional cultural property, which is in the process being forwarded to the New Mexico State Historic Preservation Office for review and concurrence. In addition, several other locations have been identified by the Pueblo of San Ildefonso for consideration as traditional cultural properties. None of these are locations that would have a significant impact on current mission activities at LANL.

The Cerro Grande Fire did not damage any known traditional cultural properties with the exception of light damage to one site in Rendija Canyon. Subsequent rehabilitation and fire prevention was carried out at all traditional cultural properties within the Rendija Canyon. The conveyance of the Rendija Tract to Los Alamos County would affect a number of traditional cultural properties (LANL 2002b).

A number of traditional cultural properties were identified in the Rendija Canyon Tract in 1993 in response to the then proposed Bason Land Exchange (LANL 2002b); another traditional cultural property was identified during the Land Conveyance and Transfer Project. Although not directly disturbed, seven traditional cultural properties within the tract were threatened by persons driving through a traditional cultural properties-dense area and by disturbance through the removal of stones to use in the apparent burial of a pet. Corrective actions have been taken in order to prevent further damage to these sites including placing fencing around all traditional cultural properties in the Rendija Canyon Tract, posting areas as environmentally sensitive, documenting damage, strengthening gates, and installing surveillance cameras. Additionally, discussion have been held with Santa Fe National Forest archaeologists and recreation specialists to formulate a shared strategy for helping to prevent or limit future vandalism in Rendija Canyon (LANL 2006a).

4.8 Socioeconomics and Infrastructure

This section describes changes that have occurred in the LANL socioeconomic region of influence and LANL site infrastructure since the publication of the *1999 SWEIS*. These changes have been compared to impact projections made in the *1999 SWEIS* for the Expanded Operations Alternative at LANL. This comparison provides an appraisal of whether those projected impacts continue to fall within the operating envelope established by the *1999 SWEIS* with regard to impacts on socioeconomic conditions in the region of influence and demands and usage of LANL site infrastructure.

4.8.1 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics of a region. The number of jobs created by the Proposed Action could affect regional employment, income, and expenditures. Job creation is characterized by two types: (1) construction-related jobs, which are transient in nature and short in duration, and thus less likely to impact public services; and (2) operations-related jobs, which would last longer, and thus could create additional public service requirements in the region of influence.

In order to determine whether socioeconomic impacts in the region of influence since publication of the *1999 SWEIS* are below, at, or above levels predicted for the Expanded Operations Alternative, comparisons were made between site employment projections predicted in the *1999 SWEIS* and those reported in the *SWEIS Yearbook* – 2005 (LANL 2006g) and other site documents.

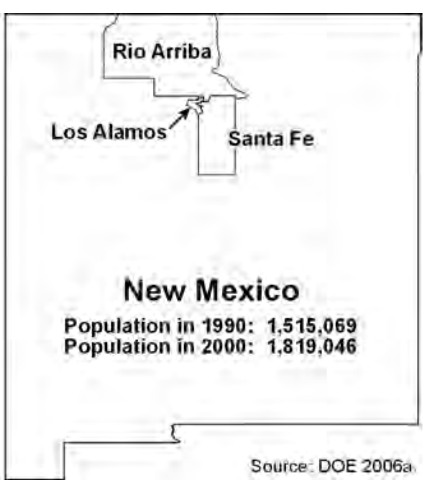


Figure 4–28 Counties in the Los Alamos National Laboratory Region of Influence

4.8.1.1 Regional Economic Characteristics

Socioeconomic impacts were analyzed in the *1999 SWEIS* for a region of influence that included the "Tri-County" region consisting of Los Alamos, Rio Arriba, and Santa Fe Counties in New Mexico (see **Figure 4–28**). Over 85 percent of LANL site employees and their families reside in these counties (see **Table 4–32**). Thus, the socioeconomic conditions of these counties have the most potential to be directly or indirectly affected by changes in operations at LANL. In 2005, a total of 13,504 persons were employed by LANL contractors, of which approximately 12,650 resided in New Mexico.

Table 4–32 Distribution of Los Alamos National Laboratory Affiliated Work Force by Place of Residence in the Region of Influence

Year	*Total LANL Employees*	*LANL Employees that Reside in the ROI*	*Percent of LANL Employees that Reside in the ROI*	*ROI Employed*	*LANL as a Percent of ROI Employed*
1996	11,155	9,913	88.9	86,038	11.5
1997	11,496	10,259	89.2	87,819	11.7
1998	12,008	10,703	89.1	90,046	11.9
1999	12,412	11,028	88.9	92,246	12.0
2000	12,015	10,780	89.7	96,258	11.2
2001	12,380	10,941	88.4	98,121	11.2
2002	13,524	11,867	87.7	99,960	11.9
2003	13,616	12,031	88.4	102,945	11.7
2004	13,261	11,727	88.4	104,185	11.3
2005	13,504	11,564	85.6	107,090	10.8
Average 1996 to 2005	12,537	11,081	88.4	96,471	11.5

ROI = Region of Influence.
Sources: NMDOL 2005, 2006a; LANL 2003h, 2004f, 2005f, 2006g.

Between 2000 and 2005, the civilian labor force in the Tri-County area increased 11.6 percent to the 2005 level of 112,003. In 2005, the annual unemployment average in the region of influence was 4.4 percent, which was smaller than the annual unemployment average of 5.3 percent for New Mexico (NMDOL 2006a).

In 2005, direct government employment represented the largest sector of employment in the Tri-County area (29.9 percent), followed by retail and wholesale trade (14.1 percent), leisure and hospitality (12.8 percent), and healthcare and social assistance (11.4 percent). The totals for these employment categories in New Mexico were 23.2 percent, 15.0 percent, 10.8 percent, and 11.1 percent, respectively (NMDOL 2006b).

4.8.1.2 Demographic Characteristics

The 2000 demographic profile of the region of influence population and income information is included in **Table 4–33**. Persons self-designated as minority individuals in the Tri-County region comprise 57.9 percent of the total population. This minority population is composed largely of Hispanic or Latino and American Indian residents. The Pueblos of San Ildefonso, Santa Clara, San Juan, Nambe, Pojoaque, Tesuque, and part of the Jicarilla Apache Indian Reservation are included in the region of influence.

The *1999 SWEIS* projected that within the first year of expanded operations, the total population in the Tri-County region would grow by 2.5 percent. In the 10 years between the 1990 census and the 2000 census, the population in this area grew 24.7 percent, or approximately 2.3 percent a year (DOC 2006a, 2006b). In July 2005, the total population in the Tri-County region was estimated to be 200,292 (DOC 2007).

Table 4–33 Demographic Profile of the County Population in the Los Alamos National Laboratory Region of Influence

Population Group	Los Alamos County – Population (percent)	Rio Arriba County – Population (percent)	Santa Fe County – Population (percent)	Region of Influence – Population (percent)
Minority				
Hispanic alone	1,505 (8.2)	17,701 (43.0)	36,263 (28.0)	55,469 (29.4)
Black or African American	67 (0.4)	143 (0.3)	826 (0.6)	1,036 (0.5)
American Indian or Alaska Native	107 (0.6)	5,717 (13.9)	3,982 (3.1)	9,806 (5.2)
Asian	694 (3.8)	56 (0.1)	1,133 (0.9)	1,883 (1.0)
Native Hawaiian or Pacific Islander	6 (0.0)	47 (0.1)	94 (0.1)	147 (0.1)
Some other race	495 (2.7)	10,554 (25.6)	22,936 (17.7)	33,985 (18.0)
Two or more races	418 (2.3)	1,353 (3.3)	5,268 (4.1)	7,039 (3.7)
Total Minority	3,292 (17.9)	35,571 (86.4)	70,502 (54.5)	109,365 (57.9)
White alone	15,051 (82.1)	5,619 (13.6)	58,790 (45.5)	79,460 (42.1)
Total	18,343 (100.0)	41,190 (100.0)	129,292 (100.0)	188,825 (100.0)

Source: DOC 2006b.

4.8.1.3 Regional Income

Income information for the LANL region of influence is included in **Table 4–34**. There are major differences in the income levels among the three counties, especially between Rio Arriba County at the low end with a median household income in 2004 of $32,935 and a per capita income of $22,194 and Los Alamos County at the upper end with a median household income of $94,640 and a per capita income of $52,524. The median household income in Los Alamos County is over twice that of the New Mexico State average and is the highest for any county in the Nation (DOC 2006c). In 2004, only 3.2 percent of the population in Los Alamos County was below the official poverty level compared with 18.1 percent of the population of Rio Arriba County.

Table 4–34 Income Information for the Los Alamos National Laboratory Region of Influence

	Los Alamos County	Rio Arriba County	Santa Fe County	New Mexico
Median household income 2004 (dollars)	94,640	32,935	43,727	37,838
Per capita income 2004 (dollars)	52,524	22,194	36,095	26,679
Percent of persons below poverty line (2004)	3.2	18.1	12.0	16.7

Sources: BEA 2007, DOC 2006c.

The Pueblo of San Ildefonso is a minority-dominated community near LANL (see Figure 4–1) and had, in the year-2000 census, a median household income of $30,457. About 12.4 percent of the families lived below the poverty level. The median household incomes of four additional nearby pueblos were as follows (DOE 2004e):

- Santa Clara: $30,946 (16.4 percent of families below poverty level);
- Cochiti: $35,500 (13.2 percent of families below poverty level);

- Jemez: $28,889 (27.2 percent of families below poverty level); and
- Pojoaque: $34,256 (11.3 percent of families below poverty level).

4.8.1.4 Los Alamos National Laboratory-Affiliated Work Force

The LANL-affiliated workforce includes both management and operating contractor employees and subcontractors (see **Table 4–35**). From 1999 through 2005, the number of employees exceeded *1999 SWEIS* ROD projections. The 13,504 employees at the end of 2005 were 2,153 more employees than *1999 SWEIS* ROD projections of 11,351. The 1999 projections were based on 10,593 employees identified for the index year (employment as of March 1996) (LANL 2003h).

Table 4–35 Los Alamos National Laboratory-Affiliated Work Force

SWEIS ROD [a]	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
11,351	12,412	12,015	12,380	13,524	13,616	13,261	13,504

[a] The total number of employees was presented in the *1999 SWEIS;* the breakdown had to be calculated based on the percentage distribution shown in that document for the base year.
Sources: LANL 2003h, 2004f, 2005f, 2006g.

These employees have had a positive economic impact on northern New Mexico. Through 1998, DOE published a report each fiscal year regarding the economic impact of LANL on north-central New Mexico, as well as the State of New Mexico. The findings of these reports indicate that LANL's activities resulted in a total increase in economic activity in New Mexico of about $3.2 billion in 1996, $3.9 billion in 1997, and $3.8 billion in 1998. The publication of this report was discontinued after 1998 due to funding deficiencies. However, based on the increases in number of employees and payroll, it is assumed that LANL's yearly economic contribution has continued to increase (LANL 2004f).

4.8.1.5 Housing

Table 4–36 lists the total number of occupied housing units and vacancy rates in the region of influence. In 2000, there were a total of 83,654 housing units in the Tri-County area, with 89.7 percent occupied and 10.3 percent vacant. The median value of owner-occupied homes in Los Alamos County ($228,300) was the greatest of the three counties, and over twice the median value of owner-occupied homes in Rio Arriba County ($107,500). The vacancy rate was the smallest in Los Alamos County (5.5 percent) and highest in Rio Arriba County (16.5 percent). During the Cerro Grande Fire, approximately 230 housing units were destroyed or damaged in the northern portions of Los Alamos County (DOE 2000f) and as a result, vacancy rates likely decreased. Although available housing can change year to year, in 2005 there was generally a housing shortage in Los Alamos County.

The residential distribution of management and operating contractor employees reflects the overall housing market dynamics of the three counties. In 2005, approximately 86 percent of management and operating contractor employees continued to reside in the Tri-County area as shown in **Table 4–37**.

Table 4–36 Housing in the Los Alamos National Laboratory Region of Influence

	Los Alamos County	*Rio Arriba County*	*Santa Fe County*	*Region of Influence*
Housing (2000)				
Total units	7,937	18,016	57,701	83,654
Occupied housing units	7,497	15,044	52,482	75,023
Vacant units	440	2,972	5,219	8,631
Vacancy Rate (percent)	5.5	16.5	9.0	10.3
Median value (dollars)	228,300	107,500	189,400	175,067

Source: DOC 2006b.

Table 4–37 Percentage of Los Alamos National Laboratory Employees Residing in the Region of Influence

Year	*Los Alamos County*	*Rio Arriba County*	*Santa Fe County*	*Total*
1999	52.6	16.6	19.7	88.9
2000	52.6	17.0	20.1	89.7
2001	50.9	17.6	19.9	88.4
2002	49.5	17.5	20.8	87.7
2003	49.2	17.6	21.5	88.4
2004	48.3	18.5	21.6	88.4
2005	47.3	15.9	22.4	85.6

Sources: LANL 2003h, 2004f, 2005f, 2006g.

4.8.1.6 Local Government Finances

Local DOE activities directly and indirectly account for more than a third of employment, wage and salary income, and business activity in the Tri-County region. If there is a change in employment, employee incomes, or procurement at LANL, these changes would be expected to have an immediate and direct effect on city and county revenues, such as the gross receipts tax, in the Tri-County region (Lansford et al. 1996).

Table 4–38 shows the general funds revenues for the Tri-County region. Los Alamos County generates the highest revenues, more than double those of Santa Fe County and nearly 7 times those of Rio Arriba County. The general funds of these communities support the ongoing operations of their governments as well as community services such as police protection and parks and recreation. In Los Alamos County, the fire department serving LANL and the community is funded through a separate fund derived from DOE contract payments. In addition to the general fund, most governments have separate enterprise funds for utilities and capital improvements.

Table 4–38 General Funds Revenues in the Tri-County Region (Fiscal Year 2003)

Source	*Los Alamos County*	*Rio Arriba County* [a]	*Santa Fe County* [b]
Property Taxes	4,298,335	4,178,176	26,782,625
Gross Receipt Taxes	16,541,971	9,309,389	66,982,214
Oil, Gas and Mineral Taxes	Not available	7,256,598	0
Other Taxes, Penalties and Interest	428,236	721,654	9,426,917
Licenses, Permits, Fees and Service Charges	64,203,173	5,566,310	65,304,807
Misc. Income	Not available	3,536,397	16,905,470
Restricted Funds	Not available	5,146,384	16,928,997
Other	55,760,870	6,943,392	47,645,434
Total Receipts	141,232,585	42,658,300	249,976,464

[a] Includes revenues for Española.
[b] Includes revenues for the city of Santa Fe.
Source: LANL 2004c.

4.8.1.7 Services

New Mexico is divided into 89 school districts, 4 of which are predominantly within the Tri-County area. Total public school enrollment in these districts is 24,061 students for the 2005 to 2006 school year. In the Los Alamos School District, enrollment of 3,628 in 2005 to 2006 is essentially the same as it was 5 years earlier. Enrollment at the Española Public School District decreased by approximately 5 percent from 2000 to 2001 school year to the 2005 to 2006 school year; current enrollment is 4,702 students. At the Pojoaque Public School District, enrollment remained relatively stable over the same time frame with current enrollment at 1,991 students. Enrollment in the Santa Fe Public School District grew by 2.7 percent over that time frame to the current enrollment of 13,740 students (NMDOE 2002, NMPED 2006).

The Los Alamos County Fire Department provides fire suppression, medical, rescue, wildland fire suppression and fire prevention services to both LANL and the Los Alamos County community. There are six manned fire stations with 141 budgeted positions including 123 uniformed personnel (LAC 2006a).

The Los Alamos County Police Department has 31 officers and 10 detention staff. The ratio of commissioned police officers in Los Alamos County was 1.58 officers per 1,000 of population in 2000 compared to Albuquerque (2.02) or Santa Fe (2.14) (DOJ 2004).

Four hospitals serve the Tri-County region: Los Alamos Medical Center, Española Hospital, and St. Vincent Regional Medical Center and the Public Health Service Santa Fe Indian Hospital in Santa Fe. These hospitals have a bed capacity of 47, 80, 268, and 39, respectively (LAMC 2006, Presbyterian 2006, St. Vincent 2006, AHA 2007).

4.8.2 Infrastructure

Site infrastructure includes the physical resources required to support the construction and operation of LANL facilities. Utility infrastructure at LANL encompasses the electrical power, natural gas, steam, and water supply systems. Sanitary wastewater treatment and solid waste management are addressed in Sections 4.3 and 4.9, respectively. Transportation infrastructure is addressed in Section 4.10. There have been a number of developments at LANL regarding utility infrastructure since the *1999 SWEIS* was issued, both in terms of the trend in resource usage and infrastructure capacity availability as well as with regard to the purveyor of some utility services.

4.8.2.1 Electricity

Electrical service to LANL is supplied through a cooperative arrangement with Los Alamos County, known as the Los Alamos power pool, which was established in 1985. Electric power is supplied to the pool through two existing regional 115-kilovolt electric power lines. The first line (the Norton-Los Alamos line) is administered by DOE and originates from the Norton Substation east of White Rock, and the second line (the Reeves Line) is owned by the Public Service Company of New Mexico and originates from the Bernalillo-Algodones Substation south of LANL. Both substations are owned by the Public Service Company of New Mexico (DOE 2003d, LANL 2006g). These facilities are shown in **Figure 4–29**.

Import capacity is now limited only by the physical capability (thermal rating) of the transmission lines based on recent changes (as of August 1, 2002) in transmission agreements with the Public Service Company of New Mexico. The import capacity is approximately 110 to 120 megawatts from a number of hydroelectric, coal, and natural gas-powered generators throughout the western United States (LANL 2004c, 2006g). Previously, the pool's import capacity was contractually limited to 72 megawatts during the winter months and 94 megawatts during the spring and early summer months (DOE 1999a). In addition, renewable energy sources such as wind farms and solar plantations are providing a small (about 5 percent) but growing percentage of Public Service Company of New Mexico's total power portfolio (PNM Resources 2006, PSCNM 2006).

Within LANL, DOE also operates a natural gas-fired steam and electrical power generating plant at TA-3 (TA-3 Co-Generation Complex or Power Plant), which is currently capable of producing up to 20 megawatts of electric power that is shared by the power pool under contractual arrangement. Generally, onsite electricity production is used to fill the difference between peak loads and the electric power import capability. The DOE-maintained electric distribution system at LANL consists of various low-voltage transformers at LANL facilities and approximately 34 miles (55 kilometers) of 13.8-kilovolt distribution lines. It also consists of two older power distribution substations: the Eastern TA Substation and the TA-3 Substation (LANL 2004c; LANL 2006g). In 2002, DOE completed construction of the new Western TA Substation (see Figure 4–29). This 115-kilovolt (13.8-kilovolt distribution) substation has a main transformer rated at 56-megavolt-amperes or about 45 megawatts. The substation will provide redundant capacity for LANL and the Los Alamos Townsite in the event of an outage at either of LANL's two existing substations (LANL 2004c, 2006g).

The trends in peak electric load demand and total electrical energy consumption within the Los Alamos power pool are provided in **Table 4–39** and **Table 4–40**, respectively. Annual (fiscal year) observed peak load and total energy requirements for the period 1999 through 2005 are compared to projections made in the *1999 SWEIS* for the Expanded Operations Alternative. These data provide the basis for the projections made in Chapter 5 of this SWEIS.

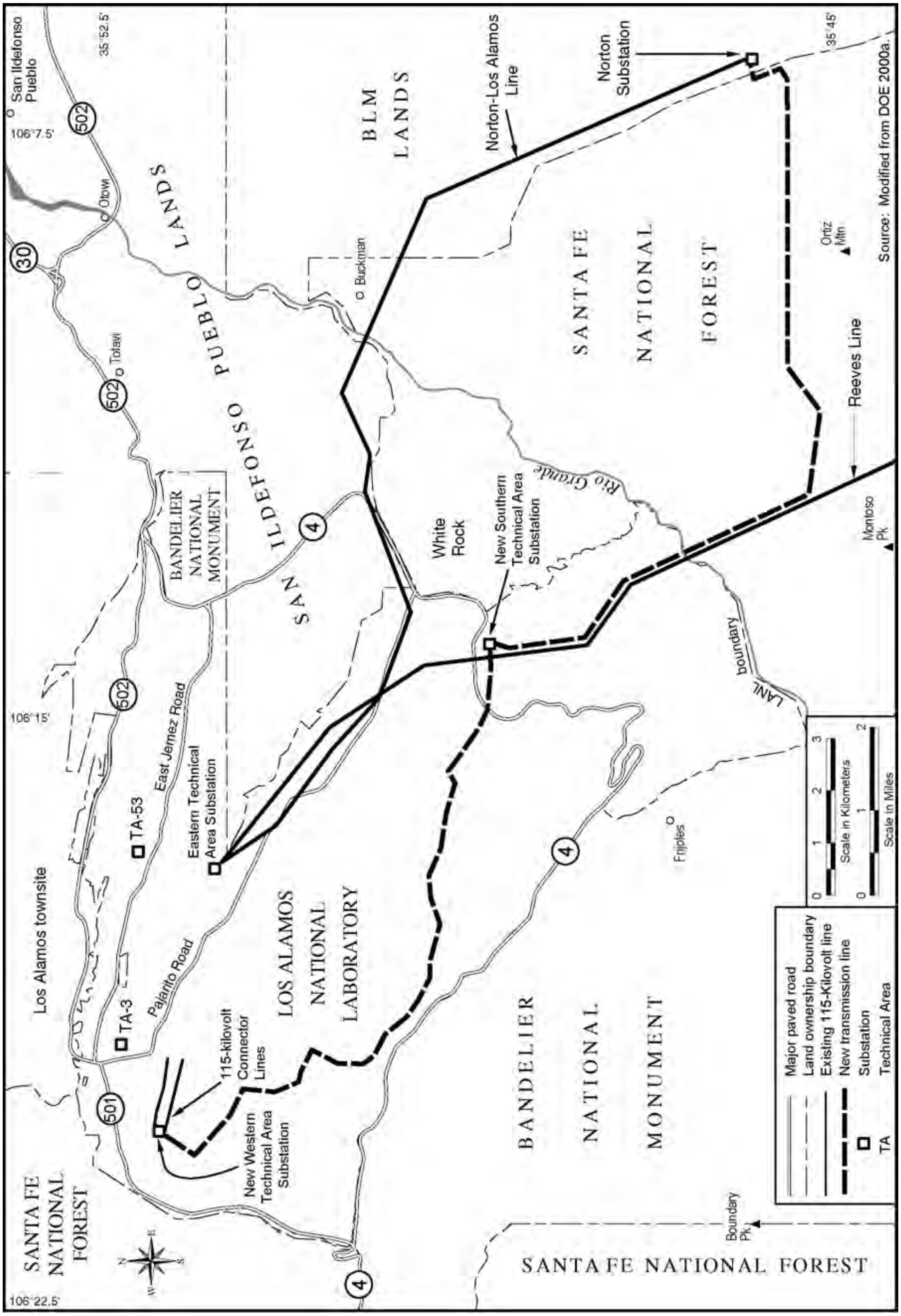


Figure 4–29 Los Alamos Area Electric Power Distribution System

Table 4–39 Trend in Peak Electric Load Demand for the Los Alamos Power Pool

Fiscal Year	*LANL Base*	*LANSCE*	*LANL Total*	*County Total*	*Pool Total*
1999 SWEIS [a]	50,000	63,000	113,000	Not projected	Not projected
1999	43,976	24,510	68,486	14,399	82,885
2000	45,104	20,343	65,447	15,176	80,623
2001	50,146	20,732	70,878	14,583	85,461
2002	45,809	20,938	66,747	16,653	83,400
2003	50,008	20,859	70,867	16,910	87,777
2004	47,608	21,811	69,419	16,231	85,650
2005	47,586	21,874	69,460	18,319	87,779

LANSCE = Los Alamos Neutron Science Center.
[a] Projections from the *1999 SWEIS* for the Expanded Operations Alternative.
Note: All values are in kilowatts consistent with the reporting convention used in the *LANL SWEIS Yearbooks*. To convert kilowatts to megawatts, divide by 1,000.
Sources: DOE 1999a; LANL 2000f, 2001e, 2002e, 2003h, 2004c, 2004f, 2006g.

Table 4–40 Trend in Total Electrical Energy Consumption for the Los Alamos Power Pool

Fiscal Year	*LANL Base*	*LANSCE*	*LANL Total*	*County Total*	*Pool Total*
1999 SWEIS [a]	345,000	437,000	782,000	Not projected	Not projected
1999	255,562	113,759	369,321	106,547	475,868
2000	263,970	117,183	381,153	112,216	493,369
2001	294,169	80,974	375,143	116,043	491,186
2002	299,422	94,966	394,398	121,013	515,401
2003	294,993	87,856	382,849	109,822	492,671
2004	327,117	86,275	413,392	127,429	540,821
2005	328,371	93,042	421,413	129,457	550,870

LANSCE = Los Alamos Neutron Science Center.
[a] Projections from the *1999 SWEIS* for the Expanded Operations Alternative (DOE 1999a).
Note: All values are in megawatt-hours. To convert megawatt-hours to kilowatt-hours, multiply by 1,000.
Sources: DOE 1999a; LANL 2004c, 2006g.

Electrical energy use at LANL remains below projections in the *1999 SWEIS*. Peak demand was projected to be 113 megawatts with 63 megawatts being used by LANSCE and about 50 megawatts being used by the rest of LANL. Annual electrical energy consumption was projected to be 782,000 megawatt-hours with 437,000 megawatt-hours being used by LANSCE and about 345,000 megawatt-hours being used by the rest of LANL. Actual use has fallen below these values to date, and the projected periods of brownouts have not occurred. On a regional basis, failures in the Public Service Company of New Mexico system have caused blackouts in northern New Mexico and elsewhere (LANL 2006g).

Historically, year-to-year fluctuations in LANL's total electrical energy use have largely been attributable to LANSCE operations. In recent years, an increase in LANL base peak load demand and particularly in base electrical energy use, independent of LANSCE operations, is evident. This is punctuated by the observed spike both in LANL base electrical energy use and in use by other Los Alamos County consumers since 2003 within the generally upward trend in total electricity demand (see Table 4–40).

Nevertheless, operations at several of the large LANL load centers have changed since 1999 including at LANSCE, which complicates attempts to forecast future electricity demands. For the past several years, LANSCE's electric load demand peaked with the rest of LANL, usually in July or August, but the peak load has now shifted to the winter (around January). This will change the overall electric demand for LANL, since LANSCE's peak load demand is such a large portion of the site's total peak load. Otherwise, LANSCE operations continued at reduced levels due to budgetary constraints that continued through fiscal year 2005. Also at TA-53, the Low-Energy Demonstration Accelerator which had not operated since fiscal year 2000 due to funding constraints was decommissioned in fiscal year 2003. This has reduced load demands by 2 to 4 megawatts (LANL 2006g). Regular, full-power operations of the Low-Energy Demonstration Accelerator as originally proposed would have tripled electric peak load demand to more than 60 megawatts, consistent with the projection from the *1999 SWEIS* (LANL 2006a). Further, while the National High Magnetic Field Laboratory in TA-35 has not operated since fiscal year 2000, the 60-Tesla superconducting magnet that failed in 2000 has been redesigned and reconstructed and has been operational since 2004 at about 2 megawatts of load. The DARHT facility began commissioning operations of its first axis in fiscal year 2001. The load level is about 1 megawatt for the first axis (LANL 2006g). LANL received authorization to begin full power operations of the second axis in January 2008.

Overall, in 2005 the total peak load was about 69.5 megawatts for LANL and about 18.3 megawatts for the rest of the power pool users (see Table 4–39). A total of 421,413 megawatt-hours of electricity were used at LANL in 2005. Other Los Alamos County users consumed an additional 129,457 megawatt-hours for a power pool total electric energy consumption of 550,870 megawatt-hours (see Table 4–40). Over the period 1999 to 2005, total maximum peak load demand has fluctuated, but has shown an upward trend, peaking again in 2005 when LANL and other Los Alamos County users required 59 percent of the capacity of the power pool. In a similar fashion, total maximum electric energy demand occurred in 2005 when 42 percent of the power pool system capacity was required. Electric power availability from the existing transmission system of the power pool is conservatively estimated at 963,600 megawatt-hours (reflecting the lower thermal rating of 110 megawatts for 8,760 hours per year available for import). An additional 20 megawatts (175,200 megawatt-hours per year) is currently available via the upgraded TA-3 Co-Generation Complex for a power pool total electric energy availability of 1,138,800 megawatt-hours.

The *1999 SWEIS* documented the limitations of the electric transmission lines that deliver electric power to the Los Alamos power pool, as well as the need to upgrade the aging TA-3 Co-Generation Complex and onsite electrical distribution system (DOE 1999a). Specifically, projects to improve the reliability of electric power transmission to the power pool include construction of a third transmission line and associated substation and uncrossing the two existing transmission lines (the Norton and Reeves Lines) where they cross on LANL (see Figure 4–29). The reliability of these lines in serving the power pool is compromised because they do not provide physically separate avenues for the delivery of power from independent power supply sources. The crossing of power lines results in a situation where a single outage event, such as a conductor or structural failure, could potentially cause a major power loss to the power pool. Loss of power from the regional electric system results in system isolation where the TA-3 Co-Generation Complex is the only source of sufficient capacity to prevent a total blackout. If such an event occurred when the TA-3 Co-Generation Complex was not operating or was being serviced or repaired, there would be no power available to the power pool. A single outage event could have serious and disruptive consequences to LANL and to the citizens of Los Alamos County. This vulnerability was noted by the Defense Nuclear Facilities Safety Board (LANL 2006g). For example, fire damage to transmission systems from the Cerro Grande Fire in 2000 resulted in the shutdown of both 115-kilovolt transmission lines. The steam turbines at the TA-3 Co-Generation Complex were operated and the critical electric power requirement of approximately 15 megawatts was maintained until the transmission lines could be repaired and power delivery through them resumed (LANL 2004c).

To address such situations, a new transmission line was proposed that would be constructed in two segments: (1) from the Norton Substation to a new substation (Southern TA) that is being constructed near White Rock, and (2) from the new Southern TA Substation to the Western TA Substation (see Figure 4–29). The first segment will be constructed at 345 kilovolts but operated in the short term at 115 kilovolts, as large pulse power loads at LANL will need the higher voltage in the future. The second segment will be constructed and operated at 115 kilovolts (LANL 2006g). Construction of the portion of the new transmission line from the Southern TA Substation to the Western TA Substation was completed in February 2006, and construction of the new Southern TA switchyard was finished in March 2006. Refurbishment of the existing Eastern TA Substation was completed in 2007. The project to uncross the two existing transmission lines is scheduled to be complete by 2010. The construction of the portion of the line from the Norton Substation to the Southern TA Substation is in the design phase (LANL 2006a).

In late 2005, project planning was initiated for a new TA-50 Substation on the existing LANL 115-kilovolt power distribution loop. The substation would be constructed with an installed transformer capacity of 50 megavolt-amperes (about 40 megawatts) and is intended to provide independent power feed to the existing TA-55 Plutonium Complex and new Chemistry and Metallurgy Research Replacement Building (LANL 2006a).

As previously described, onsite electrical generating capability for the power pool is limited by the existing TA-3 Co-Generation Complex, which is capable of producing up to 20 megawatts of electric power. Refurbishment of this facility began in 2003, and includes upgrades to the Number 3 steam turbine and to the steam path. The Number 3 steam turbine is currently a 10-megawatt unit, and rewinding of this unit is expected to increase its output to about 17 megawatts (LANL 2006g). However, due to limitations in auxiliary systems, including cooling water, the total net capacity of the TA-3 power plant will not increase. Refurbishment activities were completed in 2007 (LANL 2006a, 2006g). In addition, construction was completed on a new gas-fired combustion turbine generator at the TA-3 Co-Generation Complex. This new 20-megawatt unit also became operational in September 2007. A second generator may be constructed at a later date. At present, DOE has no timetable for installing the second new unit, which was proposed for reliability purposes only (LANL 2006a).

Also, as part of ongoing electric reliability upgrades at LANL, a conceptual design report for the Electrical Infrastructure and Safety Upgrades Project was completed in 1998. This project seeks to upgrade the electrical infrastructure in buildings throughout LANL to improve electrical safety. Thirty-one buildings were identified for upgrades and were prioritized based on the safety hazard they presented. Since then, the project has been coordinated with annual site planning activities, and subprojects have been removed from the list as the buildings have been identified for decommissioning and demolition. To date, five subprojects have been removed from the list, for a new total of 26 General Plant Projects. An evaluation of the LANL electrical safety maintenance backlog could increase the number of subprojects under the Electrical Infrastructure and Safety Upgrades Project. As of November 2006, five upgrade projects had been completed (TA-3-40-S&W, TA-3-40-N&E, TA-3-43, TA-16-200, TA-40-1), four projects were in construction (TA-3-261, TA-43-1, TA-46-31, TA-8-21), two projects were through design (TA-46-1, TA-53-2), and two projects were still undergoing final design (TA-48-1, TA-35-2) (LANL 2006a, 2006g).

4.8.2.2 Fuel

Natural gas is the primary heating fuel used at LANL and in Los Alamos County. The natural gas system includes a high-pressure main and distribution system to Los Alamos County and pressure-reducing stations at LANL buildings. LANL and the County both have delivery points where gas is monitored and measured (DOE 2003d). In August 1999, DOE sold the 130-mile-long (209-kilometer-long) main gas supply line and associated metering stations to the Public Service Company of New Mexico. This gas pipeline traverses the area from Kutz Canyon Processing Plant south of Bloomfield, New Mexico, to Los Alamos. Approximately 4 miles (6.4 kilometers) of the gas pipeline are within LANL boundaries (LANL 2006g). Natural gas is distributed to the point of use via some 62 miles (100 kilometers) of distribution piping (LANL 2000a).

Approximately 98 percent of the gas used by LANL is currently used for heating (both steam and hot air) with the TA-3 Co-Generation Complex being the principal user of natural gas at LANL. The remainder is used for steam-generated electrical power production at the TA-3 Co-Generation Complex (see Section 4.8.2.1) (LANL 2006g). The TA-3 Co-Generation Complex currently has three dual fuel boilers with associated steam turbine-generator sets, with natural gas being the primary fuel and No. 2 fuel oil available for use as a standby fuel (LANL 2003f). The low-pressure steam is supplied to the TA-3 district heating system and some process needs and the electricity is routed into the power grid. The TA-3 steam distribution system has about 5.3 miles (8.5 kilometers) of steam supply and condensate return lines (DOE 1999a). Steam for facility heating is also currently generated at the TA-21 steam plant. This facility has three relatively small boilers, each with only about 5 percent of the capacity of the units at the TA-3 Co-Generation Complex. They are primarily natural gas-fired but can also burn No. 2 fuel oil. Steam produced in the TA-21 steam plant is used to provide space heating for the buildings in TA-21. LANL also maintains about 200 other smaller boilers, which are primarily natural gas fired (LANL 2003f). As mentioned above, relatively small quantities of fuel oil are also stored at LANL as a backup fuel source for emergency generators.

The trends in natural gas consumption for the Los Alamos service area and associated steam production at LANL are provided in **Table 4–41** and **Table 4–42**, respectively. Annual (fiscal year) recorded natural gas consumption for the period 1999 through 2005 is compared to projections made in the *1999 SWEIS* for the Expanded Operations Alternative. Total LANL natural gas consumption remains below projections in the *1999 SWEIS*. Steam production was not projected in the *1999 SWEIS* but has been tracked at LANL as a secondary measure of energy consumption for facility heating and onsite electricity generation. Total LANL natural gas consumption was projected to be 1,840,000 decatherms annually (equivalent to approximately 1.84 billion cubic feet [52.1 million cubic meters]). As shown in Tables 4–41 and 4–42, total natural gas consumption and associated steam production has trended downward at LANL since 1999 in concert with a general decline in heating demand, while consumption for electricity production has fluctuated, sometimes dramatically, from year to year. The decline in heating demand in recent years is mainly attributable to warmer winters and secondarily due to replacement of older buildings and associated workforce consolidation into more energy-efficient structures. During fiscal year 2005, total LANL natural gas consumption was 1,187,855 decatherms (equivalent to about 1.19 billion cubic feet [33.7 million cubic meters]) and total steam production was 357,341 thousand pounds. For fiscal year 2005, natural gas consumption for electricity generation was again the lowest since issuance of the *1999 SWEIS*.

Table 4–41 Trend in Natural Gas Consumption for Los Alamos National Laboratory and Los Alamos County

Fiscal Year	*Natural Gas*			*Los Alamos County Consumption* [a]	*Total Los Alamos Area Consumption*
	Total LANL Consumption	*Total Used for Electric Production*	*Total Used for Heat Production*		
1999 SWEIS [b]	1,840,000	Not projected	Not projected	Not projected	Not projected
1999	1,428,568	241,490	1,187,078	No comparable data	No comparable data
2000	1,427,914	352,126	1,075,788	870,402	2,298,316
2001	1,492,635	273,312	1,219,323	928,329	2,420,964
2002	1,325,639	212,976	1,112,663	871,566	2,197,205
2003	1,220,137	41,632	1,178,505	933,439	2,153,576
2004	1,149,936	25,680	1,124,256	931,940	2,081,876
2005	1,187,855	20,086	1,167,768	943,559	2,111,327

[a] Los Alamos County's natural gas consumption data are based on its fiscal year, which runs from July to June, as opposed to the Federal fiscal year used by LANL, which runs from October to September.
[b] Projections from the *1999 SWEIS* for the Expanded Operations Alternative (DOE 1999a).
Note: All values are in decatherms. To convert decatherms to cubic feet, multiply by 1,000; cubic feet to cubic meters, multiply by 0.028317.
Sources: Arrowsmith 2005, 2006; DOE 1999a; LANL 2004c, 2006g.

Table 4–42 Trend in Steam Production for Los Alamos National Laboratory

Fiscal Year	*TA-3 Steam Production*	*TA-21 Steam Production*	*Total Steam Production*
1999	576,548	29,468	606,016
2000	634,758	27,840	662,598
2001	531,763	29,195	560,958
2002	478,007	26,206	504,213
2003	351,905	26,147	378,052
2004	347,110	23,910	371,020
2005	333,042	24,299	357,341

TA = technical area.
Note: All values are in thousands (1,000) of pounds which is the unit of measurement at LANL. To convert pounds to kilograms, multiply by 0.45359.
Sources: LANL 2004c, 2006g.

The observed downward trend in natural gas consumption at LANL is contrasted by the generally upward trend among other Los Alamos County users, which can be attributed to development and population growth within the region (see Table 4–41). In 2005, other Los Alamos County users consumed 943,559 decatherms (equivalent to about 944 million cubic feet [26.7 million cubic meters]) as compared to 870,402 decatherms (870 million cubic feet [24.6 million cubic meters]) in 2000. For 2005, total natural gas usage for the Los Alamos service area was 2,111,327 decatherms (equivalent to about 2.11 billion cubic feet [59.7 million cubic meters]). For the period, total maximum natural gas demand occurred in 2001 when LANL and other Los Alamos County users required 30 percent of the system supply capacity. However, natural gas is abundant in New Mexico, and the region has a high import capacity. The natural gas delivery system servicing the Los Alamos area has a contractually-limited capacity of about 8.07 billion cubic feet (229 million cubic meters) per year (DOE 2003d).

It was noted in the *1999 SWEIS* that the age of the natural gas transmission and distribution system serving LANL facilities and Los Alamos County dictated modification and upgrade. This need was stressed particularly should the TA-3 Co-Generation Plant be required to burn more natural gas to meet future electricity demands. Several segments of natural gas transmission and delivery pipeline have been upgraded, and redundant loops of pipeline have been installed across LANL and across New Mexico in general over the past two decades. The most recent major upgrades to the natural gas transmission line to LANL and Los Alamos County, which included the installation of relocated segments of redundant loops, occurred in the early to mid-1990s. Within that time frame, several additional segments of the aged supply pipeline, without redundant portions, were identified across northern New Mexico. Plans to provide redundant service supply were undertaken by Public Service Company of New Mexico to correct this supply system deficiency. A critical segment of 8.1-inch (20-centimeter) pipeline in Los Alamos County and within LANL's boundaries was identified as of being of non-standard size and construction making its replacement necessary.

DOE has issued an easement to the Public Service Commission of New Mexico to allow construction, operation, and maintenance of approximately 15,000 feet (4,500 meters) of 12-inch (30-centimeter) coated steel natural gas pipeline within LANL boundaries in Los Alamos Canyon. The new segment would replace the existing 8.1-inch (20-centimeter) segment, and would cross east across the site down Los Alamos Canyon from TA-21 to connect to the existing 12-inch (30-centimeter) coated steel gas transmission mainline located within the right-of-way of New Mexico 502 in TA-72 (DOE 2002h, NNSA 2005b). Construction of the pipeline was completed in late 2005, with tie-in to the existing transmission system that was completed at the end of 2006 (LANL 2006a).

4.8.2.3 Water

The Los Alamos County water production system consists of 14 deep wells, 153 miles (246 kilometers) of main distribution lines, pump stations, and storage tanks. The system supplies potable water to all of the County, LANL, and Bandelier National Monument. Specifically, the deep wells are located in three well fields (Guaje, Otowi, and Pajarito). Water is pumped into production lines, and booster pump stations lift this water to reservoir tanks for distribution. Prior to distribution, the entire water supply is disinfected with a process that replaces the formerly used chlorine disinfectant process (LANL 2004c, DOE 2003d).

On September 8, 1998, DOE transferred operation of the system from DOE to Los Alamos County under a lease agreement. Under the transfer agreement, DOE retained responsibility for operating the distribution system within LANL boundaries, whereas the county assumed full responsibility for ensuring compliance with Federal and state drinking water regulations. DOE's right to withdraw an equivalent of about 5,541 acre-feet or 1,806 million gallons (6,830 million liters) of water per year from the main aquifer and its right to purchase a water allocation of some 1,200 acre-feet or 391 million gallons (1,500 million liters) per year from the San Juan-Chama Transmountain Diversion Project were included in the transfer (DOE 2003d, LANL 2006g).

On September 5, 2001, DOE completed the transfer of ownership of the water production system to Los Alamos County, along with 70 percent (3,879 acre-feet or 1,264 million gallons [4,785 million liters] annually) of the DOE water rights. The remaining 30 percent (1,662 acre-feet or 542 million gallons [2,050 million liters] annually) of the water rights are leased by DOE to the County for 10 years, with the option to renew the lease for four additional 10-year terms. LANL is now considered a Los Alamos County water customer, and DOE is billed and pays for the water LANL uses. The current 10-year agreement (water service contract) with Los Alamos County, started in 1998, includes an escalating projection of future LANL water consumption (LANL 2006g). While the contract does not specify a supply limit to LANL, the water right owned by DOE and leased to the county (that is 1,662 acre-feet or 542 million gallons [2,050 million liters] per year) is a good target ceiling quantity under which LANL should remain (LANL 2001a). The distribution system serving LANL facilities now consists of a series of reservoir storage tanks, pipelines, and fire pumps. The LANL distribution system is gravity fed with pumps for high-demand fire situations at limited locations (LANL 2006g).

Los Alamos County continues to pursue the use of San Juan-Chama water as a means of preserving those water rights (DOE 2003d, LANL 2006g). Studies conducted in 2002 and 2003 determined the feasibility of accessing the San Juan-Chama water allocation by lifting it from the Rio Grande up onto the mesa that overlooks White Rock Canyon. Two options were evaluated for construction of a collector system that would allow the diversion of water from the layer of gravel beneath the Rio Grande. These include (1) pumping and piping the water from the Rio Grande up the side of White Rock Canyon and (2) boring a tunnel under the mesa and drilling a collector well on top to intercept the water flowing in the tunnel, which is environmentally preferable (LAC 2004b, Glasco 2005). Since completion of Los Alamos County's San Juan-Chama project water utilization study in 2004, other options under consideration by the county include direct delivery of project water to LANL in lieu of groundwater. This would facilitate a reduction in overall LANL water demand because of the large percentage of water used for cooling purposes at LANL. As a result, the use of the low-silica San Juan-Chama project water would allow LANL's cooling towers to be operated at higher (recirculation) cycles before the water must be discharged, resulting in lower total water use (Stephens 2006).

On September 19, 2006, New Mexico Governor Richardson signed new repayment contracts on behalf of five towns and cities and two counties, including Los Alamos County, that formally secured water rights with the Bureau of Reclamation for San Juan-Chama project water. Unlike the previous purchase form contracts, the repayment contract has no termination date, giving Los Alamos County and other municipalities perpetual rights and thus negating the need to renegotiate and renew contracts in the future. Los Alamos County will have permanent use of the water as long as it meets the terms of the contract (LAC 2006b, Newman 2006). Completion of this process was necessary before the County could move forward with additional investment in the project (Glasco 2005, LAC 2006b). Use of the San Juan-Chama project along with conservation are integral to the County's Long-Range Water Supply Plan, which was commissioned to provide a sustainable water supply for the next 40 years and was completed in August 2006 (Stephens 2006).

The trend in water use for LANL and other Los Alamos County users is shown in **Table 4–43**. Annual (fiscal year) observed water demands for the period 1999 through 2005 are compared to projections made in the *1999 SWEIS* for the Expanded Operations Alternative. Water use at LANL remains below projections made in the *1999 SWEIS*. In 2005, approximately 359.3 million gallons (1,360 million liters) of water were used at LANL. This was about 400 million gallons (1.51 billion liters) less than the *1999 SWEIS* projected consumption of 759 million gallons (2.87 billion liters) per year. Approximately 60 percent of LANL's water use has historically been used for cooling tower operation, resulting in evaporative losses (LANL 2001a). The three cooling towers at LANSCE historically required about 77 million gallons (291 million liters) of water annually, or about 15 percent of the water use for all of LANL (LANL 2006a). Construction of a new cooling tower (structures 53-963 and 53-952) was completed in 2000. These new units replaced cooling towers 53-60, 53-62, and 53-64, which have been taken off line (LANL 2006g).

Table 4–43 Trend in Water Use for Los Alamos National Laboratory and Los Alamos County

Calendar Year [a]	*LANL*	*Los Alamos County*	*Total*
1999 SWEIS [b]	759,000	Not projected	Not applicable
1999	453,094	880,282	1,333,376
2000	441,000	1,133,277	1,574,277
2001	393,123	1,033,764	1,426,887
2002	324,514	1,230,826	1,555,340
2003	377,768	1,179,799	1,557,567
2004	346,624	1,035,461	1,382,085
2005	359,252	1,033,923	1,393,175

[a] Water data are routinely collected and summarized by calendar year, rather than by fiscal year as is done for electricity and natural gas.
[b] Projection from the *1999 SWEIS* for the Expanded Operations Alternative.
Note: All values are in thousands (1,000) of gallons which is the unit of measurement at LANL. To convert thousands of gallons to millions of gallons, divide by 1,000; thousands of gallons to thousands of liters, multiply by 3.7854.
Sources: Arrowsmith 2006; DOE 1999a; Glasco 2005; LANL 2004c, 2006g.

Regular, full-power operation of the Low-Energy Demonstration Accelerator at LANSCE, now decommissioned as noted in Section 4.8.2.1, was originally forecast to more than double LANSCE's total water use after 2000, which was reflected in the *1999 SWEIS* projections for LANL site-wide water use (LANL 2006a). Current water use at LANL compared to the calculated NPDES-regulated industrial effluent discharge of 198.5 million gallons (751 million liters) in 2005 indicates that the site's consumptive water use (reflecting the volume evaporated or otherwise lost and not returned as effluent) is about 55 percent (LANL 2006g). Further, water demand at the site continues to be well below the 30 percent (1,662 acre-feet or 542 million gallons [2,050 million liters] per year) of DOE's water rights that are leased by DOE to the county. The firm rated capacity of the Los Alamos County water production system is 7,797 gallons per minute (29,500 liters per minute) or approximately 4.1 billion gallons (15.5 billion liters) annually. The firm rated capacity is the maximum amount of water that can be pumped immediately to meet peak demand (LANL 2001a).

While LANL total and consumptive water use has generally decreased from 1999 to 2005, water usage by other Los Alamos County users has exhibited a generally upward trend over the period. Water use by LANL and by other Los Alamos County users declined noticeably from 2003 to 2004, as 2003 was a very dry year in the Los Alamos area compared to 2004, which illustrates the close relationship between climate and water use in the arid Southwest. Water use for 2005 is very comparable to 2004. For the period, total maximum water demand occurred in 2000 (the year of the Cerro Grande wildfire) when LANL and other Los Alamos County users required 87 percent of the available water rights from the regional aquifer.

DOE continues to maintain the onsite distribution system by replacing portions of the greater than 50-year old system as problems arise. The condition of the water distribution system was identified as a concern in the *1999 SWEIS*. DOE is also in the process of installing additional water meters and a Supervisory Control and Data Acquisition and Equipment Surveillance System on the water distribution system to keep track of water usage and to determine the specific water use for various applications. Data are being accumulated to establish a baseline for conserving water. In remote areas, DOE is trying to automate monitoring of the system to be more responsive during emergencies such as the Cerro Grande Fire. DOE has instituted a number of conservation and gray-water[5]-reuse projects, including a cooling tower conservation project to reduce water usage further and ensure that future LANL initiatives are not limited by water availability. For example, treated wastewater from the Sanitary Wastewater System Plant at TA-46 is conveyed to the TA-3 Co-Generation Complex for reuse as cooling tower makeup water (LANL 2006g).

4.9 Waste Management and Pollution Prevention

A wide range of waste types are generated through activities at LANL related to research, production, maintenance, construction, decontamination, decommissioning, demolition and environmental restoration. These waste types include: wastewaters (sanitary liquid waste, high-explosive-contaminated liquid waste, and industrial effluent); solid (sanitary) waste, including routine household-type waste and construction and demolition debris; and radioactive and chemical wastes. These wastes, discussed in more detail in Section 4.9.1 through 4.9.3 below, are regulated by Federal and state regulations, applicable to specific waste classifications. Institutional requirements for waste management activities are determined and documented by the Laboratory Implementation Requirements Program. This program provides details on proper management of all process wastes and contaminated environmental media. The waste management operation tracks waste generating process; quantity; chemical and physical

[5] *Generally treated or untreated water that is not suitable for drinking but can be used for secondary purposes such as industrial cooling.*

characteristics; regulatory status; applicable treatment and disposal standards; and final disposition of the waste (LANL 2004f).

A significant portion of waste management operations take place in facilities designed for and dedicated to waste management. Liquid wastes are treated in the Sanitary Wastewater Systems Plant, the High Explosives Wastewater Treatment Facility, and the Radioactive Liquid Waste Treatment Facility. Specialized facilities in TA-50 and TA-54 house a variety of chemical and radioactive waste management operations, including size reduction, compaction, assaying, and storage. Many hazardous wastes are now accumulated for up to 90 days at consolidated storage facilities and are then shipped directly offsite. Four of these consolidated storage facilities exist at LANL and two more are planned (LANL 2003e)

Waste minimization and pollution prevention efforts at LANL are coordinated by the Pollution Prevention Program. Source reduction, including materials substitution and process improvements, is the preferred method of reducing waste. Recycling and reuse practices are also considered for wastes, together with volume reduction and treatment options. Progress in pollution prevention initiatives at LANL in measured annually against metrics approved by the DOE (LANL 2004l). In 1999, the DOE established the 2005 Pollution Prevention goals. These goals required that DOE meet the following waste reductions for routine waste, based on the 1993 baseline:

- greater than 80 percent reduction in low-level radioactive waste
- greater than 80 percent reduction in mixed low-level radioactive waste
- greater than 50 percent reduction in transuranic waste
- greater than 90 percent reduction in hazardous waste (includes New Mexico Special waste and Toxic Substances Control Act waste)
- greater than 10 percent reduction in clean up and stabilization waste
- greater than 55 percent reduction in per capita generation of solid sanitary waste
- greater than 50 percent recycle rate
- greater than 90 percent reduction in toxic release inventory chemical usage
- 100 percent replacement of specific ozone-depleting chillers
- 100 percent affirmative procurement purchases of EPA-designated recycled content items

DOE achieved an overall rating of 97 percent towards the DOE 2005 Pollution Prevention goals for fiscal year 2005. In 2004, DOE established a prevention-based Environmental Management System at LANL based on the International Standards Organization 14001 standard to meet DOE Order 450.1. The Environmental Management System is a systematic method for assessing mission activities, determining environmental impacts of those activities, prioritizing improvements, and measuring results (LANL 2004l). Environmental Management System action plans have been developed to address environmental issues, including objectives for pollution prevention, compliance and continual improvement.

4.9.1 Wastewater Treatment and Effluent Reduction

LANL has three primary sources of wastewater: sanitary liquid wastes, high explosives-contaminated liquid wastes, and industrial effluent. Radioactive liquid waste is addressed in Section 4.9.3.

4.9.1.1 Sanitary Liquid Waste

DOE continues to operate the TA-46 Sanitary Wastewater System Plant to treat liquid sanitary wastes, as described in the *1999 SWEIS*. Treated liquid effluent from the Sanitary Wastewater System Plant is pumped to storage tanks near the TA-3 Power Plant before being discharged to Sandia Canyon through NPDES-permitted outfall. The Sanitary Effluent Reclamation Facility treats some liquid effluent for reuse in the cooling towers at the Metropolis Center for Modeling and Simulation.

4.9.1.2 Sanitary Sludge

Sanitary sludge from the Sanitary Wastewater System Plant is dried for a minimum of 90 days to reduce pathogens and then disposed of as New Mexico Special Waste at an authorized, permitted landfill. The volume of sanitary sludge generated and disposed of by DOE is reported annually in the site environmental surveillance reports (for example, LANL 2005h).

Between 1997 and September 2000, sludge generated from the Sanitary Wastewater System Plant was managed as polychlorinated biphenyl-contaminated (50 to 499 parts per million) waste in accordance with the Toxic Substances Control Act and disposed of at a Toxic Substances Control Act-permitted landfill. This management practice was necessary because low-levels of polychlorinated biphenyls (less than 5 parts per million) had been repeatedly detected in the sludge. During this time, DOE completed an investigation that identified the source of the polychlorinated biphenyls and subsequently completed a cleanup of contaminated sewer lines. After cleanup was completed and verified by sampling, DOE notified EPA and began managing Sanitary Wastewater System sludge as New Mexico Special Waste (LANL 2001f, 2002d, 2004a, 2004d). Additional information may be found in the site annual environmental surveillance reports.

4.9.1.3 High Explosives-Contaminated Liquid Wastes

The High Explosives Wastewater Treatment Facility, located in TA-16, became fully operational in 1997. The High Explosives Wastewater Treatment Facility treats process waters containing high-explosive compounds, using three treatment technologies. Sand filtration is used to remove particulate high explosives; activated carbon is used to remove organic compounds and dissolved high explosives; and ion exchange units are used to remove perchlorate and barium. The High Explosives Wastewater Treatment Facility receives some wastewaters by truck from processing facilities located outside TA-16 (DOE 1999a, LANL 1999b).

Equipment upgrades were performed to replace water-sealed vacuum pumps and wet high explosives collection systems with systems that do not use water. In addition, sources of non-high explosives industrial wastewater have been eliminated from the high explosives processing areas (DOE 1999a). These upgrades have resulted in a significant reduction in quantities of high explosives wastewater treated and effluent discharged to NPDES-permitted outfalls. In 2005, the High Explosives Wastewater Treatment Facility discharged about 30,000 gallons (114,000 liters) to an outfall, compared to the *1999 SWEIS* projection of 170,000 gallons (644,000 liters) (LANL 2006g).

4.9.1.4 Industrial Effluent

Industrial effluent is discharged to a number of NPDES-permitted outfalls across LANL. Currently, LANL discharges wastewater to a total of 21 outfalls, down from the 55 outfalls identified in the *1999 SWEIS*. An effort to reduce the number of outfalls was initiated in 1997, with significant reductions realized in 1997 and 1998. Most of these reductions resulted from changes at the High-Explosives Processing Key Facility and High Explosives Testing Key Facility, with the redirection of some flows to the sewage plant at TA-46, and the routing of high explosives-contaminated flows through the High Explosives Wastewater Treatment Facility (LANL 2003h).

Discharges to outfalls are regulated under an NPDES permit, effective February 1, 2001. At most outfalls, actual flows are recorded by flow meters; at the remaining outfalls, flow is estimated based on instantaneous flows measured during field visits. With the exception of discharges during 1999, total discharges for the period of 1998 through 2005 from LANL outfalls have fallen within *1999 SWEIS* projections (LANL 2003h, 2004f, 2005f, 2006g).

4.9.2 Solid Waste

Sanitary solid waste is excess material that is not radioactive or hazardous and can be disposed of in a solid waste landfill. Solid waste generated at LANL is disposed of at the Los Alamos County Landfill, located within LANL boundaries, but operated by Los Alamos County. Solid waste includes paper, cardboard, plastic, glass, office supplies and furniture, food waste, brush, and construction and demolition debris. Through an aggressive waste minimization and recycling program, the amount of solid waste at LANL requiring disposal has been greatly reduced. In 2004, 6,380 tons (5,789 metric tons) of solid waste were generated at LANL, of which 4,240 tons (3,847 metric tons) was recycled (LANL 2004l). The per capita generation of routine solid waste (food, paper, plastic) at LANL has decreased by about 58 percent over the 10-year period from 1993 through 2003 (LANL 2004f). Nonroutine solid waste is generated by construction and demolition projects, and also includes waste generated by Cerro Grande Rehabilitation Project cleanup activities. Recycling of sanitary waste currently stands at 60 percent compared to 1993, when LANL recycled only about 10 percent of the sanitary waste. In 2005, the total amount of recycled sanitary waste reached 4,417 tons (4,007 metric tons), an increase from 2004 (LANL 2006g).

The *1999 SWEIS* projected that the Los Alamos County Landfill would not reach capacity until 2014, however, in accordance with direction from NMED, the County plans on closing the landfill (LAC 2006c). The landfill is expected to operate until fall 2008, when a new transfer station, operated by the County, will be used to sort and ship LANL sanitary wastes to a solid waste landfill outside the county (DOE 2005a).

Construction and Demolition Debris—Construction and demolition debris is regulated as a separate category of solid waste under the New Mexico Solid Waste Regulations. Construction and demolition debris is not hazardous and may be disposed of in a municipal landfill or a construction and demolition debris landfill (NMAC 20.9.1). This category of waste was included in the chemical waste projections in the *1999 SWEIS* and continues to be tracked as chemical waste in the *SWEIS Yearbooks*. Although construction and demolition debris continue to be included in the chemical waste category, recent LANL tracking and projection efforts also have created a subcategory for construction and demolition debris. In 2005, approximately 78 percent of the uncontaminated construction and demolition waste was recycled. The total amount of construction waste generated in 2005 increased by 10 percent from 2004 (LANL 2006g).

4.9.3 Radioactive and Chemical Waste

Radioactive and chemical wastes are generated by research, production, maintenance, construction and environmental cleanup activities. Radioactive wastes are divided into the following categories: low-level; mixed low-level; transuranic; and mixed transuranic. Chemical wastes are a broad category including hazardous waste (designated under the RCRA regulations), toxic waste, construction and demolition debris, and special waste. Waste quantities vary with level and type of operation, construction activities, and implementation of waste minimization activities. Waste minimization efforts have resulted in overall waste reduction across most categories, due to process improvements and substitutions of nonhazardous chemicals for commonly used hazardous chemicals (LANL 2004f).

Most wastes generated are subsequently managed through the LANL waste treatment, storage, and disposal infrastructure. This section evaluates waste generation rates and the capabilities of that infrastructure. An increasing amount of waste, including wastes generated through environmental restoration activities, are shipped directly from the point of generation to offsite facilities; these wastes have little impact on the LANL waste management infrastructure (LANL 2004g).

Table 4–44 summarizes the radioactive and chemical waste quantities generated from 1999 through 2004 by waste type. The quantities include contributions across LANL, including Key Facilities, non-Key Facilities and the LANL environmental restoration activities. Projections from the ROD for the *1999 SWEIS* are included for comparison.

Site-wide waste quantities for the 7-year period from 1999 through 2005 generally were below projections presented in the *1999 SWEIS* for all waste types, with a few exceptions discussed below. For each waste type, significant variances from the *1999 SWEIS* ROD projections are noted in footnotes to the waste generation tables that follow. Most variances are due to one-time events, such as maintenance, construction, or remediation activities, rather than higher quantities of operations waste. For most waste types, the quantities produced across LANL facilities did not approach the levels projected in the *1999 SWEIS*. Waste minimization efforts have reduced waste generation rates for specific waste types as facility processes were improved and nonhazardous product substitutions were implemented. In some cases, facility workloads were less than expected, resulting in less waste generated. Additional comparisons to *1999 SWEIS* projections are presented in the waste-specific sections that follow.

Table 4–44 Los Alamos National Laboratory Waste Types and Generation

Waste Type	*Units*	*1999 SWEIS ROD Projection*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Low-Level Radioactive Waste	cubic yards per year	16,000 [a]	2,190	5,530	3,400	9,560	7,640	19,400	7,080
Mixed Low-Level Radioactive Waste	cubic yards per year	830	30	780	80	30	50	50	90
Transuranic Waste	cubic yards per year	440	190	160	150	160	530	50	100
Mixed Transuranic Waste	cubic yards per year	150	110	120	60	110	210	30	130
Chemical Waste	10^3 pounds per year	7,160	34,000	61,000	60,800	3,820	1,520	2,460	4,340

ROD = Record of Decision.
[a] Values are rounded.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.4536.
Sources: LANL 2003h, 2004f, 2005f, 2006g.

Low-Level Radioactive Wastes—Low-level radioactive waste is defined as waste that is radioactive and does not fall within any of the following classifications: high-level radioactive waste, transuranic waste, spent nuclear fuel, or by-product materials (uranium and thorium mill tailings). These wastes are generated at LANL when materials, equipment, and water are used in radiological control areas as part of the work activities; when these contaminated items are no longer useable, they are removed from the area as low-level radioactive waste. Typical waste streams include: laboratory equipment, service and utility equipment, plastic bottles, disposable wipes, plastic sheeting and bags, paper, and electronic equipment (LANL 2004l). Environmental restoration and decontamination, decommissioning, and demolition (DD&D) activities also generate low-level radioactive waste, primarily in the form of contaminated soils and debris.

Most low-level radioactive waste generated at LANL is disposed of onsite at TA-54, Area G. Disposal operations expanded into Zone 4, providing sufficient capacity for operational wastes for the long term. The facility-specific low-level radioactive waste generation rates for the 7-year period are shown in **Table 4–45**. Contributions from non-Key Facilities exceeded *1999 SWEIS* projections for several years, primarily due to heightened operational activities and new construction (LANL 2004f, 2005f, 2006g). Although there were several instances of individual facilities exceeding *1999 SWEIS* projections, overall LANL low-level radioactive waste generation was well below those levels predicted in the *1999 SWEIS* for 6 years of the 7-year period. In 2004, the *1999 SWEIS* projection was exceeded due to heightened activities and new construction at non-Key Facilities (LANL 2005f).

Table 4–45 Low-Level Radioactive Waste Generation at Los Alamos National Laboratory by Facility (cubic yards per year)

Facility	*SWEIS ROD*	*1999* [a]	*2000* [a]	*2001* [a]	*2002* [a]	*2003* [b]	*2004* [c]	*2005* [d]
Chemistry and Metallurgy Research Building	2,380	240	345	586	509	553	175	237
Sigma Complex	1,256	80	68	< 1	264	162	< 1	83
Machine Shops	793	53	535	29	58	20	20	175
Materials Science Laboratory	0	0	0	0	0	0	0	0
High-Explosives Processing	21	11	4	1	11	37	0	5
High-Explosives Testing	1,229	< 1	< 1	0	0	0	114	< 1
Tritium Facilities	628	62	64	0	118	143	33	65
Pajarito Site	190	41	18	17	0	13	0	0
Target Fabrication Facility	13	0	0	< 1	< 1	0	0	0
Biological Sciences	45	18	0	0	0	0	4	8
Radiochemistry Laboratory	353	52	75	72	45	102	23	38
Radioactive Liquid Waste Treatment Facility	209	229	173	676 [e]	252	510 [f]	464 [g]	339 [h]
Los Alamos Neutron Science Center	1,419	92	37	< 1	0	92	3	67
Solid Radioactive and Chemical Waste Facilities	228	28	17	18	46	267	54	368 [i]
Plutonium Facilities	986 [j]	451	260	392	388	513	247	380
Total low-level radioactive waste for Key Facilities	9,750	1,358	1,597	1,794	1,692	2,412	1,138	1,766
Non-Key Facilities	680	458	3,637 [k]	744	698	4,948 [l]	18,262 [m]	1,368 [n]
Total low-level radioactive waste for Key and non-Key Facilities	10,430	1,816	5,234	2,538	2,390	7,366	19,400	3,134
Percentage of Total from Key Facilities	**94**	**75**	**44**	**71**	**71**	**33**	**6**	**56**
Environmental Restoration	5,572	374	296	812	7,173	283	1	3,945
Total low-level radioactive waste for non-Key Facilities and Environmental Restoration	6,252	832	3,933	1,556	7,871	5,231	18,263	5,313
Total low-level radioactive waste = Key + non-Key Facilities and Environmental Restoration	16,002	2,190	5,530	3,350	9,563	7,643	19,401	7,079
Percentage of Total from Key Facilities	**61**	**62**	**29**	**54**	**18**	**32**	**6**	**25**

ROD = Record of Decision.
[a] LANL 2003h.
[b] LANL 2004f.
[c] LANL 2005f.
[d] LANL 2006g.
[e] Amount includes approximately 497 cubic yards of water transferred to TA-53, due to high tritium content (LANL 2003h).
[f] *1999 SWEIS* ROD projection exceeded due in part to the removal of sludge from the concrete storage tank in WM-2 (LANL 2004f).
[g] *1999 SWEIS* ROD projection exceeded due to the generation of 46 cubic yards of water pumped from manholes, 194 cubic yards of aqueous evaporator bottoms, and 136 cubic yards of soil associated with construction of new influent tanks (LANL 2005f).
[h] *1999 SWEIS* ROD projection exceeded due to soil and debris generated during tank installation and the generation of aqueous evaporator bottoms (LANL 2006g).
[i] *1999 SWEIS* ROD projection exceeded due to empty drums resulting from repackaging of transuranic waste (LANL 2006g).
[j] Includes estimates of waste generated from the facility upgrades associated with pit fabrication (LANL 2003h).
[k] Amount includes waste generated from decontamination and demolition activities and from soil and sediment removal in Mortandad and Los Alamos Canyons (LANL 2003h).
[l] *1999 SWEIS* ROD projection exceeded due to heightened activities and new construction (LANL 2004f).
[m] *1999 SWEIS* ROD projection exceeded due to heightened activities and new construction (LANL 2005f).
[n] *1999 SWEIS* ROD projection exceeded due to heightened activities and new construction (LANL 2006g).
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Mixed Low-Level Radioactive Wastes—Mixed low-level radioactive waste is waste that contains both low-level radioactive waste and hazardous waste as defined by the RCRA. Most of the operational mixed low-level radioactive waste is generated by the stockpile stewardship and research and development programs. Typical waste streams include: contaminated lead shielding bricks and debris, spent chemical solutions, fluorescent light bulbs, copper solder joints, and used oil. Environmental restoration and DD&D activities also produce some mixed low-level radioactive waste (LANL 2004l).

The facility-specific mixed low-level radioactive waste generation rates for the 7-year period are shown in **Table 4–46**. Although there were some facility-specific variances with *1999 SWEIS* projections of mixed low-level radioactive waste, LANL-wide quantities were relatively low. The largest single contributor to mixed low-level radioactive waste generation was the remediation of material disposal area (MDA) P (LANL 2004f). Overall LANL mixed low-level radioactive waste generation was below the *1999 SWEIS* projections for each year of the 7-year period.

Transuranic Wastes—Transuranic waste is waste containing greater than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years. This type of waste contains radioactive isotopes such as plutonium, neptunium, americium and curium. Specific categories are excluded from the definition of transuranic waste: 1) high-level waste; 2) waste that DOE has determined, and EPA has concurred, does not need the same degree of isolation as most transuranic waste; and 3) waste that the Nuclear Regulatory Commission has approved, on a case-by-case basis, for disposal at a low-level radioactive waste facility (LANL 2004l).

Transuranic waste is generated during research, development, and stockpile manufacturing and management activities. The waste forms include contaminated scrap and residues, plastics, lead gloves, glass, and personnel protective equipment. Transuranic waste may also be generated through environmental restoration, legacy waste retrieval, offsite source recovery, and DD&D activities. Transuranic waste is characterized and certified prior to shipment to the Waste Isolation Pilot Plant (WIPP) (LANL 2004l).

The facility-specific transuranic waste generation rates for the 7-year period are shown in **Table 4–47**. Non-Key Facilities exceeded *1999 SWEIS* projections for the years 2000 through 2005; these exceedances are all attributable to the Off-Site Source Recovery Project (LANL 2003h, LANL 2004f, LANL 2006g). Overall transuranic waste generation at LANL was well below the *1999 SWEIS* projections for 6 years of the 7-year period. In 2003, transuranic waste quantities exceeded the LANL-wide *1999 SWEIS* projection due to: (1) repackaging of legacy waste for shipment to WIPP, and (2) receipt and storage of waste by the Off-Site Source Recovery Project (LANL 2004f).

Table 4–46 Mixed Low-Level Radioactive Waste Generation at Los Alamos National Laboratory by Facility (cubic yards per year)

Facility	*SWEIS ROD*	*1999* [a]	*2000* [a]	*2001* [a]	*2002* [a]	*2003* [b]	*2004* [c]	*2005* [d]
Chemistry and Metallurgy Research Building	25	< 1	< 1	< 1	1	6	< 1	6
Sigma Complex	5	< 1	0	2	0	0	7	0
Machine Shops	0	0	< 1	< 1	0	0	0	0
Materials Science Laboratory	0	< 1	0	0	0	0	0	0
High-Explosives Processing	0.3	0	0	0	0	0	0	0
High-Explosives Testing	1	0	0	0	0	0	25 [e]	0
Tritium Facilities	4	0	0	< 1	1	2	< 1	< 1
Pajarito Site	2	10 [f]	0	0	0	0	0	0
Target Fabrication Facility	0.5	0	0	0	0	0	< 1	0
Biological Sciences	4	< 1	0	0	0	0	0	0
Radiochemistry Laboratory	5	< 1	2	4	3	8	2	< 1
Radioactive Liquid Waste Treatment Facility	0	4 [g]	3 [g]	3 [g]	5 [g]	0	< 1	0
Los Alamos Neutron Science Center	1	< 1	6	< 1	1	< 1	0	< 1
Solid Radioactive and Chemical Waste Facilities	5	0	0	0	0	0	0	0
Plutonium Facilities	17 [h]	5	2	17	4	5	2	17
Total mixed low-level radioactive waste for Key Facilities	70	25	15	30	15	22	40	26
Non-Key Facilities	39	3	13	12	11	26	13	3
Total mixed low-level radioactive waste for Key and non-Key Facilities	109	28	28	42	26	48	53	29
Percentage of Total from Key Facilities	**65**	**89**	**52**	**71**	**58**	**45**	**75**	**90**
Environmental Restoration	717	2	755 [i]	38	0	0	0	66
Total mixed low-level radioactive waste for non-Key Facilities and Environmental Restoration	756	5	768	50	11	26	13	69
Total mixed low-level radioactive waste = Key + non-Key Facilities and Environmental Restoration	826	30	783	80	26	48	53	95
Percentage of Total from Key Facilities	**9**	**83**	**2**	**38**	**58**	**45**	**75**	**27**

ROD = Record of Decision.
[a] LANL 2003h.
[b] LANL 2004f.
[c] LANL 2005f.
[d] LANL 2006g.
[e] Amount consisted mostly of lead bricks and shielding, contaminated with beryllium and depleted uranium (LANL 2005f).
[f] *1999 SWEIS* ROD projection exceeded due to maintenance activities (LANL 2003h).
[g] *1999 SWEIS* ROD projections did not envision use of Resource Conservation and Recovery Act listed hazardous chemicals in the facility or the resulting mixed waste (LANL 2003h).
[h] Includes estimates of waste generated from the facility upgrades associated with pit fabrication (LANL 2003h).
[i] Amount includes 751 cubic yards of waste generated as the result of emergency cleanups following the Cerro Grande Fire (LANL 2003h).
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Table 4–47 Transuranic Waste Generation at Los Alamos National Laboratory by Facility (cubic yards per year)

Facility	*SWEIS ROD*	*1999* [a]	*2000* [a]	*2001* [a]	*2002* [a]	*2003* [b]	*2004* [c]	*2005* [d]
Chemistry and Metallurgy Research Building	37 [e]	12	32	61 [f]	13	10	6	12
Sigma Complex	0	0	0	0	0	0	0	0
Machine Shops	0	0	0	0	0	0	0	0
Materials Science Laboratory	0	0	0	0	0	0	0	0
High-Explosives Processing	0	0	0	0	0	0	0	0
High-Explosives Testing (listed as transuranic/mixed transuranic)	0.3	0	0	0	0	0	0	0
Tritium Facilities	0	0	0	0	0	0	0	0
Pajarito Site	0	0	0	0	0	0	0	0
Target Fabrication Facility	0	0	0	0	0	0	0	0
Biological Sciences	0	0	0	0	0	0	0	0
Radiochemistry Laboratory	0	0	0	0	0	2	< 1	0
Radioactive Liquid Waste Treatment Facility	39	0	21	< 1	3	0	0	0
Los Alamos Neutron Science Center	0	0	0	0	0	0	0	0
Solid Radioactive and Chemical Waste Facilities	35	52	35	13	39	115 [g]	0	< 1
Plutonium Facilities	310 [e]	123	71	47	53	283	18	62
Total transuranic Waste for Key Facilities	421	187	159	122	108	410	25	75
Non-Key Facilities [h]	0	0	4	32	48	118	28	23
Total transuranic Waste for Key and non-Key Facilities	421	187	163	154	156	528	53	98
Percentage of Total from Key Facilities	**100**	**100**	**98**	**79**	**69**	**78**	**47**	**76**
Environmental Restoration	14	0	0	0	0	0	0	0
Total transuranic Waste for non-Key Facilities and Environmental Restoration	14	0	4	32	48	118	28	23
Total transuranic = Key + non-Key Facilities and Environmental Restoration	436	187	163	154	156	528	53	98
Percentage of Total from Key Facilities	**97**	**100**	**98**	**79**	**69**	**78**	**47**	**76**

ROD = Record of Decision.
[a] LANL 2003h.
[b] LANL 2004f.
[c] LANL 2005f.
[d] LANL 2006g.
[e] *1999 SWEIS* projections modified to reflect the ROD determination to produce nominally 20 pits per year (LANL 2003h).
[f] *1999 SWEIS* ROD projection exceeded due to remodeling activities (LANL 2003h).
[g] *1999 SWEIS* ROD projection exceeded due to Decontamination and Volume Reduction System repackaging of legacy transuranic waste (LANL 2004f).
[h] *1999 SWEIS* ROD projections exceeded due to wastes received by the Off-Site Source Recovery Project. Because this waste comes from shipping and receiving, it is attributed to non-Key Facilities (LANL 2003h, 2004f, 2005f, 2006g).
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Mixed Transuranic Wastes—Mixed transuranic waste is waste that contains both transuranic waste and hazardous waste as defined by RCRA. Mixed transuranic waste is generated through research, development, and stockpile manufacturing and management activities. The waste forms include contaminated scrap and residues, plastics, lead gloves, glass, and personnel protective equipment. Mixed transuranic waste may also be generated through environmental restoration, legacy waste retrieval, and DD&D activities. Mixed transuranic waste is characterized and certified prior to shipment to the WIPP (LANL 2004l).

The facility-specific mixed transuranic waste generation rates for the 7-year period are shown in **Table 4–48**. Generally, facility-specific generation rates are within the *1999 SWEIS* projections, with only a limited number of facilities producing mixed transuranic wastes. In the year 2000, Non-Key Facilities generated 82 cubic yards (63 cubic meters) of mixed transuranic waste compared to a *1999 SWEIS* projection of zero; the mixed transuranic waste generation for this category is solely attributable to the Transuranic Waste Inspection and Storage Project drum retrieval project (LANL 2001e). The Solid Radioactive and Chemical Waste Facilities generated mixed transuranic waste beyond that projected for the years 2000 through 2004, most notably in 2003 due to increased rates of transuranic waste repackaging for shipment to WIPP (LANL 2003h, LANL 2004f, LANL 2005f). The increasing trend, through 2003, in mixed transuranic waste generation for the Plutonium Complex and the Chemistry and Metallurgy Research Building reflect operations scaling toward full-scale production of war reserve pits (LANL 2004f). In 2004, mixed transuranic waste generation rates at the Plutonium Complex and Chemistry and Metallurgy Research Building were lower due to the 2004 work suspension and less than full-scale production (LANL 2005f). Overall mixed transuranic waste generation at LANL was below the *1999 SWEIS* projections for 6 years of the 7-year period. In 2003, mixed transuranic waste quantities exceeded the *1999 SWEIS* projection due to repackaging of legacy waste for shipment to WIPP (LANL 2004f).

Chemical Wastes—At LANL, chemical wastes are defined as a broad category including: hazardous waste (designated under RCRA regulations); toxic waste (asbestos and polychlorinated biphenyls, designated under the Toxic Substances Control Act); and special waste (designated under the New Mexico Solid Waste Regulations and including industrial waste, infectious waste, and petroleum contaminated soils). Construction and demolition debris was also included in the chemical waste category in the *1999 SWEIS* and continues to be tracked as chemical waste in the *SWEIS Yearbooks*, although this debris is disposed of as solid waste. The chemical waste category also includes all other nonradioactive waste that is managed through the Solid Chemical and Radioactive Waste Facilities, generally because the waste type is not accepted by solid waste disposal facilities (LANL 2005f). Typical hazardous waste streams include solvents, unused chemicals, acids and bases, solids such as barium-containing explosive materials, laboratory trash, and cleanup materials such as rags. Chemical waste is generated by many routine operations throughout LANL and also by environmental restoration and DD&D activities (LANL 2004l).

Table 4–48 Mixed Transuranic Waste Generation at Los Alamos National Laboratory by Facility (cubic yards per year)

Facility	*SWEIS ROD*	*1999* [a]	*2000* [a]	*2001* [a]	*2002* [a]	*2003* [b]	*2004* [c]	*2005* [d]
Chemistry and Metallurgy Research Building	17 [e]	3	1	1	22 [f]	15	< 1	4
Sigma Complex	0	0	0	0	0	0	0	0
Machine Shops	0	0	0	0	0	0	0	0
Materials Science Laboratory	0	0	0	0	0	0	0	0
High-Explosives Processing	0	0	0	0	0	0	0	0
High-Explosives Testing (Listed as transuranic/Mixed transuranic)	0.3	0	0	0	0	0	0	0
Tritium Facilities	0	0	0	0	0	0	0	0
Pajarito Site	0	0	0	0	0	0	0	0
Target Fabrication Facility	0	0	0	0	0	0	0	0
Biological Sciences	0	0	0	0	0	0	0	0
Radiochemistry Laboratory	0	0	0	0	0	0	0	0
Radioactive Liquid Waste Treatment Facility	0	6	0	6	< 1	4	0	0
Los Alamos Neutron Science Center	0	0	0	0	0	0	0	0
Solid Radioactive and Chemical Waste Facilities	0	0	10	17	20	77 [g]	< 1	3
Plutonium Facilities	133 [e]	86	22	39	72	102	31	125
Total of Mixed transuranic for Key Facilities	150	95	33	63	115	198	33	132
Non-Key Facilities	0	20	82	0	< 1	8 [h]	0	< 1
Total Mixed transuranic Waste for Key and non-Key Facilities	150	114	116	63	114	206	31	133
Percentage Total from Key Facilities	**100**	**83**	**29**	**100**	**99**	**96**	**100**	**99**
Environmental Restoration	0	0	0	< 1	0	0	0	0
Total of Mixed transuranic Waste for non-Key Facilities and Environmental Restoration	0	20	82	< 1	< 1	8	0	< 1
Total Mixed transuranic = Key + non-Key Facilities and Environmental Restoration	150	115	115	63	116	206	33	133
Percentage of Total from Key Facilities	**100**	**83**	**29**	**99**	**99**	**96**	**100**	**99**

ROD = Record of Decision.
[a] LANL 2003h.
[b] LANL 2004f.
[c] LANL 2005f.
[d] LANL 2006g.
[e] *1999 SWEIS* projections modified to reflect the ROD determination to produce nominally 20 pits per year (LANL 2003h).
[f] *1999 SWEIS* ROD projection exceeded due to remodeling activities (LANL 2003h).
[g] *1999 SWEIS* ROD projection exceeded due to Decontamination and Volume Reduction System repackaging of legacy transuranic waste (LANL 2004f).
[h] Waste generated by recovery operations at Area G involving new compactible fiberglass-reinforced crates. Because this waste was generated at a building not identified as part of the Solid Radioactive and Chemical Waste Key Facility, it is attributed to non-Key Facilities (LANL 2006g).
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

The facility-specific chemical waste generation rates for the 7-year period are shown in **Table 4–49**. From 1999 through 2001, large quantities of chemical wastes were generated by environmental restoration activities through cleanups in TA-16, including MDA P, PRS 3-056(c) in TA-3, and MDA R (LANL 2003h). Wastes generated by environmental restoration activities generally are shipped offsite for treatment and disposal and do not directly impact LANL waste management resources. Numerous facility-specific variances to the *1999 SWEIS* ROD projections occurred, mostly due to one-time events as documented in Table 4–49.

Table 4–49 Chemical Waste Generated at Los Alamos National Laboratory by Facility (pounds per year)

Facility	*SWEIS ROD*	*1999* [a]	*2000* [a]	*2001* [a]	*2002* [a]	*2003* [b]	*2004* [c]	*2005* [d]
CMR Building	23,800	10,640	4,050	1,490	1,560	3,640	3,890	370
Sigma Complex	22,050	7,070	8,100	2,790	71,420 [e]	1,940	86,620 [f]	4,890
Machine Shops	1,045,000	8,720	1,960	58,370	4,460	340	910	850
MSL	1,320	340	1,940 [g]	560	330	430	450	390
High-Explosives Processing	28,700	29,400	2,277,300 [h]	827,300 [i]	33,300 [j]	53,400 [k]	16,100	9,100
High-Explosives Testing	77,800	2,240	133,240 [l]	2,950	2,830	2,330	30	2,700
Tritium Facilities	3,750	70	20	5,770 [m]	11,390 [n]	90	20	20
Pajarito Site	8,820	3,760	280	200	180	60	60	10
Target Fabrication Facility	8,380	1,310	2,340	1,470	1,990	2,890	1,840	17,030 [o]
Biological Sciences	28,660	3,730	5,230	3,000	9,930	6,330	1,540	3,380
Radiochemistry Laboratory	7,280	3,340	27,470 [p]	39,080 [q]	410,350 [r]	10,710 [s]	68,100 [t]	1,060
Radioactive Liquid Waste Treatment Facility	4,850	440	850	151,700 [u]	2,520	150	210	20
Los Alamos Neutron Science Center	36,600	24,400	2,660	8,940	4,410	15,240	214,520 [v]	1,980
Solid Radioactive and Chemical Waste Facilities	2,030	70	1,780	990	1,900	1,800	2,640 [w]	6,240 [x]
Plutonium Facilities	18,500	5,600	3,450	25,800 [y]	31,400 [z]	42,670 [aa]	17,200	2,840
Total Chemical Waste for Key Facilities	1,317,540	101,130	2,470,670	1,130,410	587,970	142,020	414,130	50,880
Non-Key Facilities	1,435,000	1,687,400 [bb]	810,800	2,766,100 [cc]	737,100	1,377,500	2,047,100 [dd]	1,374,190
Total Chemical Waste for Key and non-Key Facilities	2,752,540	1,788,530	3,281,470	3,896,510	1,325,070	1,519,520	2,461,230	1,425,070
Percentage of Total from Key Facilities	**48**	**6**	**75**	**29**	**44**	**9**	**17**	**4**
Environmental Restoration	4,409,200	32,252,800 [ee]	57,728,200 [ff]	63,526,800 [ff]	2,497,300	68,300	207,200	2,914,400
Total Chemical Waste for non-Key Facilities and Environmental Restoration	5,844,200	33,940,200	58,539,000	66,292,900	3,234,400	1,445,800	2,254,300	4,288,590
Total Waste = Key + non-Key Facilities and Environmental Restoration	7,161,740	34,041,330	61,009,670	67,423,310	3,822,370	1,587,820	2,668,430	4,339,470

Facility	*SWEIS ROD*	*1999* [a]	*2000* [a]	*2001* [a]	*2002* [a]	*2003* [b]	*2004* [c]	*2005* [d]
Percentage of Total from Key Facilities	**18**	**< 1**	**4**	**2**	**15**	**9**	**16**	**1**

CMR = Chemistry and Metallurgy Research, MSL = Materials Science Laboratory, ROD = Record of Decision.
[a] LANL 2003h.
[b] LANL 2004f.
[c] LANL 2005f.
[d] LANL 2006g.
[e] Amount includes a significant quantity of waste generated by structure rehabilitation and equipment disposal associated with bringing the Press Building back on-line (LANL 2003h).
[f] *1999 SWEIS* ROD projection exceeded due to disposal of four years accumulation of graphite waste (nonhazardous but not accepted at solid waste or recycling facilities) and beryllium waste from the Beryllium Technology Facility (LANL 2005f).
[g] *1999 SWEIS* ROD projection exceeded due to remodeling of a C-Wing laboratory (LANL 2003h).
[h] Cleanup of MDA R generated 2,225,932 pounds of waste (LANL 2003h).
[i] Cleanup of MDA R generated 815,975 pounds of waste (LANL 2003h).
[j] *1999 SWEIS* ROD projection exceeded due to wastes disposed of through chemical cleanout initiative (LANL 2003h).
[k] *1999 SWEIS* ROD projection exceeded due to the demolition of Buildings TA-16-220, -222, -223, -224, -225, and -226 (LANL 2003h).
[l] *1999 SWEIS* ROD projection exceeded due to cleanup following the Cerro Grande Fire (LANL 2003h).
[m] Amount includes 5,181 pounds generated by refrigerant replacement at TA-16-450 (LANL 2003h).
[n] Amount includes 8,818 pounds generated by refrigerant replacement at TA-16-450 (LANL 2003h).
[o] *1999 SWEIS* ROD projection exceeded due to disposal of beryllium contaminated waste, including wastes from cleanout of a beryllium operations room and disposal of excess equipment originally from Rocky Flats (LANL 2006g).
[p] Amount includes 24,160 pounds of construction and demolition debris generated during cleanup following the Cerro Grande Fire (LANL 2003h).
[q] Amount includes 19,535 pounds of waste generated through chemical cleanout initiative (LANL 2003h).
[r] Amount includes 403,204 pounds of contaminated soil excavated during a construction project outside TA-48-1 (LANL 2003h).
[s] Amount includes waste generated through chemical cleanout initiative and the recycling of two mercury-containing shields weighing a total of 8,000 pounds (LANL 2004f).
[t] Amount includes waste generated through chemical cleanout initiative and disposal of mercury shielding as part of the facility radiological status downgrade effort (LANL 2005f).
[u] Amount includes 151,200 pounds of waste (soil and asphalt) generated as a result of replacement of storage tanks and plumbing (LANL 2003h).
[v] Amount includes four year accumulation of metals which could not be recycled due to the DOE moratorium on commercial recycling of metals from radiological areas. The moratorium metal was shipped to Oak Ridge for evaluation and disposition.
[w] *1999 SWEIS* ROD projection exceeded due to the Decontamination and Volume Reduction System repackaging of legacy transuranic waste (LANL 2005f).
[x] *1999 SWEIS* ROD projection exceeded due to generation of cutting fluids (nonhazardous mineral oil and water) during repacking of transuranic waste (LANL 2006g).
[y] Amount includes 23,001 pounds of contaminated soil and debris from the replacement of hydraulic cylinders at the front gate (LANL 2003h).
[z] Amount includes oil-contaminated soil generated when a transformer was dropped during relocation (LANL 2003h).
[aa] Amount includes 22,000 pounds of soil contaminated with diesel fuel, 1,887 pounds of waste solutions from experiments, and an additional 818 pounds of soil contaminated with diesel fuel (LANL 2004f).
[bb] *1999 SWEIS* ROD projection exceeded due to environmental restoration cleanups (LANL 2000f).
[cc] Amount includes 161,926 pounds of construction and demolition debris resulting from cleanup following the Cerro Grande Fire (LANL 2003h).
[dd] *1999 SWEIS* ROD projection exceeded due to heightened activities and new construction (LANL 2005f).
[ee] *1999 SWEIS* ROD projection exceeded due to soils excavated during remediation of MDA P (LANL 2003h).
[ff] Amount includes industrial and other chemical waste resulting from the cleanup following the Cerro Grande Fire (LANL 2003h).
Note: To convert pounds to kilograms, multiply by 0.45359.

Radioactive Liquid Waste Treated at LANL—Radioactive liquid waste treatment takes place at three facilities located at TA-21, TA-53, and TA-50. Treatment facilities are connected to source facilities by 22,000 feet (6,706 meters) of piping. The treatment facility at TA-50 handles the vast majority of radioactive liquid waste, receiving liquid waste from about 1,800 points across LANL. The Radioactive Liquid Waste Treatment Facility at TA-50 is over 40 years old, and many systems are at the end of their design life.

Radioactive liquid waste treatment rates and waste quantities for the 7-year period are shown in **Table 4–50**. The *1999 SWEIS* contained projections of volumes treated and resulting effluents and waste quantities, including the following categories: pretreatment liquids, effluent discharges, and low-level waste sludges. Of these categories, the most significant parameter is annual effluent discharge from the Radioactive Liquid Waste Treatment Facility. For the 7-year period of 1999 through 2005, all annual effluent quantities from the Radioactive Liquid Waste Treatment Facility were well within the *1999 SWEIS* projection. Source reduction efforts and process improvements were the two factors that contributed to reduced waste volumes (LANL 2005f, 2006g).

Projections made within the *1999 SWEIS* were exceeded for individual treatment activities in several instances, all related to quantities of sludge to be dewatered or solidified; the liquid waste treatment increases due to these activities are small compared to radioactive liquid treatment capacity. The overall radioactive liquid waste treatment rates at LANL were consistent with the *1999 SWEIS* projections for each year of the 7-year period.

4.9.4 Offsite Shipments of Radioactive and Chemical Wastes

Most of the radioactive and chemical wastes generated at LANL are shipped offsite for treatment and disposal. The quantities of wastes shipped offsite during 2002 through 2005 are presented in **Table 4–51**. Although low-level radioactive waste may be disposed of onsite at LANL, some is transported offsite for disposal. All mixed low-level radioactive waste is transported offsite for treatment and disposal. Transuranic and mixed transuranic wastes are characterized, certified, and placed in drums or other containers, which are then loaded into shipment containers for transport to the WIPP. Although there have been delays in meeting the planned schedule for transuranic waste shipments, process improvements have been made and recent gains in shipment numbers have been realized. In October 2006, the one-hundredth shipment of transuranic waste for the year was shipped, exceeding the number of annual shipments for any previous year (LANL 2006g). Additionally, the volume of waste shipped in 2006 (684 cubic yards [523 cubic meters]) was more than three times that of 2005 (LANL 2006a). In 2007, 823 cubic yards (629 cubic meters) of transuranic waste was sent to WIPP in 121 shipments. All chemical wastes are shipped offsite for treatment and disposal. For the subset of chemical wastes that are regulated under RCRA, onsite storage is limited to 1 year. The environment impacts associated with shipments of radioactive and chemical wastes are described in Section 4.10.

Table 4–50 Radioactive Liquid Waste Treated at Los Alamos National Laboratory

Facility	SWEIS ROD	1999 [a]	2000 [a]	2001 [a]	2002 [a]	2003 [b]	2004	2005 [c]
Pretreatment of radioactive liquid waste at TA-21	237,800 gallons per year	11,900 gallons	11,900 gallons	120,700 gallons	8,000 gallons	6,510 gallons	0	0
Percentage of SWEIS projection of pretreatment at TA-21	–	5	5	51	3	3	0	0
Pretreatment of radioactive liquid waste from TA-55	21,100 gallons per year	Less than 21,100 gallons	2,380 gallons	5,810 gallons	9,350 gallons	13,700 gallons	13,700 gallons	0
Percentage of SWEIS projection of pretreatment from TA-55	–	Less than 100	10	30	40	70	70	0
Solidification of transuranic (transuranic) sludge at TA-50	4 cubic yards per year	7 cubic yards	7 cubic yards	None	None	4 cubic yards	0	0
Percentage of SWEIS projection of solidification of transuranic sludge	–	170	170	0	0	100	0	0
Radioactive liquid waste treated at TA-50	9,246,000 gallons per year	5,283,400 gallons	5,019,300 gallons	3,698,400 gallons	3,038,000 gallons	3,566,300 gallons	2,166,200 gallons	1,796,400 gallons
Percentage of SWEIS projection of radioactive liquid waste treated at TA-50	–	57	54	40	33	39	23	19
De-water low-level radioactive waste sludge at TA-50	13 cubic yards per year	48 cubic yards	63 cubic yards	79 cubic yards	13 cubic yards	38 cubic yards	18 cubic yards	0
Percentage of SWEIS projection of low-level radioactive waste sludge de-watered at TA-50	–	370	480	600	100	290	137	0
Radioactive liquid waste treated at TA-53	Not projected	(d)	(d)	(d)	64,200 gallons	103,900 [e] gallons	88,800 [f] gallons	93,800 [f] gallons
Percentage of SWEIS projection of radioactive liquid waste treated at TA-53	NA	NA	NA	NA	NA	NA	NA	NA

ROD = Record of Decision, TA = technical area, NA = not available.
[a] LANL 2003h.
[b] LANL 2004f.
[c] LANL 2006g.
[d] Flows into the TA-53 surface impoundments started in 2000, but were first reported in the *2002 Yearbook* (LANL 2003h).
[e] LANL 2004c.
[f] LANL 2006a.
Note: To convert gallons to liters, multiply by 3.7853; cubic yards to cubic meters, multiply by 0.76456.

Table 4–51 Amount of Radioactive and Chemical Wastes Shipped Offsite

Type of Waste	Year			
	2002	2003	2004	2005
Low-Level Radioactive (cubic yards)	5	2,070	390	1,510
Mixed Low-Level Radioactive (cubic yards)	50	90	90	20
Transuranic (including mixed transuranic) (cubic yards) [a]	1	370	0	216
Chemical (pounds)	1,690,700	1,805,200	2,517,800	1,645,100

[a] Data is for fiscal year.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; pounds to kilograms, multiply by 0.45359.
Sources: LANL 2006a, 2006j.

4.10 Transportation

The primary methods and routes used to transport LANL-affiliated employees, commercial shipments, hazardous and radioactive material shipments, transportation packaging, transportation accidents, and onsite and offsite traffic volumes are presented in this subsection.

4.10.1 Regional and Site Transportation Routes

Motor vehicles are the primary means of transportation to LANL. The nearest commercial bus terminal is in Santa Fe. The nearest commercial rail connection is at Lamy, New Mexico, 52 miles (83 kilometers) southeast of LANL. There is a spur into central Santa Fe used by the Santa Fe Southern Railway. However, LANL does not currently use rail for commercial shipments.

Park-and-ride services are provided by a commercial corporation, in conjunction with the New Mexico Department of Transportation. Over 80 daily departures between Santa Fe and Española, Santa Fe and Los Alamos, Española and Los Alamos, and Albuquerque and Santa Fe and Los Alamos are provided for commuters. Monthly passes are available for unlimited use of most park-and-ride services. **Table 4–52** shows the pick-up and drop-off locations that are included among those currently serviced by this public transportation service. Typical weekday riderships for the two park-and-ride routes serving Los Alamos are shown in **Table 4–53**.

The primary commercial international airport in New Mexico is located in Albuquerque. The small Los Alamos County Airport is owned by the Federal Government, and the operations and maintenance are performed by the County of Los Alamos. The airport is located parallel to East Road at the southern edge of the Los Alamos community. The airport has one runway running east-west at an elevation of 7,150 feet (2,180 meters). Takeoffs are predominantly from west to east, and all landings are from east to west. The airport is categorized as a private use facility; however, U.S. Federal Aviation Administration-licensed pilots and pilots of transient aircraft may be issued permits to use the airport facilities.

Table 4–52 Park and Ride Pickup and Drop-Off Locations

Santa Fe
CORDOVA/CERRILLOS – This is located on the Southeast corner of Cerrillos and Cordova in the State Highway Department General Office parking lot. The bus pulls up on the Northwest corner of the parking area in front of the building.
ALTA VISTA – This is located on Alta Vista, just east of Cerrillos on the north side. The parking area is marked with signs and is just west of the Railroad crossing on Alta Vista.
SHERIDAN/PALACE – This pick up and drop off point only (no vehicle parking) is on Sheridan, just south of Marcy. It is also the north transfer point for Santa Fe Trails.
PERA – PERA Building is on the Northeast corner of Paseo de Peralta and the Old Santa Fe Trail. The boarding area is near the middle of the parking lot on the West side of the building.
DISTRICT 5 – This parking lot is located on Jaguar Street, west of Cerrillos on the south side. It is a fenced lot on the New Mexico Department of Transportation property.
Española
ESPAÑOLA – This parking lot is located on Onate, about 0.25 miles west of Riverside (US84/285) on the south side.
Los Alamos
TA-3 – This parking area and shuttle pick up area for LANL is located just east of Diamond Drive on Jemez Road on the south side.
CENTRAL/20th – This parking and drop off area is in front of the Los Alamos Library, just west of 20th Street.

Note: To convert miles to kilometers, multiply by 1.6093.
Source: All Aboard America 2005.

Table 4–53 Park and Ride Use

Route	*Dates*	*Average Number of Riders - Daily*	*Percent of Capacity*
Blue Route: Santa Fe/Los Alamos	October 24-28, 2005	369	71
Green Route: Española/Los Alamos	October 24-28, 2005	165	66

Source: NMDOT 2005b.

Northern New Mexico is bisected by I–25 in a generally northeast-southwest direction. This interstate highway connects Santa Fe with Albuquerque. The regional highway system and major roads in the LANL vicinity are illustrated in **Figure 4–30**. Regional transportation routes connecting LANL with Albuquerque and Santa Fe are I–25 to US 84/285 to NM 502, with Española is NM 30 to NM 502, and with Jemez Springs and western communities is NM 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to NM 4 to NM 502. East Jemez Road, as designated by the State of New Mexico and governed by 49 CFR 177.825, is the primary route for the transportation of hazardous and radioactive materials. The average daily traffic flow at LANL's main access points are presented in **Table 4–54**.

Table 4–54 Los Alamos National Laboratory Main Access Points

Location	*Average Daily Vehicle Trips*
Diamond Drive across the Los Alamos Canyon Bridge	24,545
Pajarito Road at NM 4	4,984
East Jemez Road at NM 4	9,502
West Jemez Road at NM 4	2,010
DP Road at Trinity Drive	1,255
Total	42,296

Source: KSL 2004, LAC 2005.

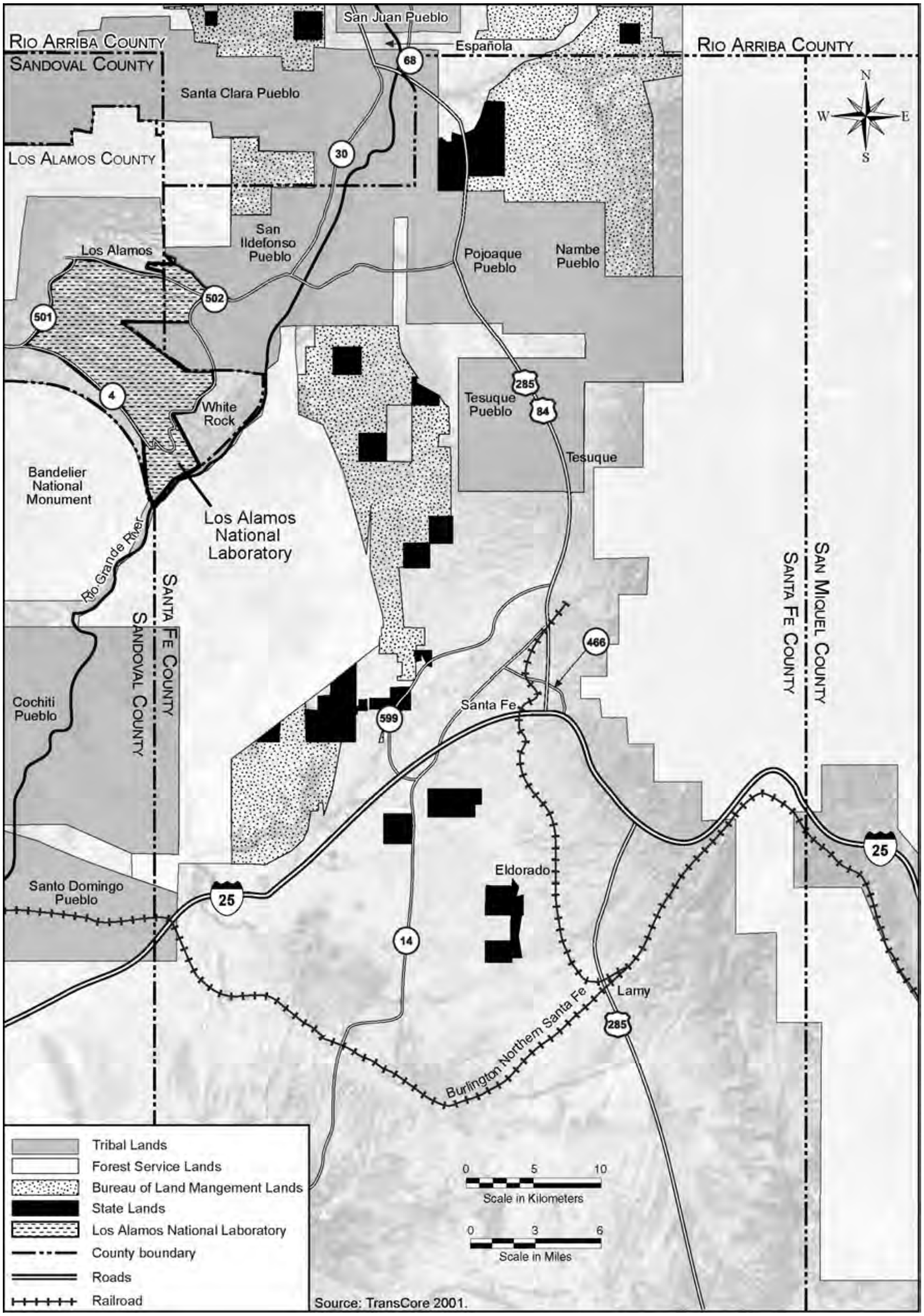


Figure 4–30 Los Alamos National Laboratory Vicinity Regional Highway System and Major Roads

Only two major roads, NM 502 and NM 4, access Los Alamos County. Los Alamos County traffic volume on these two segments of highway is primarily associated with LANL activities. Most commuter traffic originates from Los Alamos County or east of Los Alamos County (Rio Grande Valley and Santa Fe) as a result of the large number of LANL employees that live in these areas (see Section 4.8.1). A small number of LANL employees commute to LANL from the west along NM 4. The average weekday traffic volume at various points in the vicinity of NM 502 and NM 4 measured in September 2004 are presented in **Table 4–55**.

Table 4–55 Average Weekday Traffic Volume in the Vicinity of NM 502 and NM 4

Location	*Average Daily Vehicle Trips*
Eastbound on NM 502 east of the intersection with NM 4	10,100
Westbound on NM 502 east of the intersection with NM 4	7,765
Eastbound on NM 502 west of the intersection of NM 502 and NM 4	6,540
Westbound on NM 502 west of the intersection of NM 502 and NM 4	4,045
Westbound on NM 4 between East Jemez Road and the NM 502/4 intersection	6,505
Eastbound on NM 4 between East Jemez Road and the NM 502/4 intersection	6,665
Transition road from northbound NM 4 to eastbound NM 502	5,170
Transition road from eastbound NM 502 to southbound NM 4	1,610

Source: LSC 2004.

The primary route designated by the State of New Mexico to be used for radioactive and other hazardous material shipments to and from LANL is the approximately 40-mile (64-kilometer) corridor between LANL and Interstate–25 at Santa Fe. This route passes through the Pueblos of San Ildefonso, Pojoaque, Nambe, and Tesuque and is adjacent to the northern segment of Bandelier National Monument. This primary transportation route bypasses the city of Santa Fe on NM 599 to Interstate–25.

4.10.2 Transportation Accidents

Motor vehicle accidents in Los Alamos County and nearby counties are reported in **Table 4–56**. In 2004, there were over 5,700 motor vehicle accidents in Los Alamos, Rio Arriba, and Santa Fe Counties resulting in 58 fatalities. When accidents are considered per 100 million vehicle miles traveled, travel in Santa Fe County was the most dangerous in the region of influence during 2004, although Rio Arriba County had the highest fatality rate. Since the *1999 SWEIS* was issued, there have been two fatal traffic accidents on the site. On November 1, 1999, there was one fatality as a result of two private vehicles colliding at the intersection of Eniwetok Drive and Diamond Drive, and on October 2, 2001, a motorcyclist was killed after colliding with a private vehicle at the intersection of Sigma Road and Diamond Drive (LANL 2006a).

Table 4–56 New Mexico Traffic Accidents in Los Alamos and Nearby Counties, 2004

County	*Total Accidents*	*Crash Rate* [a]	*Fatalities*	*Death Rate* [b]
Los Alamos	274	246	0	0
Rio Arriba	698	144	32	6.61
Santa Fe	4,744	267	26	1.46
New Mexico	52,288	223	522	2.23

[a] Crash rate measures crashes per 100 million vehicle miles traveled.
[b] Death rate measures deaths per 100 million vehicle miles traveled.
Source: NMDOT 2006.

Table 4–57 shows the accident history for Los Alamos County from 1999 through 2004. As shown in the table, the county's crash rate and death rate were lower than the state average during this period.

Table 4–57 Los Alamos County Traffic Accidents, 1999 - 2004

Year	*Total Accidents*	*Crash Rate* [a]	*Fatalities*	*Death Rate* [b]
1999	252	119	1	0.47
2000	252	123	0	0
2001	270	132	3	1.46
2002	307	310	0	0
2003	259	221	1	0.85
2004	274	246	0	0
County Average 99-04	269	192	0.8	0.46
State Average 99-04	48,359	210	462	2.0

[a] Crash rate measures crashes per 100 million vehicle miles traveled.
[b] Death rate measures deaths per 100 million vehicle miles traveled.
Sources: NMDOT 2001, 2002, 2003, 2004, 2005a, 2006.

4.10.3 Los Alamos National Laboratory Shipments

Hazardous, radioactive, industrial, commercial, and recyclable materials, including wastes, are transported to, from, and on the LANL site during routine operations. Hazardous materials include commercial chemical products that are nonradioactive and are regulated and controlled based on whether they are listed materials, or if they exhibit the hazardous characteristics of ignitability, toxicity, corrosivity, or reactivity. Radioactive materials include special nuclear material (plutonium, enriched uranium), medical radioisotopes, and other miscellaneous radioactive materials. Offsite shipments, both to and from LANL, are carried by commercial carriers (including truck, air-freight, and government trucks), and by DOE safe secure transport trailers. Numerous regulations and requirements govern the transportation of hazardous and radioactive materials, including those of the U.S. Department of Transportation, U.S. Nuclear Regulatory Commission, DOE, U.S. Federal Aviation Administration, International Air Traffic Association, and LANL.

4.10.3.1 Onsite Shipments

Onsite hazardous and radioactive material shipments are transported in conformance with U.S. Department of Transportation regulations. A shipment is considered an onsite shipment if both the origin and destination are at LANL. These shipments are transported in LANL-operated vehicles. These vehicles vary depending on the quantity and radioactivity of the material shipped, from LANL-owned pick-up trucks to DOE-owned safe secure trailers. Maintenance of these vehicles is closely monitored for physical performance as well as security.

Hazardous material shipments vary from bulk gases and liquids to small quantities of laboratory chemicals. Hazardous waste shipments are made to the hazardous waste storage facility at TA-50 and radioactive and hazardous waste shipments are made to the waste management area at TA-54.

Onsite radioactive material shipments are transported in conformance with U.S. Nuclear Regulatory Commission regulations or DOE requirements. A primary feature of these regulations is stringent packaging requirements governing shipments on public roads. In a few cases, it is not cost effective for DOE to meet these stringent packaging requirements. In such cases, roads are temporarily closed during the shipments; DOE safety requirements still apply in these cases.

Onsite transport constitutes the majority of activities that are part of routine operations in support of various programs. The radioactive materials transported onsite between TAs are mainly of limited quantities, short travel distances, and mostly on closed roads. The impacts of these activities are part of the normal operations at these areas. For example, worker dose from handling and transporting the radioactive materials are included as part of operational activities. Specific analyses performed in the *1999 SWEIS* indicated that the projected collective radiation dose for LANL drivers from a projected 10,750 onsite shipments to be 10.3 person-rem per year, or on average, less than 1 millirem per transport. Review of recent onsite radioactive materials transportation indicates a much smaller number of shipments than those projected in the *1999 SWEIS*.

4.10.3.2 Offsite Shipments

Offsite transports of radioactive materials would occur using both trucks and airfreight. The radioactive materials transported would include tritium, plutonium, uranium (both depleted and enriched), offsite source recovery, medical isotopes, small quantities of activation products, low-level radioactive waste, and transuranic waste. At LANL, DOE transports and receives radioactive and other hazardous materials and waste shipments to and from other DOE facilities and commercial facilities nationwide. As discussed above, shipments meet applicable U.S. Department of Transportation, U.S. Nuclear Regulatory Commission, U.S. Federal Aviation Administration, regulations or DOE requirements. Most unclassified shipments are transported via commercial carriers.

From 2002 through 2005, there was an average of 273 offsite waste shipments per year. These consisted, on average, of 199 shipments of hazardous materials and 74 shipments of radioactive materials as shown in **Table 4–58**. Significant year-to-year changes in the volume of waste generated are discussed in Section 4.9.2 and provide the basis for the fluctuations shown in Table 4–58.

Table 4–58 Offsite Waste Shipments 2002 - 2005

Waste Type	*2002*	*2003*	*2004*	*2005*	*Total*
Hazardous	154	157	262	225	798
Low-Level Radioactive	3	68	12	50	133
Mixed Low-Level Radioactive	17	19	19	16	71
Transuranic	1	46	0	44	91
Total	175	290	293	335	1,093

Source: LANL 2006a.

DOE regulations require that safe secure trailers be used for offsite shipments of special nuclear material, weapons components, and explosive-like assemblies in DOE custody. Safe secure trailers are similar in appearance to commercial tractor-trailers but are equipped with unique security and safeguard features that prevent unauthorized cargo removal and minimize the likelihood of an accidental radioactive materials release as a result of a vehicle accident. Classified shipments are made in safe secure trailers.

The primary regulatory approach to promote safety from radiological exposure is the specification of standards for the packaging of radioactive materials. Packaging represents the primary barrier between the radioactive material being transported and radiation exposure to the public, workers, and the environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents during normal transport conditions. For highly radioactive material such as high-level radioactive waste or spent nuclear fuel, packagings must contain and shield its contents in the event of severe accident conditions. The type of packaging used is determined by the total radioactive hazard presented by the material within the packaging. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B. See Appendix K for additional information on the shipment of radioactive materials to and from LANL.

4.11 Environmental Justice

Under Executive Order 12898, DOE is responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority or low-income populations. Minority persons are those who identify themselves as Hispanic or Latino, Asian, Black or African American, American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, or multi-racial (with at least one race designated as a minority race under Council on Environmental Quality Guidelines [CEQ 1997]). Persons whose income is below the Federal poverty threshold are designated as low income.

Disproportionately High and Adverse Human Health Effects

Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).

Disproportionately High and Adverse Environmental Effects

A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian Tribes are considered (CEQ 1997).

4.11.1 Region of Analysis

The region of analysis for environmental justice corresponds to the region of analysis for the resource area being considered. The source of offsite impacts addressed in the SWEIS is radiological air emissions. The study area considered in the *1999 SWEIS* environmental justice analysis was the area within a 50-mile (80-kilometer) radius of LANL. **Figure 4–31** shows areas potentially at radiological risk from the current missions performed at LANL. These areas include the city of Santa Fe and Indian Reservations in North Central New Mexico. Eight counties are included or partially included in the potentially affected area (see **Figure 4–32**): Bernalillo, Los Alamos, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe, and Taos.

The center of the area was the emissions stack at LANSCE in TA-53. The LANSCE stack was chosen because it was the primary source of LANL airborne radionuclide emissions and therefore has the greatest potential for affecting offsite populations. Today, LANSCE is still the largest contributor to radioactive air emissions (LANL 2005h). Sampling data collected from vegetation, animals, fish, water and soils onsite or near LANL were used to estimate doses from ingestion by individuals existing on a subsistence diet. On this basis, the same study area is used for this environmental justice analysis of human health impacts. The use of a 50-mile (80-kilometer) radius is patterned after the methodology used by the U.S. Nuclear Regulatory Commission for assessing potential risks to populations from nuclear power plants and is intended to encompass the potential impacts from LANL operations (DOE 1999a). The location of minority and low-income populations within the 50-mile (80-kilometer) radius circle remained unchanged since the publication of the *1999 SWEIS*. However, the number of persons in these communities rose slightly over the past 5 years.

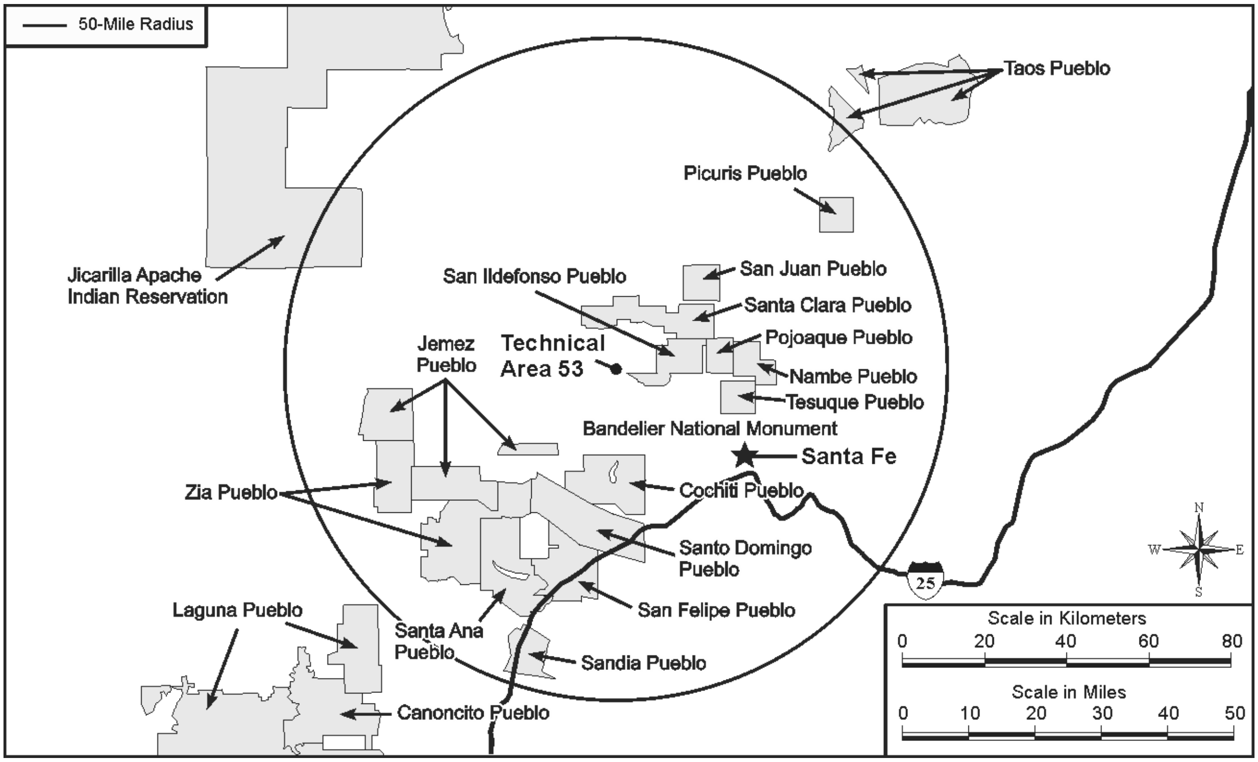


Figure 4–31 Location of Technical Area 53 and Indian Reservations Surrounding Los Alamos National Laboratory

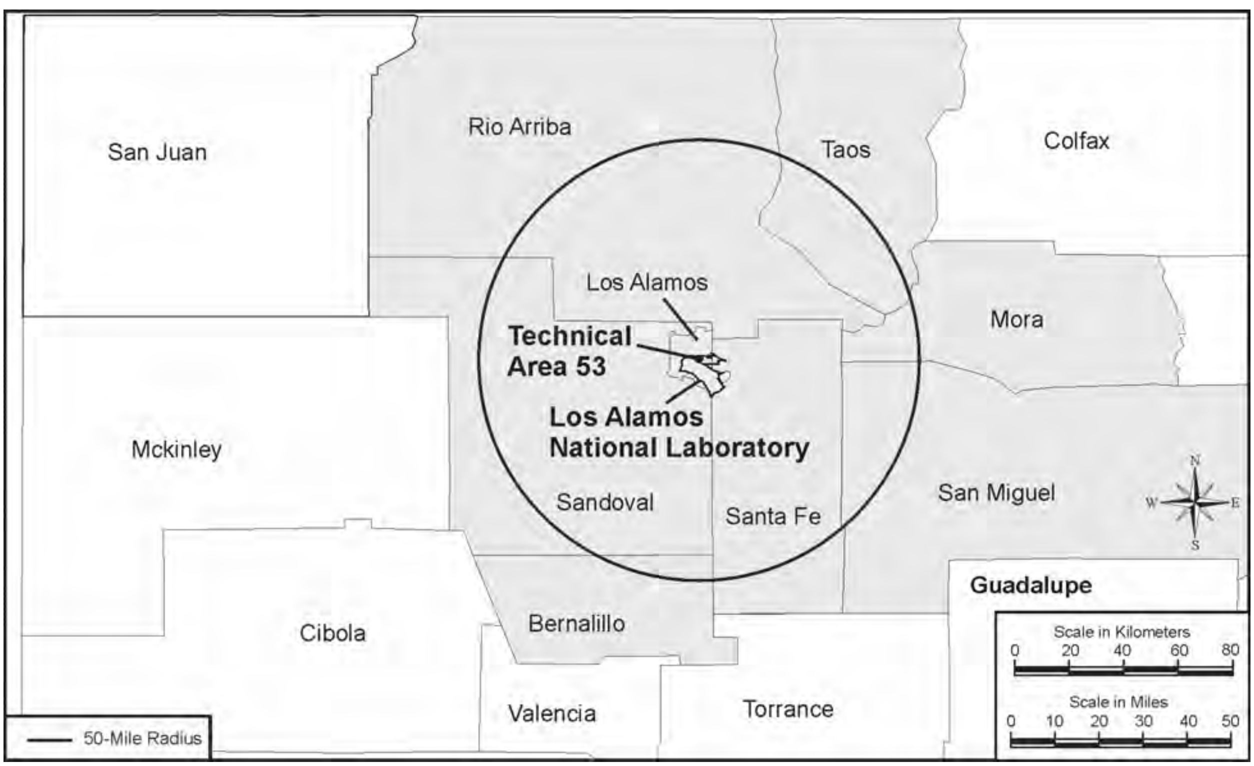


Figure 4–32 Potentially Affected Counties Surrounding Los Alamos National Laboratory

4.11.2 Changes Since the *1999 SWEIS*

To determine the extent of changes in minority and low-income populations in potentially affected counties surrounding LANL since the publication of the *1999 SWEIS*, comparisons were made between population estimates based on 1990 and 2000 census data. However, caution must be used when interpreting these changes, because of changes in the definitions of race and ethnicity used in the 2000 census. As a result, 2000 census data on race are not directly comparable with data from the 1990 or earlier censuses. Nevertheless, census data demonstrate that the minority population in these potentially affected counties grew by 33 percent between 1990 and 2000.

Table 4–59 provides the racial and Hispanic composition for these counties using data obtained from the census conducted in 2000. In the year 2000, a majority (54 percent) of these county residents designated themselves as members of a minority population. Hispanics and American Indians or Alaska Natives comprised approximately 91 percent of the minority population. As a percentage of the total resident population in 2000, New Mexico had the largest percentage minority population (55 percent) among the contiguous states and the second largest percentage minority population among all states (only Hawaii had a larger percentage minority population [77 percent]).

Table 4–59 Populations in Potentially Affected Counties Surrounding Los Alamos National Laboratory in 2000

Population Group	*Population*	*Percentage of Total*
Minority	490,172	54.4
Hispanic	400,725	44.5
Black or African American	15,945	1.8
American Indian or Alaska Native	44,468	4.9
Asian	12,188	1.4
Native Hawaiian or Pacific Islander	527	0.1
Two or more races	14,859	1.6
Some other race	1,460	0.2
White	410,524	45.6
Total	900,696	100.0

Source: DOC 2006b.

The percentage of low-income population for whom poverty status was determined was approximately 13 percent of those residing in potentially affected counties in 2000. In 2000, nearly 18 percent of the total population of New Mexico reported incomes less than the poverty threshold.

In terms of percentages, minority populations and low-income resident populations in potentially impacted counties were lower than the State percentage in 2000. Despite slight increases in the percentage of minority and low-income populations in the potentially affected counties, impacts to these populations over the past 5 years have not been disproportionately high or adverse, due to the overall low level of potential impacts. The effects of new construction projects since the publication of the *1999 SWEIS* were either minor, confined to the site, or within the historical operational effects of LANL.

Since 1990, the minority population in potentially affected counties surrounding LANL grew by about 33 percent (from 49.3 percent in 1990 to 54.4 percent in 2000) of the total population in the potentially affected counties (see **Table 4–60**). The area's largest minority group, the Hispanic population, grew by 30 percent, followed by American Indians (26 percent) and Asians (52 percent). The African-American population remained relatively unchanged.

Table 4–60 Populations in Potentially Affected Counties Surrounding Los Alamos National Laboratory in 1990

Population Group	*Population*	*Percentage of Total*
Minority	368,785	49.3
Hispanic	309,520	41.4
Black	15,595	1.8
American Indian, Eskimo, or Aleut	35,319	4.7
Asian or Pacific Islander	8,038	1.1
Some other race	2,313	0.3
White	379,644	50.7
Total	748,429	100.0

Source: DOC 2007.

In 1989, 21 percent of the population of New Mexico lived below the poverty threshold (DOE 1999a). In 1999, 18 percent of the population of New Mexico lived below the poverty threshold (see Section 4.11.4).

4.11.3 Minority Population in 2000

According to 2000 census data, approximately 153,518 minority individuals resided within the 50-mile (80-kilometer) radius of LANL. This represented 55 percent of the total population within the 50-mile (80-kilometer) radius. The largest minority group in the study area was the Hispanic population (127,671 or about 46 percent), followed by American Indians (17,371 or about 6 percent). Minorities are about 18 percent of Los Alamos County's population, with Hispanics being the largest minority group (12 percent). Hispanics reside throughout the 50-mile (80-kilometer) radius area, but most are located in the Española Valley and in the Santa Fe metropolitan area.

Census block groups with minority populations exceeding 50 percent were considered minority block groups. Based on 2000 census data, **Figure 4–33** shows minority block groups within the study area where more than 50 percent of the block group population is minority.

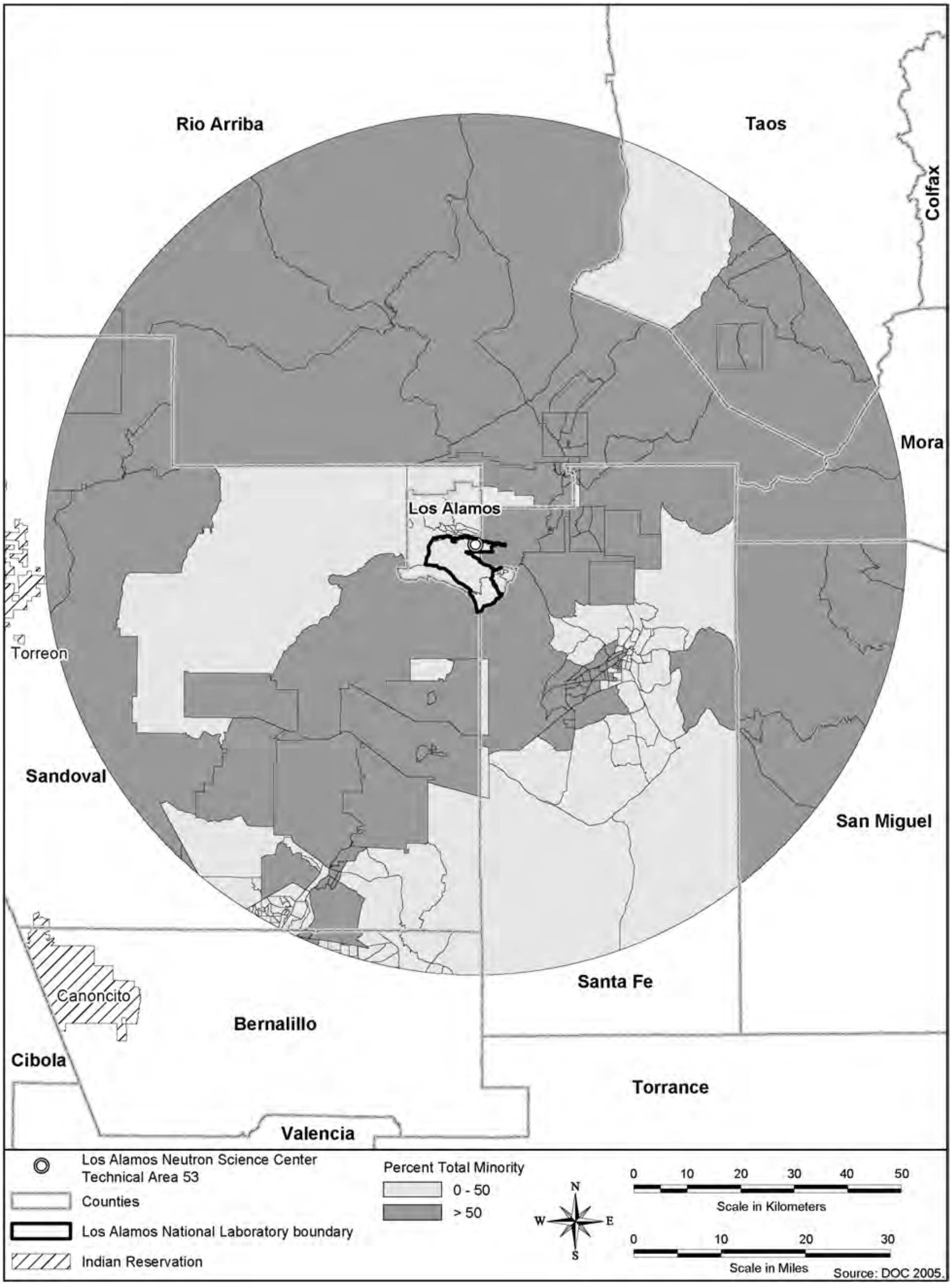


Figure 4–33 Minority Population – Block Groups with More Than 50 Percent Minority Population within a 50-Mile (80-kilometer) Radius of Los Alamos National Laboratory

4.11.4 Low-Income Population in 2000

According to 2000 census data, approximately 44,278 individuals residing within the 50-mile (80-kilometer) radius of LANL were identified as living below the Federal poverty threshold, which represent approximately 16 percent of the study area population. The median household income for New Mexico in 1999 was $34,133, while 18 percent of the population was determined to be living below the Federal poverty threshold ($17,029 for a family of four).

Los Alamos County had the highest median income ($78,993) within the State, and the lowest percentage (2.9 percent) of individuals living below the poverty level when compared to other counties in the area.

Census block groups were considered low-income block groups if the percentage of the populations living below the Federal poverty threshold exceeded 18 percent. Based on 2000 Census data, **Figure 4–34** shows low-income block groups within the study area where more than 18 percent of the block group population is living below the Federal poverty threshold.

4.12 Environmental Restoration

Environmental restoration activities are designed to reduce the risks associated with the legacy of past operations that resulted in releases of contaminants. As the LANL environmental restoration effort completes site investigations and cleanups, this progress translates to a reduction in the risk posed by past releases, and, in some cases, provides additional land use options in and around LANL. The *1999 SWEIS* evaluated environmental restoration impacts in the ecological and human health risk assessments and in analyses related to the transport, treatment, storage, and disposal of waste.

The LANL environmental restoration staff originally identified over 2,100 potential release sites, at and around LANL, including 1,099 regulated by the NMED under RCRA and 1,025 regulated by DOE. However, as a result of investigations, remediations, no further action determinations, and consolidation of geographically proximate sites, a total of 829 potential release sites remained within the environmental restoration program at the end of 2005 (LANL 2006g).

Each site remediation reduces potential impacts to ecological and human health. The environmental restoration project has made significant progress in the last 6 years. A multi-year cleanup at MDA P was completed in 2002, resulting in the excavation of more the 52,500 cubic yards (40,100 cubic meters) of soil and debris. Over this same timeframe, three wastewater surface impoundments at TA-53 were remediated (LANL 2003h). The project has also completed a number of source removals through voluntary corrective actions and has continued site investigations (LANL 2003h, 2004f). In 2005, the LANL environmental restoration staff completed nine characterization and remediation reports, performed soil and sediment sampling at a number of locations, and planned and performed accelerated remediation work in support of infrastructure improvements (LANL 2006g). In 2005, numerous characterization and remediation plans and reports were submitted to NMED in accordance with the Consent Order. In addition, accelerated remediation activities were implemented at sites that potentially could be affected by upcoming infrastructure and construction projects. NMED issued certificates of completion (replacing former no further action determinations) for eight sites (LANL 2006g).

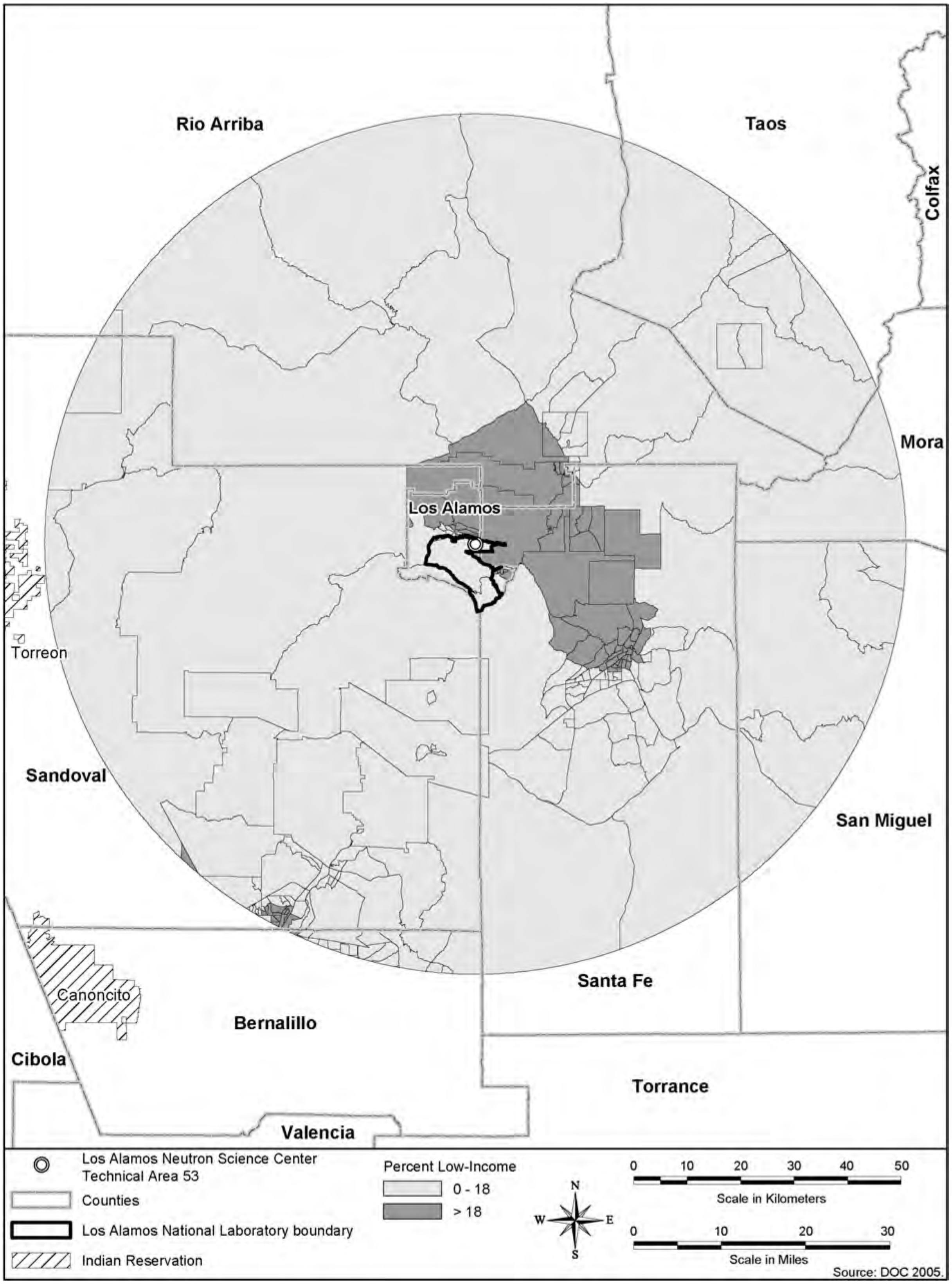


Figure 4–34 Low-Income Population – Block Groups with More Than 18 Percent of the Population Living Below the Federal Poverty Threshold within a 50-mile (80-kilometer) Radius of Los Alamos National Laboratory

Major unplanned environmental restoration activities were undertaken by LANL in response to the Cerro Grande Fire. Due to the threat of erosion and enhanced contaminant transport, the following activities were performed: evaluation and stabilization of sites touched by the fire; baseline sampling to characterize conditions in fire-impacted watersheds; and evaluation, stabilization or removal of sites subject to flooding. Accelerated cleanups in response to the fire were conducted at MDA R and in Los Alamos Canyon (LANL 2003h)

The large-scale cleanups have generated significant quantities of mostly chemical wastes, as discussed in Section 4.9. Because waste types and quantities at environmental restoration sites are difficult to estimate in advance, the generation of chemical waste exceeded *1999 SWEIS* ROD projections for several years out of the previous six. For many site cleanups, wastes are transported directly offsite from the point of generation, minimizing impacts on LANL waste management infrastructure.

Other environmental restoration-related impacts addressed qualitatively in the *1999 SWEIS* include fugitive dust, surface runoff, soil and sediment erosion, and worker health and safety risks (DOE 1999a). The controls presented in the *1999 SWEIS* to mitigate these impacts continue to be implemented, and in many cases, have been enhanced in response to the Cerro Grande Fire.

The successful site cleanups have produced beneficial environmental impacts, including risk reductions and land transfers. Actions taken in response to the Cerro Grande Fire prevented additional impacts that could have resulted from increased erosion and enhanced mobility of contaminants. With the exception of the chemical waste generation rates discussed in Section 4.9, environmental restoration activities have operated within the envelope evaluated in the *1999 SWEIS*.

Requirement for correction actions performed at LANL in accordance with RCRA and its Hazardous and Solid Waste Amendments (HSWA) has been transferred from the LANL's RCRA Permit to a Compliance Order on Consent (Consent Order), signed on March 1, 2005 (NMED 2005). The Consent Order is a comprehensive agreement that documents the investigation and remediation steps necessary to complete RCRA- and HSWA-driven environmental restoration activities at LANL by the year 2015. However, the Consent Order does not cover more than 500 sites that received no further action decisions from the EPA when it had primary authority, preventing duplication of completed work. The Consent Order also does not address releases of radionuclides, which are under the regulatory authority of DOE. Nonetheless, 125 non-HSWA module sites previously approved by DOE for no further action will be re-evaluated by NMED under the terms of the Consent Order. Notwithstanding the Order, LANL's environmental restoration activities and associated impacts have remained within the scope of the *1999 SWEIS* and the ROD projections.

CHAPTER 5
ENVIRONMENTAL CONSEQUENCES

5.0 ENVIRONMENTAL CONSEQUENCES

The following sections evaluate the environmental consequences of proposed Los Alamos National Laboratory (LANL) construction and operations on the surrounding region. The impact on each resource area is evaluated for the three proposed alternatives: the No Action Alternative, Reduced Operations Alternative, and Expanded Operations Alternative. In addition, the analysis looks at the cumulative impacts of these alternatives when combined with other past, present, and future actions that could affect the region. As applicable, possible mitigation measures are discussed with regard to implementing one of the proposed alternatives.

As described in earlier chapters, changes have occurred or are expected to take place at LANL that were not anticipated at the time the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (*1999 SWEIS)* was issued together with the Record of Decision (ROD). Such changes include alteration of the physical environment, as well as changes to LANL's operations and capabilities. The Cerro Grande Fire of 2000 resulted in changes to the physical environment in the form of burned habitat, damaged or destroyed structures, and potential for significant runoff and erosion. Another change to the physical environment is the past and planned conveyance of certain lands to Los Alamos County and the transfer of land to the U.S. Department of the Interior (to be held in trust for the San Ildefonso Pueblo) that, in effect, alters the site boundaries and removes from National Nuclear Security Administration (NNSA) stewardship the ecological and cultural resources included in those lands.

Included in the analysis supporting this new Site-Wide Environmental Impact Statement (SWEIS) are the impacts associated with manufacturing plutonium pits at LANL. Under the No Action and Reduced Operations Alternatives, the analysis includes the impacts associated with manufacturing up to 20 pits per year in existing facilities in the Plutonium Facility Complex (Technical Area [TA-] 55). The Expanded Operations Alternative includes the impacts associated with manufacturing up to 80 pits per year in TA-55. Manufacturing pits in TA-55 at any of the levels discussed above is not expected to have a distinguishable effect on a number of resource areas evaluated in this SWEIS. The different levels of pit manufacturing activities in TA-55 would likely cause only minor differences in impacts on land use, visual resources, water resources, geology and soils, air quality, noise, ecological resources, public health, cultural resources, and infrastructure. Depending on the alternative chosen, larger impacts to worker health, socioeconomics, waste management, and transportation would be expected.

The analysis also includes the impacts associated with the remediation of material disposal areas (MDAs) and other potential release sites (PRSs). For several years, the LANL management and operating contractor has conducted an environmental restoration program to identify locations where hazardous constituents may have been released into the environment and to carry out corrective measures in compliance with the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA). Since 1990, investigations and corrective actions have been carried out in accordance with the LANL Hazardous Waste Facility permit. The Compliance Order on Consent (Consent Order) entered into by the U.S. Department of

Energy (DOE), the University of California as the management and operating contractor, and the State of New Mexico requires a more specific program of studies and corrective measures and that cleanup be completed by 2015. The impacts of implementing the investigations and remediations under the Consent Order are presented as part of the Expanded Operations Alternative. Two scenarios for environmental restoration have been evaluated to bound the range of possible consequences of implementing corrective measures required by the Consent Order. A Capping Option, a Removal Option, and a No Action Option are assumed and evaluated in Appendix I of this SWEIS. The No Action Option is the base case in which remedial investigations and activities would continue at a level comparable to that of recent years, and this option is part of the No Action and Reduced Operations Alternatives[1]. The Capping Option reflects the assumption that the waste and contamination within the MDAs would be left in place and stabilized by installation of evapotranspiration caps as a mitigation measure. The Removal Option reflects the assumption that the waste and contamination within the MDAs would be removed. For both the Capping and Removal Options, several additional PRSs would be remediated annually. These options are intended to bound the range of possible corrective measures and are included in the Expanded Operations Alternative.

As changes in the operations and capabilities active at LANL could change the releases to the environment and the impacts of potential accidents, they are factored into the analyses presented below. In addition to changes in LANL operations and the environment, new projects or ongoing projects to maintain existing LANL capabilities are also evaluated for environmental impacts. The impacts of these individual projects are detailed in Appendices G through J and are discussed in this chapter as appropriate. These projects are generally included as part of the Expanded Operations Alternative.

5.1 Land Resources Impacts

This section addresses the impacts of the No Action, Reduced Operations, and Expanded Operations Alternatives on Land Use and Visual Resources. **Table 5–1** summarizes the expected land use impacts for each of the three alternatives.

5.1.1 Land Use

Land use is defined as, "The way land is developed and used in terms of the kinds of anthropogenic activities that occur (for example, agriculture, residential areas, industrial areas)" (EPA 2003). A comparative methodology was used to determine impacts to land use at LANL. Construction, building modification, operations, and demolition activities associated with each alternative were examined, as appropriate, and compared to existing land use conditions and future land use projections. Impacts were identified as they relate to changes in land use categories, ownership, and alternative or conflicting uses.

---

[1] NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in this SWEIS.

Table 5–1 Summary of Environmental Consequences of Land Use Changes

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
	Land Conveyance and Transfer – 1,820 acres (737 hectares) remain to be conveyed or transferred. – Development could occur on up to 826 acres (334 hectares). – Potential introduction of incompatible land uses. – Loss of recreational opportunities. *Electrical Power System Upgrades* – 473 acres (191 hectares) affected by upgrades. – Project generally compatible with existing land use, but some constraint on high explosives testing and future experimental use within part of LANL. *Wildfire Hazard Reduction Program* – No impact *Disposition of Flood Retention Structures* – No impact	Same as No Action Alternative	Same as No Action Alternative plus: *MDA Remediation Project* – Fewer restrictions on land use for the Removal Option than for the Capping Option. – No major changes in land use designations in most cases because surrounding land uses would remain in their current classification; however, some land use changes possible. *Security-Driven Transportation Modifications Project* – Most development would not conflict with current land use designations. – Auxiliary Action A – Within scope of current land use plans. – Auxiliary Action B – Partially within scope of current land use plans; however, plans have no provision for a bridge over Sandia Canyon.
Affected Technical Areas			
TA-3	No change in land use	Same as No Action Alternative	*Replacement Office Buildings Project* – 13 acres (5.3 hectares) of undisturbed land would be developed. – Development would be consistent with a change in future land use from Reserve to Physical/Technical Support.
TA-21	No change in land use	Same as No Action Alternative	*TA-21 Structure DD&D Project* – Future LANL development could negate the proposed change in land use from the current designation to Reserve.
TA-72	No change in land use	Same as No Action Alternative	*Remote Warehouse and Truck Inspection Station* – Construction would affect 4 acres (1.6 hectares) of undisturbed land. – Land use designation would change from Reserve to Physical/Technical Support.

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative
Key Facilities			
Pajarito Site (TA-18)	No change in land use	Same as No Action Alternative	*TA-18 DD&D* Land use could change from Nuclear Material Research and Development to Reserve.
Radiochemistry Facility (TA-48)	No change in land use	Same as No Action Alternative	*Radiological Sciences Institute* – 12.6 acres (5.1 hectares) of undeveloped land to be developed. – Land use change is consistent with future land use designations.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in land use	Same as No Action Alternative	*Radioactive Liquid Waste Treatment Facility Upgrade* – Construction of new liquid waste management buildings would not result in a change in land use. – New evaporation tanks, if built, would likely result in a change in land use designation from Reserve to Waste Management. – Construction would affect up to 5.4 acres (2.2 hectares) of undeveloped land.
Solid Radioactive and Chemical Waste Facilities (TA-54 and Generic Site)	No change in land use	Same as No Action Alternative	*Waste Management Facilities Transition* – No change in land use within TA-54 – Construction of the TRU (Transuranic) Waste Facility could affect up to 7 acres (2.8 hectares) of undeveloped land and could result in a change in land use designation.
Bioscience Facilities	No change in land use	Same as No Action Alternative	*Science Complex* – Construction would affect 5 acres (2 hectares) of undeveloped land. – For Options 1 and 2, development would be consistent with a change in future land use from Reserve to Experimental Science. – For Option 3 there would be no change in land use designation.

MDA = material disposal area; TA = technical area; DD&D = decontamination, decommissioning, and demolition.

5.1.1.1 No Action Alternative

The No Action Alternative is discussed in terms of the existing environment as it relates to land use; actions that DOE has decided upon, but has not fully implemented; and the results of National Environmental Policy Act (NEPA) compliance reviews issued since the *1999 SWEIS*. Impacts on land use are described in terms of projects that affect the site as a whole and those that affect only specific TAs. Key Facilities are addressed separately. Only those projects that have been evaluated via their respective environmental analyses to have an impact on land use are addressed below.

Los Alamos National Laboratory Site-Wide Impacts

Since issuance of the *1999 SWEIS* ROD, NEPA documentation has been prepared for two projects that are being implemented and have potential impacts on land use across a number of TAs: (1) conveyance and transfer of land under Public Law 105-119, and (2) proposed electrical power system upgrades (DOE 1999a, 1999d, 2000a).

Conveyance and transfer of land from DOE to Los Alamos County and the U.S. Department of the Interior to be held in trust for the Pueblo of San Ildefonso began in 2002. At the end of 2006, 2,259 acres (914 hectares) had been turned over (see Chapter 4, Section 4.1.1). To meet the requirements of Public Law 105-119, Section 632 and the extension mandated in the Defense Authorization Act, the remaining acreage (1,820 acres [737 hectares]) may be turned over by 2012. The direct impact of the conveyance and transfer process on land use is a reduction in the land area of LANL to its present size of about 25,600 acres (10,360 hectares). Indirect impacts (impacts resulting from actions undertaken by the recipients after conveyance and transfer of the tracts) include possible development or redevelopment of up to 826 acres (334 hectares), potential introduction of land uses that would be incompatible with adjacent land owners' resource protection efforts, and loss of recreational opportunities on some tracts (DOE 1999d).

Although the electrical power system upgrades are not expected to have a major effect on existing land uses, they would affect up to 473 acres (191 hectares) and be 19.5 miles (31 kilometers) in length. In general, project-related activities would traverse the southwestern portion of LANL, entering the site from the east at TA-70 and proceeding northwest through portions of White Rock, Water and Pajarito Canyons, and terminating at TA-69. Construction and operations activities have been determined to be consistent and compatible with all existing land uses along the project's route, and these land uses would likely continue. Several minor impacts are possible, however, including short-term impacts on cattle grazing and recreational use during construction on one segment that is outside of LANL and potentially adverse effects on existing or future high explosives testing within LANL. Additionally, the project could provide a minimal constraint of activities within the Dynamic Testing Area and Twomile Mesa South in areas designated for future experimental use, because development could not occur within the power line right-of-way (DOE 2000a).

Management of construction fill, another activity affecting multiple TAs, would not be expected to have an effect on existing land uses. Construction fill would be stored in existing borrow areas at TA-16 or TA-61.

5.1.1.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide and Technical Area Impacts

Under the Reduced Operations Alternative, the same impacts on land use resulting from actions addressed under the No Action Alternative (see Section 5.1.1.1) would occur. None of the actions proposed under the Reduced Operations Alternative that differ from those proposed under the No Action Alternative would impact land use.

5.1.1.3 Expanded Operations Alternative

The Expanded Operations Alternative reflects proposals that would expand the overall operations levels at LANL beyond those established for the No Action Alternative (which also would take place). As such, the Expanded Operations Alternative includes a number of new projects that potentially could impact land use at LANL. Not all new projects would affect land use; many would involve actions within or modifications to existing structures or construction of new facilities within previously developed areas of LANL. Only those proposed projects that would impact land use are addressed below.

Los Alamos National Laboratory Site-Wide Impacts

Under this alternative, two proposed projects could impact land use across a number of TAs at LANL: (1) MDA Remediation and (2) the Security-Driven Transportation Modifications Project. A detailed analysis of each of these two actions is presented in Appendices I and J, respectively.

Action options for remediation of MDAs include capping or removal. Remedies for MDAs subject to the March 2005 Consent Order would be recommended by LANL, but decisions would be made by the New Mexico Environment Department. Decisions on actions would be implemented on an MDA-by-MDA basis and could involve a combination of partial removal and capping (a hybrid action for the purposes of this analysis). Because the Capping Option would stabilize rather than remove existing contaminants, future use of MDAs would remain restricted. At present, most MDAs are open areas that are fenced and excluded from any use other than safely maintaining inventories of waste. In the future, MDAs would have to be surveyed and maintained to protect public health and safety and the environment. Under the Removal Option, there would be fewer restrictions on land use than under the Capping Option. Complete removal of waste and contamination from MDAs could free up to roughly 110 acres (45 hectares) for purposes other than use as an exclusion area for storing radioactive waste. This would not mean, however, that major changes would occur in the designated land use of the TAs containing the MDAs. The extent of removal would depend on information obtained from the program and on regulatory decisions.

The investigation and remediation program for MDA B would remove waste and contamination. Alternative uses of this portion of TA-21 may be possible. Opportunities for different uses of some lands may arise following PRS remediation. This would depend on the corrective measure required by the New Mexico Environment Department and implemented by the LANL management and operating contractor, as well as the overall mission of the TA containing the PRS. Under a hybrid action, land use generally would be similar to that for the Capping Option.

Security-driven transportation modifications in the Pajarito Corridor West would require construction of two parking lots or structures (in TA-48 and TA-63), a new two-lane road along the east edge of TA-63, new auto and pedestrian crossings connecting TA-63 and TA-35, and a road through the northern edge of TA-35. While this alternative would affect future land use by developing currently undeveloped portions of the Pajarito Corridor West, all construction, except the pedestrian walkway, would take place within areas designated either for Development or for Infill. Thus, this alternative generally would be compatible with the land use plans for the Pajarito Corridor West outlined in the *Comprehensive Site Plan 2001* (LANL 2001c).

Auxiliary Action A for the Security-Driven Transportation Modifications Project involves construction of a two-lane bridge within a 1,000-foot (300-meter)-wide corridor across Mortandad Canyon and a new two-lane road from the north end of the new bridge westward through TA-60 to connect TA-35 with TA-3. These actions are within the scope of the land use plans described in the *Comprehensive Site Plan 2001*. Auxiliary Action B involves construction of a second new two-lane bridge within a 1,000-foot (300-meter)-wide corridor across Sandia Canyon, as well as a new two-lane road from the new bridge to connect with East Jemez Road. Although the terminus of the bridge and the new road to East Jemez Road would be within an area designated as Primary Development in the *Comprehensive Site Plan 2001*, there is no provision in the plan for a bridge corridor over Sandia Canyon, as there is for the bridge over Mortandad Canyon. Thus, construction of a bridge corridor over Sandia Canyon would represent a departure from the current site development plan; however, the *2000 Comprehensive Site Plan* did address the concept of a future road over the canyon (LANL 2000a, 2001c).

Technical Area Impacts

Three projects are proposed that could impact land use within TA-3, TA-21, and TA-72. The impacts described below are from project-specific analyses in Appendices G and H.

Technical Area 3

Construction of the Replacement Office Buildings at TA-3 would require 13 acres (5.3 hectares) of undeveloped land that is presently designated as Reserve. Additional acreage would be required within recently disturbed portions of the TA that are classified as Physical/Technical Support. The future land use proposal calls for the Reserve area to be redesignated as Physical/Technical Support.

Technical Area 21

Following decontamination and demolition of its buildings and structures, a 7.6-acre (3.0-hectare) parcel in the western portion of TA-21 was conveyed to Los Alamos County. In the future, it is likely that this area could be used for commercial or industrial purposes. The eastern portion of TA-21 would remain a part of LANL for the foreseeable future. Portions of the eastern parcel, however, are being considered as brownfield sites for potential reuse. Future land use proposals call for this area to be redesignated from Waste Management, Service/Support, and

Nuclear Materials Research and Development to Reserve; however, redevelopment could negate this change in designation (see Appendix H).

Technical Area 72

Construction of the Remote Warehouse and Truck Inspection Station along the south side of East Jemez Road would require clearing about 4 acres (1.6 hectares) of land. As current and future land use within the site area is designated as Reserve, development of the site would change the land use designation from Reserve to Physical/Technical Support.

Key Facilities Impacts

Five projects that could impact land use at LANL Key Facilities are proposed as part of the Expanded Operations Alternative. The impacts described below are from project-specific analyses in Appendices G and H.

Pajarito Site

Decontamination, decommissioning, and demolition (DD&D) of TA-18 buildings and structures would change the overall land use designation of the TA because the site would not be used for other LANL development purposes. The land use designation of the site would change from Nuclear Material Research and Development to Reserve.

Radiochemistry Facility

Construction of the Radiological Sciences Institute would require about 33.6 acres (13.6 hectares) of land, mainly within TA-48, as well as a small part of TA-55, of which about 12.6 acres (5.1 hectares) are currently undeveloped. Development would require some areas that are currently designated Reserve and Experimental Science to be redesignated as Nuclear Materials Research and Development; however, this is consistent with future land use concepts because TA-48 is within the Pajarito Corridor West Development Area. Construction of the Radiological Sciences Institute would take place in areas designated as Primary Development, Proposed Parking, and Potential Infill.

Radioactive Liquid Waste Treatment Facility

Construction of the new liquid waste management buildings would occur in a developed area of TA-50 and would not change the TA's current or future land use designation as Waste Management. If the evaporation tanks, which could occupy up to 4 acres (1.6 hectares) of land, were constructed near the border of TA-52 and TA-5, the land use designation for the tank areas and a portion of the pipeline route (1.4 acres [0.6 hectares]) would likely change from Reserve to Waste Management.

Solid Radioactive and Chemical Waste Facilities

While activities taking place within TA-54, including some new construction and removal of the domes, would not change the existing land use designation within the TA, construction of the TRU Waste Facility (previously called the Transuranic Waste Consolidation Facility) in an as-yet identified location in the Pajarito Road corridor could impact land use. The greatest potential impact to land use would occur at a generic site that is presently not developed. With the exception of TA-54 West, all generic sites are undeveloped; thus, up to 7 acres (2.8 hectares) of land would be disturbed. Construction of the TRU Waste Facility would change the present land use category to Waste Management at all generic sites except at TA-63. However, all generic sites have been determined to be suitable for future development because they have been designated in the *Comprehensive Site Plan 2001* (LANL 2001c) as Primary Development, Secondary Development, or Potential Infill.

Biosciences Facilities

Under Option 1, the Northwest TA-62 Site Option, a site located to the west of TA-3 would be used for construction of the Science Complex. Land use within this site area is currently designated as Reserve, and this is not predicted to change in the future (LANL 2003h). Construction of the Science Complex, however, would disturb 5 acres (2 hectares) of undeveloped land and would change the site area's future land use designation from Reserve to Experimental Science. Option 2, the Research Park Option, would also change the site area's future land use designation from Reserve to Experimental Science. Option 3, the South TA-3 Site Option, would locate the facility in an area presently occupied by a parking lot and would result in no change to its land use designation.

5.1.2 Visual Environment Impacts

Visual resources are natural and manmade features that give a particular landscape its character and aesthetic quality. A comparative analysis of the impacts to visual resources was performed, consisting of a qualitative examination of potential changes in the visual environment. Aspects of visual modification examined included site development, building modification, and demolition, as appropriate. Each of these activities could alter the appearance of LANL structures or obscure views of the surrounding landscape, result in changes in surrounding land cover that could make structures more or less visible, and cause light pollution that would alter the night sky. **Table 5–2** summarizes the expected impact on visual resources at LANL.

5.1.2.1 No Action Alternative

The visual environmental impacts of the No Action Alternative are related to the existing visual environment at LANL, including actions that DOE or NNSA has decided upon, but has not fully implemented, as well as the impacts identified by other NEPA compliance reviews issued since the *1999 SWEIS* ROD. Impacts to the visual environment are described in terms of those projects that affect the site as a whole and those that affect specific TAs. Key Facilities are addressed separately. Only those projects that have been evaluated in their respective environmental analyses to have an impact on the visual environment at LANL are addressed below.

Table 5–2 Summary of Environmental Consequences on the Visual Environment

Location	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
Site-Wide	*Land Conveyance and Transfer* – Development could degrade views of presently undeveloped tracts. *Electrical Power System Upgrades* – Short-term visual impacts during construction. – Adverse visual impact in undisturbed areas. – No overall change in view from Bandelier National Monument. *Wildfire Hazard Reduction Program* – Forest would appear more park-like. – Some LANL facilities would be more visible. *Disposition of Flood Retention Structures* – Temporary impacts if staging areas are located near Pajarito Road. – Overall, little impact because most disposition projects are not visible to the public.	Same as No Action Alternative	Same as No Action Alternative plus: *MDA Remediation Project* – Short-term visual impacts during MDA capping or removal and during remediation of other PRSs. – Temporary containment domes used under the MDA Removal Option. – Minor changes in distant views if MDAs are capped; would be maintained as open grassy areas. – Borrow pit in TA-61 would become more visible due to the large quantities of material needed. *Security-Driven Transportation Modifications Project* – Short-term impacts during construction. – Pronounced impacts due to roads, bridges, and parking lots, as well as vehicle and pedestrian bridges under auxiliary actions.
Affected Technical Areas			
TA-3	No change in impacts to visual resources	Same as No Action Alternative	*Physical Science Research Complex* – Short-term impacts during construction. – New structures would be of a unified design. – Demolition of vacated structures would improve the overall appearance of TA-3, TA-35, and TA-53. *Replacement Office Buildings Project* – Short-term impacts during construction. – New buildings and parking lot would be readily visible from West Jemez Road and Pajarito Road. – Impact of the project on distant views would be minimal.
TA-21	No change in impacts to visual resources	Same as No Action Alternative	*TA-21 Structure DD&D* – Enhancement of visual environment from removal of old structures. – Both conveyed and non-conveyed parcels could undergo development, which could change the visible environment.

Location	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
TA-72	No change in impacts to visual resources	Same as No Action Alternative	*Remote Warehouse and Truck Inspection Station* – Short-term impacts during construction. – 4 acres (1.6 hectares) would be cleared making the site readily visible from East Jemez Road. Lighting could be visible from the Tsankawi Unit of Bandelier National Monument.
Key Facilities			
Chemistry and Metallurgy Research Building (TA-3, TA-48, and TA-55)	– Temporary impacts during construction of replacement building. – Minimal visual impact to public from Pajarito Plateau rim and employees from Pajarito Road.	Same as No Action Alternative	Same as No Action Alternative
High Explosives Processing Facilities (TA-16)	– Temporary impacts during construction of replacement or new buildings. – New structures of unified design. – Removal of old buildings would enhance visual environment.	Same as No Action Alternative	Same as No Action Alternative
High Explosives Testing Facilities (TA-6, TA-22, and TA-40)	– Temporary impacts during construction of new buildings. – Minimal long-term impacts. – Removal of old buildings would enhance visual environment.	Same as No Action Alternative	Same as No Action Alternative
Pajarito Site DD&D (TA-18)	No change in impacts to visual resources	Same as No Action Alternative	*TA-18 DD&D* – Short-term impact from demolition. – Long-term positive impact as area is restored to more natural appearance.
Radiochemistry Facility (TA-48)	No change in impacts to visual resources	Same as No Action Alternative	*Radiological Sciences Institute* – Short-term impacts during demolition and construction. – Minimal visual impact to public from Pajarito Plateau rim and employees from Pajarito Road from new construction west of current buildings.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in impacts to visual resources	Same as No Action Alternative	*Radioactive Liquid Waste Treatment Facility Upgrade* – Short-term impact from construction of new treatment building in TA-50. – Permanent change to the visual environment if evaporation tanks are built near the border of TA-52 and TA-5.

Location	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No change in impacts to visual resources	Same as No Action Alternative	*Waste Management Facilities Transition* – Short-term impacts during construction. – Beneficial impact on near and distant views from removal of domes in TA-54. – Minimal visual impact of new TRU Waste Facility to public from Pajarito Plateau rim and employees from Pajarito Road. – Construction at generic sites within TA-51, TA-52, and TA-54 West would be visible from lands of the Pueblo of San Ildefonso.
Bioscience Facilities	No change in impacts to visual resources	Same as No Action Alternative	*Science Complex Project* – Short-term impacts during construction. – Under Options 1 and 2, the new facility would be readily visible from West Jemez Road and forested buffer between LANL and Los Alamos Canyon would be lost. – Potential impacts to Los Alamos Canyon from night lighting under Options 1 and 2. – Minimal impact under Option 3 because the new facility would be generally located within a developed part of TA-3.

MDA = material disposal area; PRS = potential release site; TA = technical area; DD&D = decontamination, decommissioning, and demolition.

Los Alamos National Laboratory Site-Wide Impacts

Conveyance of land to Los Alamos County, the New Mexico Department of Transportation, and transfer of land to the U.S. Department of the Interior (to be held in trust for the Pueblo of San Ildefonso) have been evaluated with respect to impacts on the visual environment. Most tracts would maintain their current level of visual aesthetic value after conveyance and transfer and any subsequent development, and the visual resources of some tracts could be improved by the removal and replacement of industrial buildings. The evaluation also determined, however, that commercial and residential development of currently undeveloped areas, such as the Rendija Canyon and White Rock Tracts, could degrade the local visual landscape. Overall, the reduction in visual quality was not found to be substantial on a regional scale (DOE 1999d).

The electrical power system upgrades were determined to affect the visual environment near the power line right-of-way both during and after construction. During construction, staging areas and equipment would cause short-term visual effects that would be out of character with the surrounding environment. Revegetation after construction, however, would return disturbed areas to a more natural condition. Analysis determined that, after construction, the power line would have two principal visual effects – selectively cleared corridors in wooded areas and visible pole structures and lines that would contrast with natural landforms. Because the corridors would be cleared selectively, no major swathes of devegetated areas would be visible. The finished power line would be most disruptive in areas where the surrounding land is undeveloped or where the contrast with the natural landscape is marked. The evaluation determined that electrical power system upgrades would not dramatically change the overall character of the view from the Bandelier National Monument Wilderness Area (DOE 2000a).

The Wildfire Hazard Reduction Program was found to have minimal effect on visual resources at LANL and in the surrounding area, given the degraded panoramas of the Pajarito Plateau and Jemez Mountains resulting from the Cerro Grande Fire. The primary aspect of the program that would affect visual resources is vegetation removal, which would occur as a result of selective thinning activities. The forest at LANL would become more natural as the diversity of shrubs, herbs, and grasses in the understory increased. Some facilities currently screened from casual view could become visible to viewers at various vantage points. The overall effect of the Wildfire Hazard Reduction Program would be to enhance the contrast between the background setting and LANL's industrial character (DOE 2000e).

Disposition of flood and sediment retention structures was determined to affect visual resources temporarily if the staging areas for the concrete removal were located near Pajarito Road. Actual demolition of the flood retention structure in Pajarito Canyon and the steel diversion wall upstream from TA-18 would occur in restricted areas that are not visible to the public. The low-head weir, located in Los Alamos Canyon, and the road reinforcements in Twomile Canyon, Pajarito Canyon, and Water Canyon would remain in place, with no change to visual resources (DOE 2002j).

Management of construction fill would not be expected to affect visual resources. Construction fill would be stored in existing borrow areas at TA-16 and TA-61.

Technical Area Impacts

No actions are contemplated under the No Action Alternative that would impact visual resources in terms of the TAs beyond the impacts related to Key Facilities, as discussed below.

Key Facilities Impacts

Since publication of the *1999 SWEIS*, NEPA compliance has been achieved for three currently active projects related to Key Facilities: construction of the Chemistry and Metallurgy Research Replacement Facility at TA-55, consolidation and refurbishment of the Weapons Manufacturing Support Facility at TA-16, and construction at the Dynamic Experimentation Complex at TA-6, TA-22, and TA-40. The impacts of these projects to visual resources are discussed below.

Chemistry and Metallurgy Research Replacement Building

Impacts to visual resources resulting from construction of the Chemistry and Metallurgy Research Replacement Facility at TA-55 were determined to be temporary in nature and include increased levels of dust and human activity. When complete, the general appearance of the new facility, which would include two buildings, would be consistent with other buildings located within TA-55. The Chemistry and Metallurgy Research Replacement Facility would be readily visible to LANL employees from Pajarito Road, and would be visible to the public from the upper reaches of the Pajarito Plateau rim (DOE 2003d). Future DD&D of the Chemistry and Metallurgy Research Building would likely result in a temporary park-like area once the site was revegetated. As infill building probably would occur later, no long-term visual change is likely because new construction would blend in with modern construction.

High Explosives Processing Facilities

Construction and demolition activities at the Weapons Manufacturing Support Facility at TA-16 would have some local short-term adverse effects and long-term beneficial effects on the viewscape. Short-term adverse visual effects would occur during the construction period. As the existing engineering complex is highly industrial in appearance, these effects would be minor. In the long term, the area would experience a beneficial effect because temporary buildings would be removed and newly built structures would be of a similar style. The visual effects of the new facilities would be confined to the immediate area of the current complex because the area generally is not visible from public roads. Demolition activities generally would result in the same local short-term adverse effects identified for the construction phase. Overall, the removal of buildings would enhance the visual characteristics of TA-3, TA-8, and TA-16 (DOE 2002l).

High Explosives Testing Facilities

Dynamic Experimentation Complex construction activities at TA-6, TA-22, and TA-40 would have some local short-term adverse effects on visual resources; long-term effects from construction and demolition are expected to be minimal. The project, which would involve constructing 15 to 25 new one- to two-story buildings, as well as new roads and parking lots, generally is not visible from public roads, and new buildings would be similar in height to existing structures. The visual effects of construction would be confined to the immediate area. In the long term, the area would experience minimal effects because its industrial park appearance would continue, but on an expanded scale with similar architecture. Demolition activities generally would result in the same local short-term adverse effects identified for the construction phase. Overall, the removal of buildings would enhance visual characteristics as some areas return to more natural conditions (DOE 2003e).

5.1.2.2 Reduced Operations Alternative

Under the Reduced Operations Alternative, the same impacts on the visual environment as those addressed under the No Action Alternative (see Section 5.1.2.1) would occur.

5.1.2.3 Expanded Operations Alternative

The Expanded Operations Alternative reflects proposals that would expand the overall operations levels at LANL beyond those established for the No Action Alternative. Additionally, the Expanded Operations Alternative includes a number of new projects that could impact the visual environment at LANL. Not all new projects would affect the visual environment because many would involve actions within or modifications to existing structures. Only those projects that impact the visual environment are addressed below.

Los Alamos National Laboratory Site-Wide Impacts

Two proposed projects could impact visual resources across a number of TAs at LANL: the MDA Remediation Project and the Security-Driven Transportation Modifications Project. A detailed analysis of each is presented in Appendices I and J, respectively.

Action options for remediation of MDAs include capping, removal, or a combination of both. Remedies for MDAs subject to the Consent Order would be recommended by the LANL management and operating contractor on an MDA-by-MDA basis, and the decision would be made by the New Mexico Environment Department. Each option would have some temporary short-term visual impacts resulting from activities such as stripping or disrupting the existing vegetative cover over the MDAs, removing waste, placing cover materials in compacted lifts, and providing revegetation. Not all land would be affected at the same time. Many of the affected sites would not be in areas that are routinely visible to the public; however, a number of MDAs are located on DP Mesa in TA-21 and are visible from the Los Alamos townsite. Remediating the MDAs would have a relatively minor impact on visual resources from higher elevations to the west and, in a few cases, from the townsite. Once capped, the views generally would be similar to those in existence prior to implementation of corrective measures. One difference between the Capping and Removal options is that, under the Removal Option, MDAs would be covered by enclosures as needed while waste is being removed. (The investigation and remediation program at MDA B also would be conducted under enclosures.) These domed structures would be visible from greater distances than the MDAs themselves under the Removal Option; however, their presence would be temporary. After waste removal was completed, the enclosures would be removed and the site would be revegetated. Under both the Capping and Removal Options, the need to obtain fill may require removal of a small hill that currently screens the TA-61 borrow pit from observation from East Jemez Road. Thus, the borrow pit, which is a cleared area several acres in size, might become visible from East Jemez Road and would remain visible until the area ultimately is reclaimed and revegetated. Remediating PRSs other than MDAs would result in few additional long-term visual impacts.

The Security-Driven Transportation Modifications Project would take place within Pajarito Corridor West, which is a highly developed area that is readily visible from both nearby and higher elevations to the west. While many actions associated with implementing the Security-Driven Transportation Modifications Project would have few or no visual impacts, construction of the two parking lots, new roads across TA-63 and TA-35, and highway and pedestrian bridges over Ten Site Canyon would noticeably add to the built-up appearance of the area. Visual impacts of constructing the parking lots and the highway and pedestrian bridges would be especially pronounced because they would involve removal of existing forest and span a forested canyon that has an otherwise natural appearance. The bridges would be readily visible from the canyon where little development is presently apparent; they would also be visible from more distant areas.

Auxiliary Action A for the Security-Driven Transportation Modifications Project involves construction of a two-lane bridge within a 1,000-foot (300-meter)-wide corridor across Mortandad Canyon and a new two-lane road from the north end of the new bridge westward through TA-60 to connect TA-35 with TA-3. Although the roadway would have minimal impact on visual resources because it would follow an existing unpaved road, the proposed bridge would represent a highly visible change in the appearance of the local environment and would stand out in contrast to the forested setting of the canyon, altering its natural appearance when viewed from both nearby locations and higher elevations to the west.

Auxiliary Action B involves construction of a second, new two-lane bridge within a 1,000-foot (300-meter)-wide corridor across Sandia Canyon and a new two-lane road from the new bridge to connect with East Jemez Road. Because Auxiliary Action B would not proceed independently of Auxiliary Action A, the impacts on visual resources would be similar to those addressed for Auxiliary Action A, but would involve bridges across two canyons.

Technical Area Impacts

Three projects are planned that could impact visual resources at TA-3 and TA-21. These projects are addressed below.

Technical Area 3

Construction of the Physical Science Research Complex (formerly the Center for Weapons Physics Research) would result in short-term impacts to the visual environment, including construction activities and increased dust generation. Once complete, the facility would be visually compatible with nearby office and computing structures and would enhance the overall architectural character of the Core Development Area. Distant views of TA-3 would not change appreciably due to the highly developed nature of the area. DD&D of buildings vacated as a result of the project would cause temporary construction-related impacts, but in the long term would improve the general appearance of TA-35 and TA-53.

Construction of the Replacement Office Buildings would require clearing and grading of 13 acres (5.3 hectares), which would result in short-term impacts to the visual environment such as construction activities and increased dust generation. The forested area along West Jemez Road would be replaced with buildings and a parking lot that would be readily visible from West Jemez Road, Pajarito Road, and nearby areas. Views from Pajarito Road, however, only would be apparent to employees because the road is closed to the public (see Appendix G). Due to the highly developed nature of TA-3, distant views would not change appreciably.

Technical Area 21

DD&D activities at TA-21 would have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Following removal of buildings and structures, the area would be contoured and revegetated, as appropriate. These efforts, however, would be aimed primarily at soil stabilization, not recreating a more natural environment, because both the western part of the site, which has been transferred to Los Alamos County, and the eastern section could be developed in the future. With redevelopment likely, future views of the TA from NM 502 and from higher elevations to the west would remain commercial or industrial in nature. Nevertheless, with proper planning, the view would be of modern architecturally compatible buildings rather than the current mix of 50-year-old structures (see Appendix H).

Key Facilities

Five projects related to Key Facilities at LANL are proposed under the Expanded Operations Alternative. The impacts described below are from project-specific analyses in Appendices G and H.

Pajarito Site

The use of heavy equipment for DD&D of buildings at TA-18 and the resultant increase in dust would have short-term impacts on visual resources; however, long-term impacts would be positive. Once the buildings and structures were removed and the site restored, including grading and planting of native species, the canyon bottom would present a natural appearance and, given time, would blend with previously undisturbed portions of the TA (see Appendix H).

Radiochemistry Facility

Construction of the Radiological Sciences Institute would result in changes in both near and distant views of TA-48. Short-term impacts would include the construction activity itself, as well as increased dust generation. Upon completion, the new buildings and parking lots would be more visible from the road than current facilities due to their increased number and size. Most of the changes to area views would be visible only to LANL workers. Construction of the Radiological Sciences Institute also would change distant views of TA-48 because the size of the developed area would increase along with the numbers of buildings and parking lots. The overall broad viewshed effect would be minimal due to the extensive nature of existing development on the mesa.

Demolition of buildings and structures at TA-48 prior to constructing the Radiological Sciences Institute would have short-term and long-term impacts on visual resources. In the short term, dust and demolition activity would adversely affect these resources; however, in the long term, the new facility would be more aesthetically pleasing in terms of architectural style than the mix of existing structures. These changes would be observed primarily by LANL employees. Distant views from higher elevations to the west would not change appreciably (see Appendix G).

Radioactive Liquid Waste Treatment Facility

One or more treatment buildings and a separate utilities structure would be constructed, or the existing building could be renovated. Regardless of the construction option, visual impacts would be temporary and localized. Any new buildings would be no more than two stories high with established color schemes for the building exteriors. If evaporation tanks were constructed, it would permanently change the visual environment because the area near TA-52 and TA-5 where the tanks would be constructed currently is undeveloped and wooded. Views of this natural setting from higher areas to the west of LANL would be disrupted by a noticeable break in the forest cover.

Solid Radioactive and Chemical Waste Facilities

Waste Management Facilities Transition activities primarily would involve work within TA-54 and a generic site. Actions taking place within TA-54, including some new construction and removal of the domes and other facilities, would occur within previously disturbed areas. While most activities taking place within TA-54 would have minimal impacts on visual resources due to the developed nature of the area, removal of the domes at MDA G would have a beneficial impact on both near and distant views because these structures can be seen many miles away from areas in the Nambe and Española area and in western and southern Santa Fe. The domes also are visible from the lands of the Pueblo of San Ildefonso. Generic sites for the TRU Waste Facility, with the exception of TA-54 West, are located within undeveloped areas. Thus, while construction of the new facility would have minimal visual impact within TA-54 West, it would create a change in the visual environment of the other generic sites. However, construction would generally not be visible to the public since Pajarito Road is open only to LANL personnel. Construction at generic locations within TA-51, TA-52, and TA-54 West would be visible from lands of the Pueblo of San Ildefonso. Regardless of where the TRU Waste Facility would be built, when viewed from higher elevations to the west it would add somewhat to the developed nature of LANL along Pajarito Road.

A second option related to the Waste Management Facilities Transition would require additional storage space for remote-handled and contact-handled transuranic waste that could be collocated with the TRU Waste Facility or be separated from it. This option also involves upgrading satellite storage areas around LANL for mixed low-level radioactive waste and hazardous or chemical waste. While impacts on visual resources from construction of the TRU Waste Facility would be similar to those described above, construction of new transuranic waste storage buildings would increase the visual impact under this option. DOE would mitigate these impacts by following the design principles provided in the LANL architectural guide (LANL 2002a).

Biosciences Facilities

The Science Complex would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Construction of the complex would result in temporary visual impacts related to the presence of heavy equipment and dust.

Once complete, the addition of the Science Complex at the Northwest TA-62 Site or Research Park Site would impact visual resources in this area because views from TA-3 or from West Jemez Road to the west, north, and east would be obstructed. In addition, after construction of the Science Complex on the north side of the road, the natural forested buffer area between LANL and Los Alamos Canyon would be lost. These options would add somewhat to the overall "built-up" appearance of LANL when viewed from higher elevations to the west. Under the South TA-3 Site option, there would be little overall impact to visual resources because the Science Complex would be located within a highly developed part of LANL.

Under the Northwest TA-62 Site or Research Park Site options, it is possible that the security lighting associated with the Science Complex may illuminate some portion of the south and north walls of Los Alamos Canyon; however, the project would conform to the New Mexico Night Sky Protection Act per architectural and design guidelines and LANL engineering standards. Impacts from night lighting under the South TA-3 option would not be expected.

Remote Warehouse and Truck Inspection Station

Construction of the Warehouse and Truck Inspection Station would result in temporary visual impacts related to clearing activities, the presence of heavy equipment, and dust. Once complete the facility would be readily visible from East Jemez Road. Nighttime lighting would be required in a location that previously was unlighted. Although the Remote Warehouse and Truck Inspection Station would not be visible from the trails or parking lot at the Tsankawi Unit of Bandelier National Monument, the nighttime sky glow from lighting at the facility could be visible from Tsankawi under normal conditions. The trails at Tsankawi, however, are closed to the public after dusk. The lighting that would be installed would comply with the New Mexico Night Sky Protection Act to the extent it does not compromise security.

5.2 Geology and Soils

This section discusses the projected impact on LANL geology and soils under the three alternatives evaluated in this SWEIS. In general, present LANL operations have limited impact on geology and soils, except in specific circumstances. This is because most of LANL is not industrialized, so the majority of the soil column is not disturbed, and few LANL processes involve subsurface work, so there is limited interaction with geological materials. Although LANL activities do not impact geology and soils, there is a geological impact that applies to LANL facilities. An updated seismic hazard analysis completed in 2007 (LANL 2007a) presents an increased estimated probabilistic seismic hazard for LANL. As a result, the hazard assessments for existing and planned facilities will be evaluated and updated as necessary to meet DOE facility design criteria. This may impact LANL facilities under all of the three alternatives (see Section 5.12).

The information for the geology and soils sections feeds into several other sections within this new SWEIS, including human health, accidents, and ecological risk. The following section addresses each of the subject areas previously described in Chapter 4, Affected Environment.

Table 5–3 summarizes the impacts of each of the proposed alternatives on geology and soils.

Table 5–3 Summary of Environmental Consequences for Geology and Soils

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
	Volcanism & Seismic Activity – No activities that could increase the probability of seismic events. *Slope Stability, Subsidence, & Soil Liquefaction* – No impact. *Soil Monitoring* – No increase in the level of legacy contaminants. – Overall decrease in soil contamination occurring over time. *Soil Erosion* – No impact. *Mineral Resources* – No impact.	Same as No Action Alternative, except: *Soil Monitoring* – Potential for soil contamination would decrease due to the 20 percent reduction in high explosives testing activities.	Same as No Action Alternative, except: *Soil Monitoring* – Facility DD&D and MDA and PRS remediation would have a positive impact by removing or containing legacy contamination. *Soil Erosion* – Combined activities could impact up to 3.2 million cubic yards (2.5 million cubic meters) of soil and rock. – Standard best management practices would serve to minimize soil erosion and loss. *Mineral Resources* – MDA remediation would have a significant impact on geological resources -- up to 2.5 million cubic yards (1.9 million cubic meters) of crushed tuff and other materials would be required under the Capping Option. – Up to 2.2 million cubic yards (1.7 million cubic meters) of crushed tuff and other materials would be required under the Removal Option. – Materials would be available at LANL or from nearby offsite sources. – TA-61 borrow pit would be expanded. *Security-Driven Transportation Modifications Project* – Would disturb up to 240,000 cubic yards (183,000 cubic meters) of soil and rock for construction. – Construction of bridges as part of the auxiliary actions could disturb up to 28,000 cubic yards (21,000 cubic meters) of soil and rock. – Excavated materials would be managed to minimize erosion and losses.
Affected Technical Areas			
TA-3	No impacts to geology and soils.	Same as No Action Alternative	Same as No Action Alternative except: – Construction of Replacement Office Buildings and Physical Science Research Complex would impact approximately 868,000 cubic yards (664,000 cubic meters) of soil and rock for building excavation. – Excavated materials would be managed to minimize erosion and losses; backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. – Legacy contamination would be reduced due to removal of contaminated soils during DD&D.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
TA-21	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative except: – No impact to native soils because all areas were disturbed previously by site activities. – Positive impact due to removal or improved containment of contaminated soils as a result of MDA remediation and DD&D of existing structures.
TA-61	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – If all MDA Capping Option tuff requirements came from TA-61, 25 acres (10 hectares) would have to be excavated an average of 50 feet (15 meters). – If all MDA Removal Option tuff requirements came from TA-61, up to 24 acres (9.7 hectares) would have to be excavated an average of 50 feet (15 meters).
TA-72	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – Construction of Remote Warehouse and Truck Inspection Station would impact about 90,000 cubic yards (69,000 cubic meters) of soil and rock for building excavation. – Excavated materials would be managed to minimize erosion and losses; backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. – Negative impact in the areas where construction would occur in areas with previously undisturbed soils.
			Key Facilities
Pajarito Site DD&D (TA-18)	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – No impact to native soils because all areas were disturbed previously. – Positive impact due to removal of contaminated soils and reduction of legacy soil contamination at LANL.
Radiochemistry Facility (TA-48)	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – DD&D of existing facilities would reduce legacy contamination and potential soil erosion. – Construction of Radiological Sciences Institute would impact approximately 802,000 cubic yards (613,000 cubic meters) of soil and rock for building excavation, some up to 45 feet (14 meters) below grade. – Excavated materials would be managed to minimize erosion and losses; backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. – Negative impact in the areas where construction would occur in areas with previously undisturbed soils.
Radioactive Liquid Waste Treatment Facility (TA-50 and TA-54)	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – Construction would impact up to 95,000 cubic yards (73,000 cubic meters) of soil and rock for building excavation. – Construction of evaporation tanks and pipeline would impact approximately 69,000 cubic yards (53,000 cubic meters) of soil and rock. – Excavated materials would be managed to minimize erosion and losses; backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. – DD&D of North or South Annexes would reduce legacy contamination and potential soil erosion.

	No Action Alternative	Reduced Operations Alternative	Expanded Operations Alternative
			– Negative impact in the areas where construction would occur in areas with previously undisturbed soils.
Bioscience Facilities	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – Construction of Science Complex would impact about 840,000 cubic yards (640,000 cubic meters) of soil and rock for building excavation. – Excavated materials would be managed to minimize erosion and losses; backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. – Negative impact in the areas where construction would occur in areas with previously undisturbed soils.
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – Waste Management Facilities transition would impact up to 169,000 cubic yards (129,000 cubic meters) of soil and rock for building excavation and construction. Option 1 (Accelerated Actions) would impact approximately 80,000 cubic yards (61,000 cubic meters) and Option 2 (Interim Actions) would impact up to 89,000 cubic yards (68,000 cubic meters), depending on whether Option 2a, 2b, or 2c were selected. – No impact to native soils because all areas were disturbed previously. – Positive impact due to removal of wastes, contaminated soils and reduction of legacy soil contamination at LANL. – Excavated materials would be managed to minimize erosion and losses; backfill would be obtained at LANL or from nearby offsite sources.
Radiography Facility (TA-55)	No impacts to geology and soils	Same as No Action Alternative	Same as No Action Alternative, except: – Construction of the New Radiography Building would impact up to 8,000 cubic yards (6,100 cubic meters) of soil and rock for building excavation. – No impact to native soils because all areas were disturbed previously. – Positive impact due to removal of contaminated soils and reduction of legacy soil contamination at LANL. – Excavated materials would be managed to minimize erosion and losses; backfill would be obtained at LANL or from nearby offsite sources.

DD&D = decontamination, decommissioning, and demolition; MDA = material disposal area; PRS = potential release site; TA = technical area.

5.2.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

Volcanism and Seismic Activity

LANL operations under the No Action Alternative do not include activities that could modify the movement of magma, trigger volcanic activity, or increase the probability of seismic events (such as underground nuclear tests or operation of injection wells). This is unchanged from the *1999 SWEIS* impact analysis (DOE 1999a). The estimated potential for seismic impact to LANL facilities was updated in 2007 (LANL 2007a). The result is an increase in the probabilistic hazard that will require a review and update to the existing seismic hazard assessment for existing facilities.

Slope Stability, Subsidence, and Soil Liquefaction

The No Action Alternative does not include any new activities that would result in additional slope stability impacts. This is unchanged from the *1999 SWEIS* impact analysis (DOE 1999a). The potential for slope failure under this alternative is related primarily to increased stream downcutting, which may result from greater streamflow. The No Action Alternative does not include activities that would significantly increase streamflow, such as startup of new facilities or use of new industrial processes that discharge large volumes of water. Similarly, this alternative does not include any activities that would increase surface subsidence or the potential for soil liquefaction.

Soil Monitoring

The No Action Alternative does not include any activities that would appreciably increase the level of legacy contaminants (both chemical and radiological) in soils at the site. As discussed in Chapter 4, Section 4.2.3.1, the levels of legacy contaminants generally are decreasing over time as a result of contaminant decay, soil losses, improvements in LANL work practices, and environmental remediation.

Soil Erosion

The No Action Alternative does not include any activities that would significantly impact the potential for soil erosion. Construction activities yet to be undertaken under the No Action Alternative would continue using standard mitigation measures to minimize the effect of surface runoff and erosion.

Mineral Resources

The No Action Alternative would not affect the mineral resources in use at LANL. As discussed in Chapter 4, Section 4.2.4, the potential mineral resources at LANL are sand, gravel, tuff, and pumice deposits. These materials can be used for backfill or construction of evapotranspiration covers for environmental remediation projects. Under the No Action Alternative, the areas for proposed new construction activities are relatively small and would not impede the availability of borrow material. The only area being used for mineral resources, the East Jemez Road Borrow

Pit in TA-61 (Stephens and Associates 2005) would continue to be available under the No Action Alternative. At present, however, the pit is used to stockpile and manage materials from other areas; no quarrying is being conducted.

Technical Area Impacts

No activities planned under the No Action Alternative are expected to contribute additional impacts on geology and soils at any of the TAs.

Key Facilities

No activities planned under the No Action Alternative and related to construction or operations at any of the site's Key Facilities are expected to additionally impact geology and soils.

5.2.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Geology and soils impacts under the Reduced Operations Alternative would be similar to those under the No Action Alternative.

Technical Area Impacts

Geology and soils impacts under the Reduced Operations Alternative with respect to the TAs would be similar to those under the No Action Alternative.

Key Facilities

High Explosives Testing Facilities

Compared to the No Action Alternative, the potential impact of LANL operations on soil contamination could decrease under the Reduced Operations Alternative due to a 20 percent reduction in activities at the High Explosives Testing Facilities.

5.2.3 Expanded Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Similar to the impacts expected under the No Action Alternative, LANL operations under the Expanded Operations Alternative would not be expected to impact the site with respect to volcanism, seismic activity, slope stability, subsidence, or soil liquefaction. Proposed activities (including facility construction and DD&D) would not significantly alter overall LANL subsurface conditions.

Volcanism and Seismic Activity

All proposed new facilities would be designed, constructed, and operated in compliance with the applicable DOE Orders, requirements, and governing standards established to protect public and worker health and the environment. DOE Order 420.1B (DOE 2005f) requires that nuclear or nonnuclear facilities be designed, constructed, and operated so that the public, the workers, and the environment are protected from the adverse impacts of natural phenomena hazards, including earthquakes. The Order stipulates the natural phenomena hazards mitigation requirements for DOE facilities and specifically provides for re-evaluation and upgrade of existing DOE facilities when there is a significant degradation in the safety basis for the facility. DOE Standard 1020-2002 (DOE 2002a) implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components, as well as for evaluation, modification, or upgrade of existing structures, systems, and components, to ensure that DOE facilities can safely withstand the effects of natural phenomena hazards such as earthquakes. The criteria specifically reflect adoption of the seismic design and construction provisions of the International Building Code for DOE Performance Category 1 and 2 facilities. The updated seismic hazard analysis completed in 2007 (LANL 2007a) presents increased estimated probabilistic seismic hazard for LANL. As a result, the hazard assessment for existing and planned facilities will be reviewed and updated so that these data can be used in facility design to meet DOE Orders, requirements, and governing standards.

Slope Stability, Subsidence, and Soil Liquefaction

Similar to the No Action Alternative, the Expanded Operations Alternative does not include any new activities that would result in additional slope stability impacts. This alternative also does not include activities that would significantly increase streamflow, such as startup of new facilities or use of new industrial processes that discharge large volumes of water. Similarly, this alternative does not include any activities that would increase surface subsidence or the potential for soil liquefaction. All new facilities built under this alternative would be located a sufficient distance away from steep slopes (such as canyon walls) and would use standard construction practices, as detailed in a text box in Appendix G, “Construction Work Elements,” to minimize the potential for slope failure.

Soil Monitoring

This alternative would decrease the level of legacy contamination at facility construction, DD&D, and MDA and PRS remediation sites, where excavated soil and rock would be monitored for contamination. Any contaminated materials would be managed according to the LANL environmental restoration and waste management programs. The overall effect would be to remove contaminated soil from LANL, thereby reducing the levels of legacy contamination onsite. The impact of removal would be much greater under the Expanded Operations Alternative than the No Action or Reduced Operations Alternatives due to the greater volume of soil to be excavated, monitored, and potentially removed as contaminated media.

At sites involving excavation or other soil disturbances, potential impacts on PRSs and PRS-affected areas could result. Prior to commencing any ground disturbance, potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with procedures established under the LANL Risk Reduction and Environmental Stewardship Remediation Program.

Soil Erosion

Under the Expanded Operations Alternative, facility construction and DD&D would impact geological materials. A total of approximately 3.2 million cubic yards (2.5 million cubic meters) of soil and rock would be impacted; however, over 90 percent of the material would be from areas already disturbed by present or past activities. This would minimize the impact to native soils (soils formed by natural processes and that are not impacted by construction or other anthropogenic activities). The impacts would include both facility footprints and support areas such as soil staging areas and construction equipment laydown yards.

Surface soils and unconsolidated sediments exposed in excavations would be subject to wind and water erosion if left exposed over time. In all instances, adherence to standard best management practices for soil erosion and sediment control, including watering during construction, would minimize soil erosion and loss. See Appendix G text box "Construction Work Elements" for description of additional examples. After construction, disturbed areas that have not been paved would be stabilized and/or revegetated and would not be subject to long-term soil erosion.

Mineral Resources

Projects and activities proposed under the Expanded Operations Alternative would significantly impact mineral resources at LANL due to the proposed closures of MDAs under the Consent Order[2] (NMED 2005) through either waste containment (via construction of evapotranspiration covers) or waste removal (via excavation and offsite disposal). If final covers were constructed at the MDAs and contaminated areas in TA-49 under the Capping Option, 750,000 to 2,000,000 cubic yards (570,000 to 1,500,000 cubic meters) of crushed tuff would be needed through 2016 depending on the required thickness of the covers. Up to 460,000 cubic yards (350,000 cubic meters) of additional rock, gravel, topsoil, and other bulk materials would be required for the final surface and erosion control. The total amount of geologic materials needed would be up to 2.5 million cubic yards (1.9 million cubic meters). Total impacts to soil and rock from possible construction of vertical and subsurface horizontal containment walls would be minor.

If the waste were removed under the Removal Option, approximately 1,300,000 cubic yards (1,000,000 cubic meters) of backfill would be needed to replace the excavated waste and contamination, as well as 61,000 cubic yards (47,000 cubic meters) of rock, gravel, topsoil, and other bulk materials used for erosion control and site restoration. An additional 220,000 to 600,000 cubic yards (170,000 to 460,000 cubic meters) of crushed tuff could be needed to cap remaining disposal units in Area G and contaminated areas in TA-49, as well as about 160,000 cubic yards (120,000 cubic meters) of additional bulk materials. The total amount of geologic materials needed would be up to 2.2 million cubic yards (1.7 million cubic meters). Total impacts to soil and rock from possible construction of vertical and subsurface containment walls would be minor.

---

[2] *NNSA is including impacts associated with Consent Order implementation in the SWEIS in order to more fully analyze the impacts resulting from Consent Order compliance. NNSA intends to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in the SWEIS.*

For economic and feasibility reasons, these materials would need to be produced from borrow pits and quarries in the LANL area (Stephens and Associates 2005). The only borrow pit now in use at LANL is the East Jemez Road Borrow Pit in TA-61. There would be sufficient tuff available for quarrying at the pit to provide the needed volumes of crushed tuff. Other sources available in the area would be required to provide other materials (such as soil and coarse material for erosion control) needed to complete MDA remediation. Borrow materials also could be collected from areas of opportunity on the site, such as facility construction or DD&D areas where excess uncontaminated excavated soils may meet backfill or capping criteria. The use of excavated soils as fill or cap material would minimize the need for additional borrow pits and the impacts to LANL soils and surface water, as well as the potential impact to groundwater from enhanced infiltration.

Security-Driven Transportation Modifications

The proposed Security-Driven Transportation Modifications Project would disturb up to 240,000 cubic yards (183,000 cubic meters) of soil and rock during construction. In addition, construction of both optional bridges under this proposal could disturb up to 28,000 cubic yards (21,000 cubic meters) of soil and rock.

Technical Area Impacts

Technical Area 3

Construction of the Replacement Office Buildings and the Physical Science Research Complex would impact about 868,000 cubic yards (664,000 cubic meters) of soil and rock due to building excavation. DD&D of existing facilities would reduce legacy contamination and potential soil erosion. Excavated materials would be managed to minimize erosion and losses, and backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. There would be negative impacts on areas where construction would affect undisturbed native soils.

Technical Area 21

Remediation of the MDAs in TA-21, as well as DD&D of structures, would occur in areas that are already disturbed by site activities so there would be no impacts on native soils. Additional fill materials would be obtained onsite or from nearby offsite sources. Completion of DD&D and MDA remediation would have a positive impact due to the removal of contaminated soils from the site and a reduction of legacy soil contamination at LANL.

Technical Area 61

As discussed above, the only borrow pit now in use at LANL is the East Jemez Road Borrow Pit in TA-61. The site containing the borrow pit currently covers approximately 43 acres (17 hectares). If all of the tuff materials required to support the MDA Capping Option at maximum thickness were taken from this borrow pit, 25 acres (10 hectares) of the pit would have to be excavated an average of 50 feet (15 meters). Under the MDA Removal Option, there would be a comparable maximum tuff requirement. The TA-61 borrow pit would need to be excavated an average of 50 feet (15 meters) over 24 acres (9.7 hectares).

Technical Area 72

Construction of the Remote Warehouse and Truck Inspection Station would require excavation of approximately 90,000 cubic yards (69,000 cubic meters) of soil and some of the underlying rock. The facility would be constructed in previously undisturbed areas, resulting in a negative impact due to the loss of native LANL soils. During construction, the excavated soil and rock would be managed to minimize erosion and losses. If necessary, backfill material would be obtained from LANL sources.

Key Facilities

Pajarito Site

DD&D and shutdown activities would have no impact to native soils because all areas were previously disturbed. After DD&D and shutdown were complete, there would be a positive impact due to the removal of contaminated soils from the site and a reduction of legacy soil contamination at LANL.

Bioscience Facilities

Construction of the Science Complex would impact about 840,000 cubic yards (640,000 cubic meters) of soil and rock due to building excavation. Although a similar volume of earthwork would be required under each of the three options for building this facility, the impact to native (undisturbed) LANL soils would depend on the option selected. Option 1 (Northwest TA-62 Site) and Option 2 (Research Park Site) would have the greater impact on LANL soils because the complex would be built in a relatively undeveloped area, resulting in excavation and disruption of the native soil material. Option 3 (South TA-3 Site) would have less impact on native LANL soils because the facility would be placed on an area presently occupied by a parking lot and on fill material previously placed at the site. There would be some impact to native LANL soils along the margins of facility construction under Option 3.

Materials excavated for facility construction would be managed to minimize erosion and losses. Backfill for facility construction would be obtained from LANL sources.

Radiochemistry Facility

Construction of the Radiological Sciences Institute would impact about 802,000 cubic yards (613,000 cubic meters) of soil and rock for building excavation. DD&D of existing facilities would reduce legacy contamination and potential soil erosion. Excavated materials would be managed to minimize erosion and losses and backfill for DD&D buildings would be obtained at LANL or from nearby offsite sources. There would be a negative impact on areas where construction would affect undisturbed native soils.

Radioactive Liquid Waste Treatment Facility

Construction of a Radioactive Liquid Waste Treatment Facility would impact up to 95,000 cubic yards (73,000 cubic meters) of soil and rock for building excavation. Another 69,000 cubic yards (53,000 cubic meters) of soil and rock would be impacted by construction of evaporation tanks and a pipeline. DD&D of the North or South Annexes would reduce legacy contamination and potential soil erosion. Excavated materials would be managed to minimize erosion and losses, and any additional backfill required would be obtained at LANL or from nearby offsite sources. There would be a negative impact on areas where construction would affect undisturbed native soils.

Solid Radioactive and Chemical Waste Facilities

Waste Management Facilities Transition activities primarily would involve work within TA-54, TA-50, and TA-63. Earthmoving operations would impact 80,000 to 169,000 cubic yards (61,000 to 129,000 cubic meters) of soil and rock; the total volume impacted would depend on the combination of Option 1 and Option 2a, 2b, or 2c. Option 1 (accelerated removal and disposition of wastes with supporting removal, relocation, and replacement of applicable facilities) would impact approximately 80,000 cubic yards (61,000 cubic meters) of rock and soil. The impacts of Option 2 (interim actions necessary for meeting Consent Order and other options) impacts would be additional to those under Option 1. Option 2a would impact approximately 89,000 cubic yards (68,000 cubic meters) of additional soil and rock for facility construction. Option 2b would impact approximately 82,000 cubic yards (63,000 cubic meters), and Option 2c would have a negligible impact on soil and rock because an additional facility would not be constructed.

There would be minimal loss of native LANL soils because the activities would occur in areas previously disturbed by LANL activities. During construction, excavated soil and rock would be managed to minimize erosion and losses. If necessary, backfill material would be obtained from LANL sources. The necessary backfill volume would not significantly deplete geological resources at LANL. There also would be a positive impact from the removal of wastes and contaminated soil from LANL, as well as a reduction in legacy soil contamination.

TA-55 Radiography Facility

Relocation of high-energy x-ray radiography into a TA-55 Radiography Facility would impact up to 8,000 cubic yards (6,100 cubic meters) of soil and rock. The construction would be at the site of the former Building TA-55-41, so there would be no impact to native LANL soils. During construction, best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater, other water discharges, or wind. Uncontaminated backfill would be stockpiled at an approved material management area at LANL for future use.

5.3 Water Resources

Water resource impacts considered in this section include changes in surface water quality and quantity, sediments, floodplains, and groundwater quality and quantity.

5.3.1 Surface Water

Surface water quality is measured using sampling data from National Pollutant Discharge Elimination System (NPDES) outfalls, stormwater flows, and watershed monitoring stations. As it is difficult to predict future sampling results, a qualitative analysis of actions that could affect those results was performed based on patterns observed from previous actions. For example, one of the effects expected from installing a new treatment system at the Radioactive Liquid Waste Treatment Facility would be a reduction in the number of downstream surface water samples containing detectable levels of the treated constituents. The effect may not be immediate if effluents are diluted by perennial or stormwater flows, but the long-term effect would be improved surface water quality in that canyon, a significant beneficial impact.

A potential source of surface water contamination is the sediment located in certain canyon bottoms. Sampling results following the Cerro Grande Fire showed that unusually large volumes of stormwater could mobilize contaminants in sediment and transport them for long distances downstream. Actions that could increase surface water volumes would likely mobilize contaminated sediment, which would have potentially adverse effects on surface water quality.

Surface disturbance from construction activities could remove protective vegetative or other earth cover, loosen soil particles, and generate accelerated erosion that could result in sediment entering the waterways. For this analysis, it was assumed that accelerated erosion from surface disturbance during construction would be minimized by installation and maintenance of erosion and sediment controls specified in Stormwater Pollution Prevention Plans, in compliance with state and Federal regulations under the Clean Water Act, including the NPDES Construction General Permit and Section 404 and Section 401 permits.

Stormwater volumes could be directly affected by LANL construction due to changes in the size of impervious areas that affect runoff flow rates and volumes. Changes in LANL effluent discharges from the NPDES outfalls can affect the quantity of flow in sections of the canyons. The surface water flows in various canyons could be affected if some of the flood structures from the Cerro Grande Fire were removed.

To calculate the changes in runoff volume under each alternative, it is first necessary to estimate the acreage of the impervious area in each watershed located near the LANL facilities to be constructed; however, the proposed facility designs are not developed to the point where the footprint sizes of the facilities are usable for that purpose. Stormwater management controls, including mitigation measures for increased stormwater flows and sediment loads, are required as part of LANL's construction specifications (LANL 2004b). For this analysis, it was assumed that new construction would include installing construction site stormwater controls, so there would be only minor increases in sediment-laden runoff reaching the canyons.

The environmental consequences of LANL actions under the different alternatives could impact surface water quality, surface water quantity, floodplains and wetlands, and sediments. Impacts on wetlands are discussed in Section 5.5 because wetlands are an important habitat for diverse flora and fauna. **Table 5–4** summarizes the expected surface water impacts for each of the three alternatives.

Table 5–4 Summary of Environmental Consequences on Surface Water

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
	LANL Site		
	Land Transfer − Negligible impact on surface water quality and floodplains (White Rock Y and Rendija Canyon).	Same as No Action Alternative	Same as No Action Alternative
	Wildfire Hazard Reduction Program − Minor impact on surface water quality, quantity, and floodplains. Beneficial long-term effects due to wildfire risk reduction.		Same as No Action Alternative
	Flood Structures Removal − Minor beneficial impact on surface water quality and quantity. − Temporary adverse impact on Pajarito floodplains due to removal of structures that retained flow and sediment. Restoration of normal flow would cause sediments to alter channel and readjust floodplains.		Same as No Action Alternative
	Security Perimeter Project − Minor impact on surface water quality if soil contaminants mobilized.		Same as No Action Alternative
	MDA Remediation LANL's environmental restoration program continues, but no significant remediation of MDAs occurs.		Actions taken in compliance with the Consent Order with respect to MDA remediation would ensure water quality is protected (long-term) by removal or stabilization of potential contamination sources.
	TAs		
TA-21	No impact on surface water quality.	Same as No Action Alternative	DD&D of the Steam Plant and the Tritium Science and Fabrication Facility would result in removal of two NPDES-permitted outfalls. Minor impact on surface water quantity in Los Alamos Canyon, but little to no impact on surface water quality.
TA-46	Significant beneficial impact on surface water quality and quantity in Sandia Canyon from recycling Sanitary Wastewater Systems Plant outfall volume for use in cooling towers.	Same as No Action Alternative	Same as No Action Alternative

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
		Key Facilities	
High Explosives Testing Facilities – Dynamic Operations Complex	Minor beneficial impact on surface water quality due to shot containment.	Minor impact on surface water quantity in Water Canyon due to reduction of operations. Minor beneficial impact on surface water quality by discharge reduction.	Same as No Action Alternative.
Radioactive Liquid Waste Treatment Facility (TA-50)	No impact on surface water quality.	Same as No Action Alternative	Although increased pit production would increase the Radioactive Liquid Waste Treatment Facility outfall volumes by 25 percent, this would have a negligible effect on surface water volumes in Mortandad Canyon because other facilities contribute 90 percent of the outfall flow in that canyon. Implementing the zero discharge option at the Radioactive Liquid Waste Treatment Facility would have a minor effect on surface water volume, but would improve surface water quality by reducing the movement of historical contaminants in the sediments downstream of that outfall.
LANSCE (TA-53)	No impact on surface water quality.	Effects may be temporary or permanent, if shut down. Significant beneficial impacts in Los Alamos Canyon due to shutdown of operations and removal of two NPDES – permitted outfalls.	Same as No Action Alternative.
Pajarito Site (TA-18)	No impact on surface water quality.	Same as No Action Alternative.	DD&D would have minor beneficial impact on surface water quality by removing potential contaminant sources. Minor impact to Pajarito Canyon floodplains by removing TA-18-184 building obstruction.

MDA = material disposal area; TA = technical area; DD&D = decontamination, decommissioning, and demolition; NPDES = National Pollutant Discharge Elimination System; LANSCE = Los Alamos Neutron Science Center.

LANL NPDES outfall volumes affect surface water quantities and could be altered by the proposed LANL activities. Although direct impacts from changes to effluent discharges are usually localized to a short section within a canyon, such changes could affect the entire downstream drainage system. Changes to effluent discharges under each alternative were compared to the baseline for NPDES outfall volumes in each canyon, as calculated from the totalized or estimated average flows from 2002 through 2005. **Table 5–5** summarizes the estimated outfall volumes for the three alternatives evaluated. The assumptions used to calculate the projected changes in outfall volumes for each alternative are listed at the end of Table 5–5.

Changes in outfall volume within a canyon of less than 5 percent of current flows are considered negligible, and changes of greater than 40 percent are considered significant. The greater-than-40-percent threshold for significance was selected specifically for this SWEIS to provide a measure of change that was based on past changes that made a difference to water quality and quantity. In those canyons where flows are typically relatively low, outfall changes are predicted to affect both water quality and quantity downstream.

5.3.1.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

To reduce the potential impacts of LANL activities on water resources, LANL has several programs that monitor and protect surface water quality and quantity. Under the No Action Alternative, the NPDES industrial permit was modified (EPA 2007b) to reduce the total number of outfalls from 21 to 17. The four outfalls that were removed from the permit (03A024, 05A097, 03A047, and 03A049) have not discharged effluent in recent years, so no direct impacts to water quality or flow volumes in the canyons would result.

When NNSA determines that site conditions have returned to pre-Cerro Grande Fire conditions, the aboveground portion of the flood retention structure and the entire steel diversion wall upgradient of TA-18 would be removed via the Flood Structures Removal Project (DOE 2002j). Best management practices would be implemented during the controlled demolition and removal of the flood control structures to control disturbed sediment that might enter the watercourse during construction. No excavation or demolition debris would be placed in or near drainages or in the Pajarito Canyon floodplain, so the potential for surface water contamination after construction would be minimal (DOE 2002j). After removal of the flood control structures in Pajarito Canyon is completed, the potential for sediment transport would increase in the short term as the channel adjusts to the change (LANL 2002c).

Continued maintenance of the low-head weir and detention basin in Los Alamos Canyon and the road reinforcements above Pajarito, Twomile, Los Alamos, and Water Canyons would minimize adverse impacts to surface water quality and the floodplains in those canyons even if the Flood Structures Removal Project were implemented. Long-term stabilization at the sites of the removed structures using recontouring and reseeding would protect surface water quality in Pajarito Canyon. Sediment and water sampling in the canyons would monitor potential contamination and trigger remedial actions, if needed (DOE 2002j).

Table 5–5 Estimated National Pollutant Discharge Elimination System Permitted Discharges by Facility and Canyon (million gallons per year)

Facility	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Los Alamos Canyon			
Tritium Facilities – 2 outfalls	17.4	17.4	0.0 [a]
LANSCE – 3 outfalls	28.2	0.0 [b]	28.2
Canyon Total	45.6	17.4	28.2
Sandia Canyon			
Sigma Complex – 1 outfall	0.0 [c]	0.0 [c]	0.0 [c]
LANSCE – 1 outfall	1.3	0.0 [b]	1.3
Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center) – 1 outfall	13.6	13.6	17.7 [d]
Non-Key Facilities – 3 outfalls	172.4	172.4	172.4
Canyon Total	187.3	186.0	191.4
Mortandad Canyon			
Chemistry and Metallurgy Research Building –1 outfall	1.9	1.9	1.9
Sigma Complex – 1 outfall	5.8	5.8	5.8
Plutonium Complex– 1 outfall	4.1	4.1	4.1
Radioactive Liquid Waste Treatment Facility– 1 outfall	4.0	4.0	5.0 [e]
Non-Key Facilities – 1 outfall	28.5	28.5	28.5
Canyon Total	44.3	44.3	45.3
Water Canyon (including Cañon de Valle)			
High Explosives Processing – 3 outfalls	0.06	0.05 [f]	0.06
High Explosives Testing – 2 outfalls	2.2	1.8 [g]	2.2
Canyon Total	2.26	1.81	2.26
Subtotal Key Facilities (including the Metropolis Center)	78.6	48.6	66.2
Non-Key Facilities	200.9	200.9	200.9
Totals	279.5	249.5	267.1

LANSCE = Los Alamos Neutron Science Center.
Assumptions used to predict outfall volumes:
[a] Zero discharge based upon removal of TA-21 buildings including the Steam Plant Outfall and the Tritium Science and Fabrication Facility Outfall.
[b] Zero discharge based upon safe shutdown of LANSCE.
[c] This outfall has not discharged any effluents in recent years and has been proposed for removal from the National Pollutant Discharge Elimination System permit.
[d] 30 percent increase in cooling water based upon operation of a third cooling tower.
[e] 25 percent increase based upon increased activity of facilities that generate radioactive liquid waste.
[f] 20 percent decrease based upon 20 percent reduction in high explosives processing.
[g] 20 percent decrease based upon 20 percent reduction in high explosives testing.
Note: To convert gallons to liters, multiply by 3.78533. Totals may not add due to rounding.
Sources: EPA 2007b, LANL 2006a, 2006h.

The removal of fuels through the Wildfire Hazard Reduction Program would improve forest health, stabilize the watersheds, and reduce the long-term potential for wildfires. This would beneficially impact surface water quality because wildfires destroy the vegetation that stabilizes the soil and promotes stormwater infiltration. Fewer wildfires would reduce the potential for stormwater runoff eroding soil and mobilizing contaminants (DOE 2000e), and thus the potential for surface water contamination from high sediment loads in stormwater. Reducing the potential for wildfire also would limit other adverse impacts to surface water quality such as scoured stream channels that alter the extent of floodplains. Potentially adverse impacts resulting from tree cutting, chipping, and slash pile burning in the floodplains (performed as part of the Wildfire Hazard Reduction Program) would be mitigated through required environmental protection measures (DOE 2000e).

Construction activities associated with the Security Perimeter Project (DOE 2003a; NNSA 2004a, 2005a) could require compliance with Section 404 and Section 401 permits, thereby requiring provisions to protect the watercourse from potential increased runoff and sediments during bridge construction (although previously analyzed, a bridge is not included in current plans). Adverse impacts on surface water quality due to construction on the canyon walls, as well as access control and traffic improvements near the watercourse, would be minimized through implementation of a Stormwater Pollution Prevention Plan to control soil erosion in accordance with the NPDES Construction General Permit. Such best management practices could include the use of silt fences, straw bales, and check dams.

The Security Perimeter Project would have a minor beneficial effect on surface water quality if the PRSs at solid waste management units located in the proposed bypass road corridors were remediated, which would include removing contaminants found in the drainage pathway from a chemical (polychlorinated biphenyls) storage area. There would be a negligible adverse effect from increased stormwater runoff over the new impervious road surfaces that would allow additional flows containing potential contaminants.

Continuing the LANL environmental restoration program in existence before the 2005 Consent Order would cause the removal of contaminated soil and sediment, and thus have a positive impact on surface water quality.

Management of construction fill would have no effect on surface water quality. Construction fill would be stored at existing borrow areas at TA-16 and TA-61. Best management practices would be employed to protect surface waters.

Technical Area Impacts

NPDES-permitted outfalls would be maintained at four non-Key Facilities: the TA-3 Power Plant (001); the TA-3 Laboratory Data Computing Center cooling tower outfall (03A199); the Sanitary Wastewater Systems Plant at TA-46 (13S), which routes its effluent through storage tanks at TA-3 for recycling or discharge; and a cooling tower outfall at TA-35 (03A160). Total effluent discharges from these outfalls would continue to be lower than the 1999 actual volumes, although individual facilities could have higher volumes. If the Sanitary Effluent Recycling Facility for supplying water to cooling towers at the Metropolis Center becomes effective, reduced NPDES-outfall volumes and associated contaminants from the TA-46 Sanitary Wastewater System Plant would have a significant beneficial impact on surface water quality and quantity in Sandia Canyon (LANL 2006a).

Key Facilities Impacts

Sigma Complex

At the Sigma Complex, one cooling tower NPDES outfall (03A024) has been removed. There has been no flow from this outfall in recent years, so flow volumes in Mortandad Canyon, where this effluent discharged, would not be affected. The Sigma Complex would retain a separate cooling water outfall into Sandia Canyon (03A022) (LANL 2006a).

High Explosives Processing Facilities

At the High Explosives Processing Facilities, one NPDES outfall (05A097) has been removed. There has been no flow from this outfall in recent years, so flow volumes in Water Canyon, where this effluent discharged in the past, would not be affected. The high explosives outfall from the High Explosives Wastewater Treatment Facilities (05A055) at TA-16 and the cooling water outfall (03A130) at TA-11 would continue discharging treated effluent into Water Canyon (LANL 2006a).

High Explosives Testing Facilities

At the High Explosives Testing Facilities, use of foam at the Dual Axis Radiographic Hydrodynamic Test site has reduced impacts to surface water quality from depleted uranium contamination by containing 75 percent of experimental material from shots (LANL 2001d). Enhanced containment of shot debris and augmented cleanup of debris from uncontained shots would have a minor long-term beneficial effect on water quality because it would reduce the potential contaminants that could be mobilized by stormwater.

Los Alamos Neutron Science Center

At the Los Alamos Neutron Science Center (LANSCE), a project to upgrade the cooling towers would reduce the number of cooling tower outfalls at the facility from four to two. Outfalls 03A047 and 03A049 have been removed from the NPDES permit. There has been no flow from the older cooling towers in recent years, so flow volumes in Los Alamos Canyon would not be affected.

5.3.1.2 Reduced Operations Alternative

Most of the same impacts on surface water quality and quantity resulting from actions discussed under the No Action Alternative also would occur under the Reduced Operations Alternative, except those explicitly associated with the reduced ordnance operations.

Key Facility Impacts

Under the Reduced Operations Alternative, impacts to surface water quality would be the same as those described under the No Action Alternative, with the exception of the impacts described below. There would be little or no effect on floodplains from changes to Key Facilities.

High Explosives Processing Facilities

Reduced operations at the High Explosives Processing Facility would have little or no effect on surface water quality or quantity. Effluent volumes from the High Explosives Wastewater Treatment Facility (05A055) and the cooling water (03A130) NPDES outfalls would be reduced by about 20 percent, but their expected flows (less than 0.05 million gallons per year [0.2 million liters] or less than 3 percent of the total effluent discharged in Water Canyon) are not large enough to produce significant beneficial impacts to surface water.

High Explosives Testing Facilities

Reduced operations at the High Explosives Testing Facilities would result in minor beneficial effects on local surface water quality and quantity. Expected effluent flows from the cooling water NPDES outfalls (03A028 and 03A185) into Water Canyon would be reduced about 20 percent from 2.2 million gallons (8.3 million liters) per year to about 1.8 million gallons (6.7 million liters) per year. The percentage change in flow volumes from these reduced operations would not exceed the significance threshold for surface water quantity in Water Canyon.

Los Alamos Neutron Science Center

Surface water impacts from shutting down operations at LANSCE may be short-term or permanent. Shutdown of LANSCE would significantly reduce the surface water quantity in Los Alamos Canyon compared to the No Action Alternative. Cooling water NPDES outfalls from LANSCE contribute about 60 percent of the effluent flowing into Los Alamos Canyon. Shutdown of LANSCE would have a negligible effect on Sandia Canyon, resulting in approximately 1 percent less effluent flow than under the No Action Alternative. This would beneficially impact surface water quantity in both canyons because reduced flows could mobilize fewer contaminated sediments.

5.3.1.3 Expanded Operations Alternative

The same surface water quality and quantity impacts resulting from actions discussed under the No Action Alternative also would occur under the Expanded Operations Alternative.

Los Alamos National Laboratory Site-Wide Impacts

Beneficial impacts to surface water quality would follow remediation of MDAs and other PRSs. Construction of MDA final covers under the Capping Option or removal operations under the Removal Option would disturb soils and remove stabilizing vegetation temporarily. In compliance with the terms of the NPDES Construction General Permit, installation of erosion control measures described in Stormwater Pollution Prevention Plans would minimize erosion and offsite sedimentation during construction.

Following closure of the MDAs, surface water quality would gradually improve as corrective measures remove or stabilize potential sources of contamination from release sites (see Appendix I). The Capping Option and the Removal Option would decrease the risk of surface water contamination more than the No Action Alternative because additional potential contamination sources at MDAs and PRSs would be avoided or eliminated.

Technical Area Impacts

DD&D of buildings at TA-21 would eliminate both the Tritium Science and Fabrication Facility and the Steam Plant, which both discharge industrial effluent into Los Alamos Canyon. As these are the only TA-21 outfalls, discharges from this TA would be eliminated in the Expanded Operations Alternative. The impact on surface water quantity in Los Alamos Canyon would be minor, as these effluents are less than 40 percent of the discharges into that canyon. Removal of these sources would have little to no impact on surface water quality, because the majority of the effluent comes from boiler blowdown and cooling water, which does not contain many contaminants.

Key Facilities Impacts

Under the Expanded Operations Alternative, impacts to surface water quality would be the same as described under the No Action Alternative, except as described below. Construction of a new Radioactive Liquid Waste Treatment Facility, two bridges, other building construction, and demolition of the existing annexes would have little or no adverse impact on surface water quality due to installation of stormwater management and erosion and sediment controls based on compliance with site-specific Stormwater Pollution Prevention Plans and LANL's construction specifications.

Radioactive Liquid Waste Treatment Facility

Proposed increased discharges from the Radioactive Liquid Waste Treatment Facility outfall resulting from increased activity at facilities that generate radioactive liquid waste (see Table 5–5) would result in about a 25 percent higher effluent discharge rate into Mortandad Canyon from that facility, compared to the No Action Alternative. This increase would have a negligible effect on Mortandad Canyon, as the Radioactive Liquid Waste Treatment Facility effluent currently accounts for about 9 percent of LANL's discharges into that canyon. This percentage of overall flow contribution would only increase to 11 percent at the higher discharge rate. Contaminant transport through sediment mobilization could be enhanced due to the increased outfall discharge rate. Cooling water discharges are the only other LANL effluents introduced into Mortandad Canyon.

Operation of a new Radioactive Liquid Waste Treatment Facility would have a beneficial impact on surface water quality because the improved low-level radioactive waste and transuranic waste processes would reduce the contaminant concentrations in the effluent discharged into Mortandad Canyon to levels that could meet potentially more stringent future water quality standards. An auxiliary action, which could be applied to any of the options for the new Radioactive Liquid Waste Treatment Facility, is to construct evaporation tanks and eliminate discharges into Mortandad Canyon. If the facility thus becomes a zero discharge facility, surface water quality would be positively affected. Elimination of effluent flows into the canyon at the Radioactive Liquid Waste Treatment Facility outfall would minimize the potential for contaminated sediments to become mobilized in streams, resulting in a beneficial impact to downstream surface water quality. There would be a minor reduction in surface water quantity in Mortandad Canyon if the Radioactive Liquid Waste Treatment Facility outfall were eliminated. Floodplain size would not be affected by this project.

Pajarito Site

Under the Expanded Operations Alternative, unneeded structures at TA-18 would be removed, thereby removing potential contamination sources from an area where they could be flooded. Parts of TA-18 lie within the 100-year floodplain for Pajarito Canyon. For example, the building that houses the Solution High-Energy Burst Assembly (SHEBA) is partially within the floodplain boundary. Although the possibility of floodwater mobilizing contaminants from the buildings is remote, complete removal of potential contaminant sources would protect surface water quality.

5.3.2 Groundwater Resources

Alternatives evaluated in the SWEIS have the potential to impact the quality of groundwater and the quantity of water available in aquifers. Groundwater quality can be affected by radionuclides and chemicals in liquid and solid waste that infiltrate into the ground. The quantity of groundwater available can be affected by changes in recharge rates and water supply well withdrawal rates. This section addresses potential impacts to groundwater from liquid effluent releases to the canyons and from solid radioactive waste disposal on the mesa tops. In addition, the effects of changes in recharge rates and water supply well withdrawal rates on water levels in the aquifer are discussed.

Impacts to the regional aquifer in the LANL area are generally measured over many years, primarily due to the long time necessary for contaminants to flow through the rock into the regional groundwater and the relatively small volume of water transported through the vadose zone in this arid climate. For the *1999 SWEIS*, significant adverse impacts to the regional aquifer were defined as changes to groundwater that alter the contaminant levels in concentrations above the drinking water standards in a way that can affect human health and safety. This could occur if any of the activities under consideration in the three SWEIS alternatives increase the flow rate of contaminants entering the deep groundwater.

Impacts to the alluvial groundwater are likely to occur more rapidly and could be affected either beneficially or adversely by changes to outfall flows from LANL. Some of the surface water carrying contaminants enters the alluvial groundwater system through canyon bottoms. Although surface-to-subsurface infiltration is fairly rapid in the canyons, any contaminants carried by the surface water are diluted by the large volume of water already stored in the ground; conversely, uncontaminated surface water infiltrating into already contaminated groundwater would cause its dilution over time.

Impacts to the alluvial aquifer may be considered significant if the concentrations of contaminants are altered in relation to the New Mexico and U.S. Environmental Protection Agency (EPA) groundwater standards for irrigation and other non-drinking-water uses. An adverse impact to the alluvial aquifer would be significant if, as a result of any of the activities proposed in the alternatives, contaminant levels increase so that the perched groundwater no longer meets state and Federal standards. A significant beneficial impact could occur if contaminant levels were reduced below these standards.

There are still uncertainties about how waterborne contaminants interact with and move through rock fractures and the rock matrix into the regional aquifer below LANL. There also are uncertainties about the chemistry, volumes, and infiltration rates of liquid wastes from past releases into the canyon bottoms and onto disturbed ground at the MDAs. LANL will be conducting future data collection activities, along with further analysis of existing data, to better define the interaction between groundwater and the rock matrix. It is expected that the new data, coupled with improvements in numerical flow and transport models and calculation techniques, will enable better prediction of flow and transport of groundwater in the LANL region and more accurate definition of the ultimate impacts on the regional groundwater resources below LANL. This new information is being used to update the performance assessment and composite analysis for the Area G low-level radioactive waste disposal facility. Flow and transport of contaminants to the regional aquifer are discussed in more detail in the surface water and groundwater sections in Chapter 4 and in the hydrogeologic and numerical modeling sections in Appendix E. **Table 5–6** summarizes the expected groundwater impacts for each of the three alternatives.

Table 5–6 Summary of Environmental Consequences on Groundwater

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative***
LANL Site			
	Construction and DD&D activities are unlikely to affect groundwater resources due to their short duration and the small quantity of contaminants that could be released and ultimately infiltrate to groundwater. Operations-related activities, including the planned reduction of LANL outfalls, would slightly reduce the transport of contaminants into the groundwater. No significant impacts to groundwater are expected to result in the short term. Long-term impacts to groundwater are not likely to be significant.	Similar to the No Action Alternative in terms of construction and DD&D activities. The long-term impacts of operations might be reduced by eliminating additional outfalls in the canyons.	Similar to the No Action Alternative plus: *MDA Remediation* – The effects of capping or removal of waste from MDAs would not appreciably change the rate of transport of contaminants presently in the vadose zone in the short term, but would likely reduce long-term contaminant migration and impacts on the environment.

DD&D = decontamination, decommissioning, and demolition; MDA = material disposal area.

5.3.2.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

The No Action Alternative would continue current operations. Therefore, there would be little change in the flow of contaminants to the alluvial or regional groundwater as a result of the No Action Alternative. Proposed construction and demolition activities are unlikely to affect the groundwater resource due to their short duration and the small quantity of contaminants that could be released and ultimately infiltrate to underground water resources. As described in Section 5.8.2.1, under the No Action Alternative, 388 million gallons (1,469 million liters) per year of groundwater would be used, which is within the range of LANL's water use over the last 7 years (see Section 4.8.2.3), and within the LANL annual water use ceiling quantity of

542 million gallons (2,050 million liters). Therefore, additional impacts to water levels in the regional aquifer are not expected.

Groundwater is unlikely to be adversely affected in the short term by the No Action Alternative because discharges of liquid effluent have been curtailed substantially compared to past operations, and solid radioactive waste disposal on the mesa tops takes many years to affect the regional aquifer. As discussed in Section 5.3.1, discharges resulting from LANL operations are monitored to ensure that effluents to surface waters are kept below regulatory limits. In addition, as discussed in Section 4.3.2, groundwater is monitored to ensure that instances of contamination are investigated, understood, and mitigated, and that existing contamination does not impact drinking water sources.

Long-term impacts to groundwater are complex and require modeling to predict potential contaminant migration thousands of years in the future. At the waste disposal locations on the mesa tops, dry conditions coupled with porous flow and transport result in slow, unsaturated flow and contaminant transport. Annual net natural infiltration rates for dry mesas are estimated to be less than 0.4 inches per year (10 millimeters per year), and more often are estimated to be closer to 0.04 inches per year (1 millimeter per year) or less. Under these conditions, travel times for contaminants percolating downward beneath the plateau to the regional aquifer are expected to be several hundred to thousands of years. Site disturbance, however, can alter the speed of water moving through the vadose zone (Birdsell et al. 2005).

Although a sitewide groundwater model is still under development, groundwater modeling was performed for a performance assessment and composite analysis prepared for radioactive waste disposal at Area G (LANL 1997a). The impacts analysis assumed the continued existence of the interim covers currently covering the waste disposal units. The groundwater protection analysis analyzed performance over a period of 10,000 years to provide reasonable assurance that the groundwater protection performance objective could be met. The model predicted that there would be no offsite doses from the groundwater pathway during the institutional control period because no radionuclides were transported beyond the current LANL boundary within 100 years. Groundwater ingestion doses projected in the performance assessment were small, with only three contributing radionuclides (carbon-14, technetium-99, and iodine-129). The peak annual dose at 330 feet (100 meters) downgradient from Area G was 1.4×10^{-5} millirem at 4,000 years. The peak annual dose at the Pajarito Canyon location was 4.5×10^{-5} millirem at 700 years. These peak annual doses are well below the 4 millirem per year standard for groundwater protection (LANL 1997a).

Under the No Action Alternative, MDA H would be closed. The DOE-preferred closure option was to close MDA H in place and cover it with an engineered evapotranspiration cover that would be designed, constructed, and maintained to limit infiltration and slow contaminant migration from the MDA. The environmental assessment (EA) for the proposed corrective measures at MDA H concluded that neither surface nor groundwater quality would be adversely affected over the next 1,000 years (DOE 2004e). In its selection of a corrective remedy, the New Mexico Environment Department acknowledged that an evapotranspiration cover would be effective in reducing or limiting the amount of water that would percolate into the shafts under design conditions, but had concerns about the potential for intrusion into the waste by deep-rooted plants and burrowing animals, and for groundwater contamination from volatile organic compounds and tritium in soil pore gas. The selected remedy therefore requires complete encapsulation of the disposal shafts, installation of an engineered evapotranspiration cover, and installation of a soil vapor extraction system (NMED 2007b).

5.3.2.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Most impacts to groundwater resources occurring under the No Action Alternative would also occur under the Reduced Operations Alternative. Impacts might be reduced by elimination of some outfalls to the canyons and reduction of water supply well withdrawals, but no quantitative estimate of the impact of these reductions can be made.

5.3.2.3 Expanded Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Impacts to groundwater resources occurring under the No Action Alternative would be similar to those under the Expanded Operations Alternative. Direct and indirect impacts to groundwater resulting from the proposed construction and operations under the Expanded Operations Alternative also would be similar, but greater than those described for the No Action Alternative. As described in Section 5.8.2.3, under the Expanded Operations Alternative 522 million gallons (1,980 million liters) per year of groundwater would be used, which would be greater than the range of LANL's water use over the last 7 years (Section 4.8.2.3), but within the range of LANL's water use over the last 14 years (LANL 2003h). Water use under the Expanded Operations Alternative would be within the LANL annual water use ceiling quantity of 542 million gallons (2,050 million liters). Therefore, impacts to water levels in the regional aquifer would be within historical levels.

Increased pit production under the Expanded Operations Alternative would have little to no impact on groundwater resources. Although increased pit production would generate larger volumes of waste liquids than those projected for the No Action Alternative, for either alternative the waste liquids would be processed at the Liquid Radioactive Waste Treatment Facility in TA-50. Treated liquid effluent from the Liquid Radioactive Waste Treatment Facility would be discharged from an NPDES-permitted outfall. Alternatively, under a proposed auxiliary action, discharge of liquid effluents from the Radioactive Liquid Waste Treatment Facility would be eliminated by the construction and use of evaporation tanks (see Appendix G, Section G.4).

Possible impacts to groundwater resources will be addressed as part of any required corrective measure evaluation performed for MDAs and other PRSs in accordance with the Consent Order. A corrective measure evaluation for an MDA would consider both capping and removal, two bounding options for MDA remediation that were considered in Appendix I. LANL management would recommend remedies for each MDA (or other PRSs subject to the Consent Order), and the New Mexico Environment Department would determine the remedy to be applied. A corrective measure evaluation performed for MDA G in TA-54 would be coordinated with an update to the performance assessment and composite analysis that is currently being prepared. In addition to providing more recent information about the site and the contents of the disposal units, this update would consider the application of a final cover over the disposal units. Once the new performance assessment and composite analysis becomes available, the results will be reviewed in accordance with the NEPA process, and the SWEIS impact analyses will be reviewed and supplemented as necessary.

The effects of either the Capping or the Removal Option would not appreciably affect the rate of transport of contaminants presently in the vadose zone in the near term, but would likely reduce long-term migration of contaminants and corresponding impacts on the environment from wastes present in the MDAs. Under the MDA Capping Option, where engineered barriers are used to cap MDAs, the covers would be designed, constructed, and maintained to limit infiltration. Over the long term, the covers, by limiting infiltration, would slow contaminant migration from the MDAs. Under the MDA Removal Option, excavation and removal of the waste and contaminated soil and rock would eliminate nearly all of the source term. The filled, compacted excavation, however, may still experience larger infiltration rates than undisturbed areas, which might further drive migration of deeper contaminants that are beyond the reach of conventional excavation. Under either MDA remediation option, impacts to the regional aquifer would likely be small, as described under the No Action Alternative.

5.4 Air Quality and Noise

5.4.1 Nonradiological Impacts

Air pollution refers to the direct or indirect introduction of any substance into the air that could:

- endanger human health,
- harm living resources and ecosystems,
- damage material property, or
- impair or interfere with the comfortable enjoyment of life and other legitimate uses of the environment.

For the purpose of this SWEIS, only outdoor air pollutants were addressed. These may be in the form of solid particles, liquid droplets, gases, or a combination of forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants or by reaction with normal atmospheric constituents that may be influenced by sunlight). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Thus, air quality is affected by air pollutant emission characteristics, meteorology, and topography.

Ambient air quality in a given location can be described by comparing the concentrations of various pollutants in the atmosphere with the appropriate standards. Ambient air quality standards have been established by Federal and state agencies to ensure an adequate margin of safety for the protection of public health and welfare from the adverse effects of pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy; those below such standards are generally considered acceptable.

The pollutants of concern are primarily those for which Federal and state ambient air quality standards have been established, including criteria air pollutants, hazardous air pollutants, and other toxic air pollutants. Criteria air pollutants are those listed in National Primary and Secondary Ambient Air Quality Standards (40 *Code of Federal Regulations* [CFR] Part 50). Hazardous air pollutants are those listed in Title I of the Clean Air Act, as amended (Title 40 of the *United States Code*, Section 7401 *et seq.* [40 U.S.C. 7401 *et seq*.]) and those regulated by the National Emissions Standards for Hazardous Air Pollutants (40 CFR Part 61). Toxic air pollutants are considered to be those that have been proposed or adopted for regulation by the applicable state or are listed in state guidelines or permit regulations for toxic air pollutants. States may set ambient standards that are more stringent than the National Ambient Air Quality Standards. The more stringent of the state or Federal standards are shown in this document.

Potential air quality impacts of criteria pollutant emissions from construction, normal operations, and DD&D activities were evaluated for each alternative. This assessment included a comparison of pollutant concentrations under each alternative with applicable Federal and state ambient air quality standards. Operational air pollutant impacts were evaluated for combustion sources using the facility-wide analysis prepared for the LANL operating permit, as described in Appendix B. The analysis is based on the potential emissions from each source, and the results bound the potential impacts associated with the alternatives addressed in this SWEIS. Potential differences among these results are discussed for each alternative. The analysis included the following emission sources: air curtain destructors; TA-60 asphalt plant; four TA-16 boilers; three TA-48 boilers; two TA-53 boilers; two TA-55 boilers; two TA-59 boilers; TA-50 boiler; carpenter shops at TA-15 and TA-3; TA-33 generator; TA-52 paper shredder; TA-3 power plant; rock crusher; TA-21 steam plant; TA-9 boiler; and TA-35 boiler. The analysis was based on allowable facility-wide emission limits proposed in the permit application. Emissions were presented in the application for individual sources or for source groups. The emissions used in the analysis are conservative. For example, for the TA-3 boilers, the fuel with the highest emissions was assumed and all three boilers were assumed to operate simultaneously; normally only two boilers are operated at the same time (Jacobson, Johnson, and Rishel 2003). Also, air curtain destructors have been removed from operation at LANL. The impacts of criteria pollutant emissions from construction activities for various projects were evaluated using engineering estimates of emissions from site preparation and building erection activities and modeled using the Industrial Source Complex Short Term (ISCST3) dispersion model, as discussed in Appendix B.

The approach used to evaluate chemical air pollutants in the *1999 SWEIS* is based on the use of screening level emission values to identify chemicals that would be evaluated in more detail. Screening level emission values are conservatively estimated hypothetical emission rates for each of the toxic air pollutants that could be emitted from each of LANL's TAs and would not result in air quality levels that are harmful to human health under current or future conditions. These screening level emission values were compared with conservatively estimated pollutant emission rates on a TA-by-TA basis to determine the potential air quality impacts of toxic air pollutants from LANL operations. Any pollutant that could contravene a guideline value was subject to evaluation in the health and ecological risk assessment process. This approach is described in more detail in Appendix B. **Table 5–7** summarizes the expected nonradiological air quality impacts for each of the three alternatives.

Table 5–7 Summary of Environmental Consequences on Nonradiological Air Quality

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
	General – Minor impacts from construction-type activities would occur primarily in the form of fugitive dust. *Land Conveyance and Transfer* – Very minor increases in air pollutant emissions could result from increases in commute distances. *Electrical Power System Upgrades and Security Perimeter Project* – Minor air quality impacts would result from construction. *Wildfire Hazard Reduction Program* – Minor emissions would result from activities. *Disposition of Flood and Sediment Retention Structures* – Minor emission would result from activities. *Trails Management Program* – Minor air quality impacts.	Same as No Action Alternative	Same as No Action Alternative, plus: – Minor air quality impacts would result from road, bridge, and walkway construction under the Security-Driven Transportation Modifications Project. – Minor increases in vehicle emissions could result from use of the new roads and would occur in new locations. – Minor to moderate air quality impacts would result from remediating MDAs and other PRSs. – Minor increase in air pollutant emissions from increased commuter vehicles and waste and materials shipments.
Affected Technical Areas			
TA-3	– Minor change in air quality impacts from operation of new turbine generators. – Minor air quality impacts from constructing three new office buildings. – Minor operation air quality impacts from new office buildings.	Same as No Action Alternative	Same as No Action Alternative, plus: – Minor construction air quality impacts from constructing additional office buildings and the Physical Science Research Complex.
TA-21	No change in air quality impacts.	Same as No Action Alternative	Minor construction-type air quality impacts from DD&D of structures.
TA-54	Minor air quality impacts would result from MDA closure activities. Some reductions in emissions could result from closure.	Same as No Action Alternative	Minor construction-type air quality impacts from construction of new buildings and DD&D of old structures.
TA-72	No change in air quality impacts.	Same as No Action Alternative	– Minor construction-type air quality impacts from constructing the Remote Warehouse and Truck Inspection Station. – Potential decrease in emissions from reduced delivery trips.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Key Facilities			
Chemistry and Metallurgy Research Building (TA-3, TA-48, and TA-55)	Minor air quality impacts from construction of new facility at TA-55.	Smaller air quality impacts from reduced construction scope.	Same as No Action Alternative
High Explosives Processing Facilities	Minor construction-type impacts from TA-16 Engineering Complex and demolition of structures. No change in operations air quality impacts.	Same as No Action Alternative for construction. Minor reduction in operations air quality impacts from 20 percent reduction in activities.	Same as No Action Alternative for construction. Minor increase in operations air quality impacts may be indicated by increased mock explosives use.
High Explosives Testing Facilities	No change in operation air quality impacts. Minor construction impacts from construction of 15 to 25 new structures (new offices, laboratories, and shops) within the TA-22 to replace about 59 structures currently used for dynamic experimentation operations and removal or demolition of vacated structures.	Reduction in operation air quality impacts from 20 percent reduction in activities. Same as No Action Alternative for construction.	Same as No Action Alternative
Tritium Facilities (TA-21)	No change in air quality impacts.	Same as No Action Alternative	– Minor construction-type air quality impacts from DD&D of all TA-21 tritium buildings as part of the project to decommission all of TA-21. – Minor reduction in operational emissions from shutdown of boilers under the complete DD&D option.
Pajarito Site (TA-18)	No change in air quality impacts.	Minor reduction in operation air quality impacts from shutdown of activities.	– Minor reduction in operation air quality impacts from shutdown of activities. – Minor construction-type air quality impacts from DD&D of TA-18 buildings.
Bioscience Facilities	No change in air quality impacts.	Same as No Action Alternative	– Minor change in operation impacts with transfer of the Bioscience Facilities operations to the new Science Complex location. – Minor construction air quality impacts from construction of the new Science Complex and associated DD&D actions.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Radiochemistry Facility (TA-48)	No change in air quality impacts.	Same as No Action Alternative	Same as No Action Alternative for operation. – Minor construction air quality impacts from construction of the new Radiological Sciences Institute with construction of the Institute for Nuclear Nonproliferation Science and Technology (see Appendix G) and associated DD&D actions.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in air quality impacts.	Same as No Action Alternative	Same as No Action Alternative for operation. – Minor construction air quality impacts from construction of a replacement for the existing Radioactive Liquid Waste Treatment Facility at TA-50 (see Appendix G) and DD&D of the existing Radioactive Liquid Waste Treatment Facility.
LANSCE (TA-53)	No change in air quality impacts.	Reduction in air quality impacts from shutdown of LANSCE operations.	Negligible to minor air quality impacts from refurbishment.
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No change in air quality impacts.	Same as No Action Alternative	Minor air quality impacts from retrieving transuranic waste from below ground storage. – Minor air quality impacts from construction of a new TRU Waste Facility and new access control station, low-level radioactive waste compactor building, low-level radioactive waste certification building, and associated DD&D actions.
Plutonium Facility Complex (TA-55)	No change in air quality impacts.	Same as No Action Alternative	Same as No Action Alternative for operation. – Minor air quality impact from facility modifications in support of increased pit production rate and the Plutonium Facility Complex Refurbishment Project, and constructing radiography capabilities (see Appendix G). – Positive air quality impact from chiller replacement and steam system subproject; improved regulatory compliance with stack replacement.

MDA = material disposal area; PRS = potential release site; TA = technical area; DD&D = decontamination, decommissioning, and demolition; LANSCE = Los Alamos Neutron Science Center.

The National Emission Standard for Hazardous Air Pollutants for Asbestos, 40 CFR Part 61, Subpart M, requires that LANL provide advance notice to the New Mexico Environment Department for large renovation jobs that involve asbestos and for all demolition projects. The asbestos National Emission Standard for Hazardous Air Pollutants further requires that all activities involving asbestos be conducted in a manner that mitigates visible airborne emissions and that all asbestos-containing wastes be packaged and disposed of properly. LANL would be required to meet these requirements for all demolition and renovation projects as applicable to minimize the risk of asbestos exposure to the public and employees. For example, the contractor performing the demolition or renovation would employ techniques such as wetting of asbestos or the use of plastic tents to contain and capture asbestos and other airborne particulates during removal.

5.4.1.1 No Action Alternative

This section describes the estimated nonradiological air quality impacts from LANL operations under the No Action Alternative. Radiological air emissions and their impacts on human health are discussed in Sections 5.4.2 and 5.6.1, respectively.

Los Alamos National Laboratory Site-Wide Impacts

Minor impacts on nonradiological air quality would occur from construction-type activities related to previously approved projects, including construction of the electrical power system upgrades, Wildfire Hazard Reduction Program activities, disposition of flood and sediment retention structures, activities related to the Trails Management Program, mechanical and manual Wildfire Hazard Reduction Program activities, and construction related to the Security Perimeter Project. These projects would result in temporarily elevated concentrations of criteria air pollutants, especially fugitive dust from heavy equipment activity.

Analysis of criteria pollutant emissions from facilities at LANL was performed to obtain the LANL Title V operating permit. The results of this analysis were used to bound the potential impacts associated with the alternatives addressed in this SWEIS. The modeling results demonstrate that the simultaneous operation of LANL's air emission sources at maximum capacity, as described in the Title V permit application, would not exceed any state or Federal ambient air quality standards (Jacobson, Johnson, and Rishel 2003). These results are presented in **Table 5–8**. All of the equipment at the TA-3 Co-Generation Complex (TA-3 Power Plant), including the three existing boilers, the new combustion turbine generator, and an additional combustion turbine generator that would be constructed in the 2007 to 2013 timeframe, would operate within the nitrogen oxides and carbon monoxide emissions analyzed (Jacobsen, Johnson, and Rishel 2003; DOE 2002l). The air quality permit limits co-generation complex emissions to (93.4 tons [84.7 metric tons] per year for nitrogen oxides and 61.1 tons [55.4 metric tons] per year for carbon monoxide (NMED 2006a).

For criteria pollutants, the concentrations from No Action Alternative operations would be smaller than those shown in the operating permit and well below the ambient standards established to protect human health with an adequate margin of safety. Criteria pollutant emissions under the No Action Alternative are expected to continue to have minor impacts on human health.

Table 5–8 Facility-Wide Criteria Pollutant Impacts

Pollutant	*Time Period*	*Maximum Estimated Concentrations (micrograms per cubic meter)*	*New Mexico Controlling Ambient Air Quality Standards* [a] *(micrograms per cubic meter)*
Carbon monoxide	8 hours 1 hour	192.4 1,071	7,900 11,900
Nitrogen dioxide	Annual 24 hours	7.0 40.2	75 150
Sulfur dioxide	Annual 24-hours 3-hours	10.2 83.5 397.3	42 209 1,050
Total suspended particulates	Annual 24-hours	5.7 135.0	60 150
PM_{10}	Annual 24-hours	5.24 101.6	50 150

PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns.
[a] New Mexico Ambient Air Quality standards for pollutants other than particulate matter are stated in parts per million. These values were converted to micrograms per cubic meter, with appropriate corrections for temperature and pressure (elevation) following New Mexico Dispersion Modeling Guidelines (NMAQB 2003). PM_{10} standards are the National Ambient Air Quality Standards (40 CFR Part 50). The annual PM_{10} standard has recently been revoked (71 *Federal Register* [FR] 61143).
Source: Jacobson, Johnson, and Rishel 2003.

Similarly, for toxic and hazardous air pollutants, the bounding analyses (based on the emission rates evaluated in the *1999 SWEIS*) indicate that the pollutant emissions that could exceed the guideline values used in the analysis to screen emission rates were:

- Emissions from High Explosives Firing Site operations at TA-14, TA-15, TA-36, TA-39, and TA-40 (DOE 1999a). The estimated concentration of a pollutant would be greater than its guideline value for the following releases:
  - Depleted uranium, beryllium, lead, aluminum, copper, tantalum, tungsten, and iron from TA-15;
  - Depleted uranium, beryllium, lead, copper, and iron from TA-36;
  - Beryllium, lead, aluminum, and copper from TA-39;
  - Depleted uranium and lead from TA-14; and
  - Copper from TA-40.
- Additive emissions from all of the pollutants from all TAs on receptor sites located near the Los Alamos Medical Center (DOE 1999a).

In the *1999 SWEIS*, emissions from High Explosives Testing Facilities operations under the No Action Alternative were projected to be the same as the emissions projected under the Expanded Operations Alternative; this projection is similar to anticipated emissions from High Explosives Testing Facilities operations under the No Action Alternative in this SWEIS. Emissions from High Explosives Testing Facilities operations are shown in **Table 5–9**.

Table 5–9 Estimated Emission Rates of the Pollutants that Could Be Released from High Explosives Testing Facilities

TAs with High Explosives Testing Operations [a]	*Pollutants that Could Be Released During Testing Operations*	*Estimated Maximum Amount of Material that Would Be Used During Testing Operations* [b]	*Estimated Respirable Fraction Release Rate*		
			Annual Rate [b]	*8-Hour Respirable Release Rate* [c]	
		(kilograms per year)	*(kilograms per year)*	*(kilograms)*	*(grams)* [d]
TA-14	Depleted Uranium	31.4	3.1	0.267	267
	Lead	31.4	3.1	0.267	267
TA-15	Depleted Uranium	2,700	270.0	23.0	23,000
	Beryllium	30	3.0	0.256	256
	Lead	150	15.0	1.28	1,280
	Aluminum	450	45.0	3.83	3,830
	Copper	300	30.0	2.56	2,560
	Tantalum	300	30.0	2.56	2,560
	Tungsten	300	30.0	2.56	2,560
	Iron	150	15.0	1.28	1,280
TA-36	Depleted Uranium	1,200	120.0	10.2	10,200
	Beryllium	30	3.0	0.256	256
	Lead	30	3.0	0.256	256
	Aluminum	30	3.0	0.256	256
	Copper	30	3.0	0.256	256
	Tantalum	30	3.0	0.256	256
	Tungsten	30	3.0	0.256	256
	Iron	150	15.0	1.28	1,280
TA-39	Beryllium	30	3.0	0.256	256
	Lead	30	3.0	0.256	256
	Aluminum [e]	45,000	4,500.0	383	383,000
	Copper [e]	45,000	4,500.0	383	383,000
	Tantalum	30	3.0	0.256	256
	Tungsten	30	3.0	0.256	256
	Iron [e]	30,000	3,000.0	256	256,000

TAs with High Explosives Testing Operations [a]	Pollutants that Could Be Released During Testing Operations	Estimated Maximum Amount of Material that Would Be Used During Testing Operations [b]	Estimated Respirable Fraction Release Rate		
			Annual Rate [b]	8-Hour Respirable Release Rate [c]	
		(kilograms per year)	(kilograms per year)	(kilograms)	(grams) [d]
TA-40	Aluminum	240	24.0	2.04	2,040
	Copper	300	30.0	2.56	2,560
	Tantalum	90	9.0	0.767	767
	Tungsten	30	3.0	0.256	256
	Iron	60	6.0	0.511	511

TA = technical area.

[a] High explosives testing operations involve detonations of explosives at TA-14, TA-15, TA-36, TA-39, and TA-40. Particulate emissions released into the atmosphere due to detonation of high explosives contain bonded metal emissions in respirable form.

[b] Respirable release rates were estimated based on the assumption that this fraction is 10 percent of the amount of material exploded.

[c] The total 8-hour respirable release rates (in kilograms), as a result of these operations, were estimated using the scale factor of 0.085.

[d] The total amount of material released, in grams, was used in dispersion analysis to estimate 1-hour average concentrations at specified receptor locations.

[e] These quantities are dominated by the support structures constructed for tests. These structures in actuality are not expended in explosive tests and do not contribute to test air emissions.

Note: To convert kilograms to pounds, multiply by 2.2046; grams to ounces, multiply by 0.035274.

Source: DOE 1999a.

These emissions were estimated to result in air pollutant concentrations that are larger than guidance values, indicating that a human health analysis should be performed. The human health analysis (Section 5.6.2) showed that the nonradiological pollutants released from LANL High Explosives Testing Facilities operations under the No Action Alternative are not expected to cause air quality impacts that would affect human health. Although not considered in the analysis, recent use of foam to suppress emissions from high explosives tests involving beryllium has reduced emissions from these shots by 50 to 95 percent. This reduction meets the requirements of Phase I of the Phased Containment Option outlined in the *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement* (DOE 1995a). Increased use of foam and vessels for explosives testing is expected to reduce these emissions further (LANL 2006a).

A minor increase in vehicle emissions could result from development that occurs as a result of conveyance and transfer of land. This increase is not expected to produce concentrations of pollutants that would threaten human health.

An increase in truck traffic from management of construction fill could increase vehicle emissions. This increase is not expected to produce concentrations of pollutants that would affect human health.

Emissions from beryllium sources at TA-3 and TA-55 are controlled by high-efficiency particulate air (HEPA) filtration with a removal efficiency of 99.95 percent. These emissions were analyzed in the *1999 SWEIS* using the annual emission rates shown in **Table 5–10**, which were estimated based on the existing permit applications. The results of the analysis with regard to public health are discussed in Section 5.6.2.

Table 5–10 Beryllium Annual Emission Rates Associated with Technical Area 3 and Technical Area 55 Facilities

Emission Source	*Annual Permitted Emission Rate*	
	Pounds per Year	*Grams per Second*
TA-3 Building 141 (Beryllium Technology Facility)	0.11	1.58×10^{-6}
TA-55 FE-15	0.003	4.32×10^{-8}
TA-55 FE-16	0.0042	6.05×10^{-8}

TA = technical area.
Source: DOE 1999a.

Technical Area Impacts

Minor construction-related nonradiological air quality impacts would occur from construction of new office buildings at TA-3 and MDA H closure activities at TA-54. The new turbine generator at TA-3 would operate within the emission combustion limits specified in the air quality permit for the TA-3 Co-Generation Complex (DOE 2002l) and analyzed in the facility-wide air quality impact analysis; minor operations-related air quality impacts would be expected.

Key Facilities Impacts

Minor nonradiological air quality impacts would occur from construction of the Chemistry and Metallurgy Research Replacement Facility at TA-55, completion of the TA-16 Engineering Complex, demolition of structures at TA-16, construction of new buildings at the consolidated Twomile Mesa Complex within TA-22, and demolition of unneeded structures nearby, as described below.

Operation of new buildings including the Chemistry and Metallurgy Research Replacement Facility, TA-16 Engineering Complex, various new structures for dynamic experiment operations, and a new dynamic experimentation structure at TA-15 would not be expected to increase emissions of criteria pollutants because a comparable amount of space would be removed through DD&D, resulting in a comparable reduction in emissions. Emissions related to these facilities primarily are associated with heating facilities and providing electric power.

Chemistry and Metallurgy Research Building

Operation of the Chemistry and Metallurgy Research Replacement Facility at TA-55 would result in additional periodic testing of emergency generators at that location instead of at TA-3. This change in operations would likely result in minor impacts on air pollutant concentrations at the site boundary. Criteria pollutant concentrations at the site boundary estimated for generator testing are shown in **Table 5–11**.

Table 5–11 Air Quality Concentrations from Chemistry and Metallurgy Research Replacement Facility Generator Testing at Technical Area 55 [a]

Pollutant	*Averaging Period*	*Maximum Incremental Concentration (micrograms per cubic meter)*
Carbon monoxide	8 hours 1 hour	53.2 239
Nitrogen dioxide	Annual 24 hours	0.0182 45.1
Sulfur dioxide	Annual 24 hours 3 hours	0.0113 28.1 207
Total suspended particulates	Annual 24 hours	0.001 2.43
PM_{10}	Annual 24 hours	0.001 1.39

PM_{10} = particulate matter less than or equal to 10 microns in diameter.
[a] The annual concentrations were analyzed at locations to which the public has access – the site boundary and nearby sensitive areas. Short-term (24 hours or less) concentrations were analyzed at the site boundary and at the fence line of the technical area where the public has temporary access. As access to the TA-55 fenceline has been restricted since the EIS for this facility was prepared, the short-term concentrations in public areas would be less.
Source: DOE 2003d.

Plutonium Facility Complex

Operations at TA-55 to produce 20 pits per year would represent about 25 percent of the 80-pits-per-year production rate analyzed in the *1999 SWEIS* for the Expanded Operations Alternative. Emission estimates for the Plutonium Facility Complex for 2005 included about 0.12 tons

(0.11 metric tons) per year of air pollutants from chemical use, about 1 percent of the 14.6 tons (13.2 metric tons) per year evaluated in the *1999 SWEIS* (DOE 1999a, LANL 2006g). Most of the estimated emissions are hydrochloric and nitric acids from plutonium recovery operations for the complex and are not directly associated with the level of pit production; the impacts of chemical air pollutant emissions under the No Action Alternative would be less than analyzed.

5.4.1.2 Reduced Operations Alternative

The same nonradiological air quality impacts anticipated to result from activities associated with the No Action Alternative also would occur under the Reduced Operations Alternative, except for those actions specific to the Reduced Operations Alternative.

Los Alamos National Laboratory Site-Wide Impacts

Minor impacts on air quality would occur from construction-related activities on previously approved projects, as discussed for the No Action Alternative. No new construction impacts on air quality would result from implementing the Reduced Operations Alternative.

For criteria pollutants, overall emission rates for the Reduced Operations Alternative would likely be lower than those for the No Action Alternative due to cessation of operations at TA-18 and shutdown of LANSCE. The boilers at TA-53 represent emissions of less than 1 percent of the emissions from facilities at LANL. Although it is unlikely that these boilers would be completely shut down if LANSCE were shut down, use of these boilers would be reduced and would result in a small reduction in pollutant emissions. Criteria pollutant emissions under the Reduced Operations Alternative are expected to result in concentrations below the ambient standards and to have minor impacts on human health.

There would be fewer high explosives experiments each year under the Reduced Operations Alternative than under the No Action Alternative, which would reduce overall emissions. As discussed in the No Action Alternative (Sections 5.4.1.1 and 5.6.2.1), reducing emissions from these activities would result in toxic air pollutant concentrations that would not be expected to cause air quality impacts that would affect human health.

Under the Reduced Operations Alternative, chloroform use would be similar to the usage level projected under the No Action Alternative. As discussed for the No Action Alternative, this usage level would result in emissions of chloroform that would not be expected to cause air quality impacts that would affect human health.

Based on the information discussed above, release of air pollutants as projected under the Reduced Operations Alternative would not be expected to cause air quality impacts that would affect human health and the environment.

Technical Area Impacts

Construction- and operations-related air quality impacts from the TAs under the Reduced Operations Alternative would be the same as those under the No Action Alternative, except as described below in relation to Key Facilities.

Key Facilities Impacts

Under the Reduced Operations Alternative, construction-related nonradiological air quality impacts from Key Facilities generally would be the same as those under the No Action Alternative; however, there would be slightly reduced construction-related nonradiological air quality impacts because of the reduced scope of construction for the Chemistry and Metallurgy Research Replacement Facility.

Chemistry and Metallurgy Research Building

Emissions of criteria and toxic air pollutants would continue at TA-3 from operation of boilers, emergency diesel generators, and other activities at TA-3, including operation of the Chemistry and Metallurgy Research Building for a period of time. Emissions would be smaller than those estimated for the Expanded Operations Alternative in the *1999 LANL SWEIS*, which were projected to remain within Federal and State standards for ambient air concentrations.

High Explosives Processing and High Explosives Testing Facilities

A minor decrease in operational impacts would be expected from reducing high explosives testing and processing activities by 20 percent. This could result in a reduction of about 0.01 tons (0.015 metric tons) per year of air pollutant emissions from high explosives testing and 0.05 tons (0.05 metric tons) per year from high explosives processing.

Los Alamos Neutron Science Center

Implementing the Reduced Operations Alternative for LANSCE at TA-53 would shut down that facility, reducing emissions from the TA-53 boilers.

Pajarito Site

Shutdown of operations at the Pajarito Site (TA-18) also would reduce emissions, which would have a minor positive affect on overall air quality.

5.4.1.3 Expanded Operations Alternative

The same nonradiological air quality impacts that would result from activities associated with the No Action Alternative also would occur under the Expanded Operations Alternative.

Los Alamos National Laboratory Site-Wide Impacts

Under the Expanded Operations Alternative, there would be emissions of criteria, toxic, and hazardous air pollutants, including fugitive dust, from construction activities at LANL. These emissions would be short-term for any particular project, but could be ongoing for a longer term as various facilities are constructed, demolished, and closed. In addition to emissions resulting from the construction activities described for the No Action Alternative, there would be temporary increases in air pollutant concentrations at the site boundary and along roads to which the public has access due to construction of new buildings in various TAs; DD&D of buildings; road, bridge, and walkway construction under the Security-Driven Transportation Modifications Project; and MDA remediation (as described in Appendix I). These impacts, apart from

MDA activities, would be similar to the impacts of other recent construction-related activities at LANL. Emissions of fugitive dust from these activities would be controlled with water sprays, application of soil stabilizers, and other controls as appropriate. The maximum ground-level concentrations offsite and along roads to which the public has regular access would be below the ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide for certain projects that could occur near the site boundary. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements. The impact on the public would likely be minor.

The MDA Capping and Removal Options would require the use of heavy equipment that would result in additional air pollutant emissions, including criteria and hazardous pollutants. At some locations, these activities would be of longer duration than typical construction activities at LANL and would involve extensive movement of materials. Estimated emissions from these activities are presented in Appendix I. Particulate matter would be dispersed into the air from grading, earthmoving, and compaction at the MDA sites and at the borrow pit from which capping material or fill is excavated. These emissions have been estimated to be considerable and could result in minor to moderate increases in short-term concentrations of criteria pollutants near the MDA activities. In some cases, these estimated concentrations would occur near the site boundary and nearby residences and businesses. For example, based on the schedule and remediation methods assumed in Appendix I for the Removal Option at TA-21 (MDAs A, B, T, and U), estimated concentrations at the site boundary near the Los Alamos townsite would be above the 1-hour ambient standard for carbon monoxide and the 24-hour standard for nitrogen dioxide. In addition, for the Removal Option at TA-54 (MDA G), the estimated concentrations at the site boundary near White Rock would be above the 1-hour and 8-hour ambient standards for carbon monoxide and the 24-hour and annual standards for nitrogen dioxide. The contribution to concentrations of particulate matter less than or equal to 10 microns in diameter (PM_{10}) from the Removal Option at MDA G could result in concentrations greater than 80 percent of the ambient standard. Concentrations under the Capping Option at MDA G would be about 8 percent of those under the Removal Option. Overall emissions from heavy equipment for the Removal Option were estimated to be more than 10 times those for the Capping Option. The Removal Option would greatly reduce or eliminate long-term release of volatile organic compounds from the MDAs. Particulate emissions would be controlled using standard dust control measures such as water sprays or through use of an enclosure. Other emissions would be reduced by management controls and scheduling to minimize impacts on the public and to meet regulatory requirements.

Changes in LANL operations proposed under the Expanded Operations Alternative, including relocation of existing operations, reinvestment in and refurbishment of existing facilities, and new operations or levels of operations, would not result in emissions beyond the level evaluated for the facility-wide air quality impact analysis (see Section 5.4.1.1). The results of the analysis bound the impacts of the Expanded Operations Alternative, and the highest estimated concentration of each pollutant would be below the ambient air quality standards and would likely have minor impacts on human health.

The impacts of toxic and hazardous air pollutants were assessed for this SWEIS based on analysis of the *1999 SWEIS* Expanded Operation Alternative. In all but two cases, the estimated pollutant concentrations would be below the corresponding guideline values established for the analysis in the *1999 SWEIS*. Guideline values are the levels established to identify chemicals for further analysis. The two cases where estimated emission rates would be above guideline values (which were referred to the human health and ecological risk assessment processes for further analysis) were High Explosive Testing Facilities operations and additive emissions from all pollutants from all TAs on receptor sites located at or near the Los Alamos Medical Center.

Operational nonradioactive air pollutants released under the Expanded Operations Alternative in this SWEIS would not be expected to cause air quality impacts that would affect human health and the environment (see Sections 5.4.1.1 and 5.6.2). In addition, if activities from the Bioscience Facilities were moved to the new Science Complex, the impacts resulting from LANL operations on receptor sites located near the Los Alamos Medical Center would likely be reduced.

Minor changes in vehicle emissions could result from activities under the Security-Driven Transportation Modifications Project. A small increase from shuttle bus emissions could be partially offset by a decrease from less use of personally owned vehicles.

Increased employment under the Expanded Operations Alternative of 2.2 percent per year could result in similar increases in LANL commuter vehicle emissions from additional employee vehicles commuting from Santa Fe and Rio Arriba County and other locations. The increase in employee vehicles and the increase in other vehicles resulting from the population increase that the state projects will occur would result in increases in vehicle emissions along the routes used to access the site. Along NM 30 the estimated increase in traffic levels during the 2007 through 2011 time period from increased operation and construction employee traffic would be about five percent over current traffic levels. Along NM 502 the estimated increase in traffic levels during the 2007 through 2011 time period from increased operation and construction employee traffic and shipments would be about six percent over current traffic levels. Similar increases in air pollutants emissions from traffic along these routes would be expected. The primary pollutants from commuter vehicles are hydrocarbons, carbon monoxide and nitrogen oxides. Elevated levels of carbon monoxide inhibit the blood’s capacity to carry oxygen. Nitrogen oxides and hydrocarbons are contributors to the formation of ozone. Ozone damages lung tissue, aggravates respiratory disease, and makes people more susceptible to respiratory infections. As discussed in Section 4.4.2.1 the area around Los Alamos and most of New Mexico is designated as attaining for the National Ambient Air Quality Standards for carbon monoxide, nitrogen oxides, ozone, and the other criteria pollutants (40 CFR 81.332). Even with the continuing growth in population there has been a decreasing or steady trend in concentrations in the region of carbon monoxide, nitrogen oxides, and ozone. Carbon monoxide and nitrogen oxides concentrations are well below the ambient standards (EPA 2006a). The ambient standards are set to protect the public health and welfare.

Technical Area Impacts

Construction-related nonradiological air quality impacts would be the same as those for the No Action Alternative for specific TAs (TA-3, TA-21, and TA-54), except for additional temporary construction impacts from new office buildings and the Physical Science Research Complex at TA-3, minor construction impacts from DD&D of TA-18 buildings, and temporary construction-related impacts at the Science Complex and the Remote Warehouse and Truck

Inspection Station. Construction-related impacts would occur during daytime hours from construction equipment operations and fugitive dust generation.

Operational nonradiological air quality impacts from specific TAs (TA-3, TA-21, and TA-54) would be similar to those under the No Action Alternative. There would be potential decreases in emissions from reduced intrafacility vehicle trips related to the Science Complex and from reduced delivery trips resulting from construction of the new Remote Warehouse and Truck Inspection Station.

Key Facilities Impacts

Construction-related nonradiological air quality impacts from Key Facilities would be similar to those of the No Action Alternative. Minor temporary construction impacts would occur from DD&D of TA-21 buildings, DD&D of TA-18 buildings, construction of the new Science Complex, construction of the new Radiological Sciences Institute and the Institute for Nuclear Nonproliferation Science and Technology, construction of a replacement for the Radioactive Liquid Waste Treatment Facility at TA-50, DD&D of the existing Radioactive Liquid Waste Treatment Facility, retrieval of transuranic waste from belowground storage at the Solid Radioactive and Chemical Waste Facilities, construction of a new TRU Waste Facility and other buildings, and minor facility modifications and construction at TA-55.

Operation of new buildings, including those discussed under the No Action Alternative, the new Science Complex, the Radiological Sciences Institute, the Institute for Nuclear Nonproliferation Science and Technology, the replacement Radioactive Liquid Waste Treatment Facility, the new TRU Waste Facility, new office buildings at TA-3, and a new radiography facility at TA-55, would not be expected to increase emissions of criteria pollutants because a comparable amount of space would be removed through DD&D of the old buildings. These emissions primarily would be associated with heating of facilities and providing electric power. Plutonium Facility Complex Refurbishment activities such as stack upgrades, steam system upgrades, and chiller replacement would have positive impacts on air quality and regulatory compliance. Operational nonradiological air quality impacts from other Key Facilities would be the same under the Expanded Operations Alternative as those under the No Action Alternative.

High Explosives Processing Facilities

There could be a minor increase in operational impacts corresponding to the 2.5 percent increase in High Explosives Processing Facilities activity indicated by the increased use of mock explosives. This could result in an increase of about 0.03 tons (0.027 metric tons) per year of hazardous air pollutant emissions from increased safety and mechanical testing. These chemicals could include various chemicals listed under the New Mexico permit regulations on toxic air pollutants and emission (NMAC 20.2.72.502) such as dicyclopentadienyl iron, ethyl ether, iodine, isopropyl alcohol, nitric acid, dimethyl acetamide, potassium hydroxide, sulfuric acid, and VM&P Naphtha. Hazardous air pollutant emissions such as chloroform, hydrazine, and nitrobenzene are subject to the limits on hazardous air pollutant emissions in the LANL Title V permit.

Tritium Facilities

Operations-related emissions from three boilers at TA-21 would be eliminated, which would reduce Tritium Facilities emissions by as much as 1.6 tons (1.5 metric tons) per year of nitrogen oxides (about 3.1 percent of nitrogen oxides emissions at LANL); 0.12 tons (0.11 metric tons) of particulates, (about 2.4 percent of the LANL total); and 1.3 tons (1.2 metric tons) of carbon monoxide (about 3.8 percent of carbon monoxide emissions at LANL).

5.4.2 Radiological Air Quality Impacts

Impacts of the emission of radioactive constituents to the air from continued operations at LANL were evaluated in terms of the increased dose (above the dose from background radiation) and corresponding risk of a latent cancer fatality (LCF) to the population in the vicinity of LANL and to a nearby maximally exposed individual (MEI). This impacts assessment is presented in Section 5.6. The following assessment of radiological air quality impacts represents an intermediate step in developing the dose estimates. The impacts are presented here as the projected quantities of radionuclides emitted under each alternative.

Radioactive air emissions from LANL come from point sources, such as stacks and vents, as well as diffuse or nonpoint (area) sources. Although there are other minor contributors of radioactive emissions, the Key Facilities represent essentially all of the site emissions that are relevant to the calculation of doses to the population and an MEI. Specifically, a few Key Facilities and certain radionuclides dominate the human health effects. Therefore, this analysis focuses on radioactive air emissions from those facilities, including gaseous mixed activation products associated with LANSCE operations and tritium, plutonium, americium, and uranium emissions associated with other Key Facilities.

Table 5–12 summarizes the expected radiological air emissions for each of the three alternatives. Air emissions are summarized as total emissions for the site. A detailed presentation of the radionuclides emitted from each of the Key Facilities is included in Appendix C.

5.4.2.1 No Action Alternative

Key Facility Impacts

Under the No Action Alternative, radioactive air quality impacts at the LANL site-wide and TA levels are not discussed separately because they are accounted for in the following discussion of emissions from the Key Facilities. Radiological air emissions for the No Action Alternative generally are projected to remain at levels similar to those projected in the *1999 SWEIS* Expanded Operations Alternative.

Chemistry and Metallurgy Research Building

The Chemistry and Metallurgy Research Replacement Facility at TA-55 would be completed and become operational. With the exception of the Wing 9 hot cell, activities in the current Chemistry and Metallurgy Research Building in TA-3 would be moved into the new facility. As a result of a decision not to move certain capabilities to the Chemistry and Metallurgy Research Replacement Building, tritium is no longer projected to be a significant emission from this building.

Table 5–12 Summary of Annual Projected Radiological Air Emissions (curies per year)

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site [a]			
Tritium [b]	2,400	2,400	2,400 [c]
Americium-241	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6} [d]
Plutonium [e]	0.00082	0.000092	0.00084 [d]
Uranium [f]	0.15	0.12	0.15
Particulate and Vapor Activation Products	30	0.014	30
Gaseous Mixed Activation Products	30,600	100 [g]	30,600 [g]
Mixed Fission Products [h]	1,650	1,650	1,650
Affected Technical Areas			
TA-21, TA-49, TA-50, TA-54 for major MDAs	Not applicable	Not applicable	Variable [i]

TA = technical area; MDA = material disposal area.
[a] These LANL site data include emissions from all Key Facilities. Radiological air emission data by Key Facility are presented in Appendix C.
[b] Includes both gaseous and oxide forms of tritium.
[c] Tritium emissions include 550 curies of tritium for TA-21 stacks. Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. Decontamination, decommissioning, and demolition of TA-21 under the Expanded Operations Alternative would permanently eliminate this potential source of tritium release.
[d] Americium-241 emissions could increase to 1.1×10^{-5} curies per year and plutonium emissions to 0.00089 curies per year if the Decontamination and Volume Reduction System, the new TRU (Transuranic) Waste Facility (formerly the Transuranic Waste Consolidation Facility), and remote-handled transuranic waste retrieval and processing activities operated simultaneously (estimated to occur from 2012 through 2015).
[e] Includes plutonium-238, plutonium-239, and plutonium-240.
[f] Includes uranium-234, uranium-235, and uranium-238.
[g] Gaseous mixed activation product emissions would decrease by 100 curies per year after about 2009 due to the shutdown of TA-18 thereafter, resulting in zero emissions of gaseous mixed activation product for the Reduced Operations Alternative and 30,500 curies per year in the Expanded Operations Alternative.
[h] Mixed fission products include krypton-85, xenon-131m, xenon-133, and strontium-90.
[i] There would be additional emissions from the remediation of the larger MDAs. These emissions would depend on radionuclides present, whether an MDA is being capped or removed, the number of MDAs being remediated at one time, and whether exhumation occurs under an enclosure (see Appendix I).

Radiochemistry Facility

Based on actual emissions from 1999 to 2005, the projected level of emissions from the Radiochemistry Facility has been increased by 10 percent.

Los Alamos Neutron Science Center

Projected emissions from LANSCE are determined by multiplying the microamp-hours of LANSCE operations by an emissions factor derived from stack monitoring results. Based on LANSCE emissions over recent years, the emissions factor used to estimate releases of gaseous mixed activation products has increased by a factor of about 7 from about 0.003 to 0.02 curies per microamp-hour. Therefore, the projected emissions from LANSCE are higher than previously estimated.

5.4.2.2 Reduced Operations Alternative

Key Facility Impacts

Under the Reduced Operations Alternative, radioactive air quality impacts at the LANL site-wide and TA level are not discussed separately because they are accounted for in the following discussion of Key Facility emissions. Activities at selected Key Facilities would be reduced or eliminated from those identified in the No Action Alternative, resulting in lower emissions of radiological constituents. The lower radiological emissions would result in lower radiological doses and risks under the Reduced Operations Alternative compared to the No Action Alternative (see Section 5.6).

Chemistry and Metallurgy Research Building

Based on information in the *CMRR EIS* (DOE 2003d), continued operation of the Chemistry and Metallurgy Research Building in TA-3 is projected to result in reduced airborne emissions of actinides compared to the assumed operation of the Chemistry and Metallurgy Research Replacement Building in TA-55 for the No Action Alternative; that is, from 0.00076 to 0.00003 plutonium curies per year.

High Explosives Processing and High Explosives Testing Facilities

A lower level of operations at both the High Explosives Processing and High Explosives Testing Facilities would result in a 20 percent reduction in their emissions. This reduction is shown in Table 5–12 as a reduction in emissions of uranium isotopes from 0.15 to 0.12 curies per year.

Los Alamos Neutron Science Center

The largest impacts on emissions would be due to cessation of LANSCE operations. Emissions of particulate and vapor activation products would be reduced by about 30 curies per year; the remaining 0.014 curies per year shown in Table 5–12 would be from the Radiochemistry Facility. Shutdown of LANSCE would also eliminate emissions of about 30,500 curies per year of gaseous mixed activation products.

Pajarito Site

Cessation of operations at TA-18, particularly shutdown of SHEBA, would reduce the remaining gaseous mixed activation product emissions by 100 curies per year. Complete cessation of TA-18 operations is assumed to occur in about 2009.

5.4.2.3 Expanded Operations Alternative

Implementation of the Expanded Operations Alternative would decrease some emissions of radiological constituents due to closure and DD&D of certain facilities; however, there would be both long-term and short-term increases in other emissions. The long-term increases would be associated with higher levels of operational activities at certain facilities. The short-term increases could occur during construction or DD&D activities, as well as from actions related to the implementation of the Consent Order.

Los Alamos National Laboratory Site-Wide Impacts

Major MDA remediation, canyon cleanups, and other Consent Order actions could result in temporary increases of radiological air emissions. The highest level of emissions would be from remediation of the large MDAs, which is the focus of the analysis in Appendix I. Remediation of other PRSs is expected to produce lower emissions. Emissions of radiological contaminants from remediation activities would depend on a number of factors. (Emissions from each MDA would be greatly affected by the remediation option selected; removal would result in larger emissions than capping.) Under the Removal Option, various radiological air emissions would be expected depending on the inventory of the MDA being remediated and whether or not exhumation would occur inside an enclosure equipped with a filtered exhaust system. Under the Capping Option, improving the covers on the MDAs would reduce the potential for radiological air emissions. Remediation of an MDA would occur over a few months to several years depending on the size of the MDA and the remediation option implemented. All of these factors would affect the quantity and timing of releases of radiological constituents, resulting in variable releases over time. Although the amount of these releases would vary over time and depend on the remediation option selected, Section 5.6 presents an estimated dose based on the assumptions that the Removal Option would be selected for all of the MDAs and that some of the removal actions would occur within an enclosure with a filtered exhaust.

Technical Area Impacts

A number of the projects analyzed in Appendices G, H, and J involve construction activities related to either excavation or DD&D of buildings, or both. These activities could cause minor short-term increases in emissions of radiological contaminants. The potential for these emissions would be minimized by conducting radiation surveys before the activities begin, as well as the use of a range of contamination control techniques such as decontamination, application of dust suppressants, and use of enclosures. Consequently, these activities generally would not be expected to increase emissions appreciably. Effects on radiological emissions associated with the TA-21 Structure DD&D are discussed as part of the Tritium Facilities section under the Key Facilities Impacts.

Key Facility Impacts

The Expanded Operations Alternative would result in both increases and decreases in projected emissions from Key Facilities. In addition, the location of some emission sources would change. As discussed above under Technical Area Impacts above, construction and DD&D activities may result in minor, short-term increases in radioactive emissions. Similar minor short-term increases in emissions also may occur in connection with projects at Key Facilities.

Chemistry and Metallurgy Research Building

The Chemistry and Metallurgy Research Replacement Facility at TA-55 would be completed and become operational. With the exception of the Wing 9 hot cell, activities in the current Chemistry and Metallurgy Research Building in TA-3 would be moved into the new facility. As discussed in Appendix G, the Wing 9 hot cell capabilities would be moved to the Radiological Sciences Institute when it is available. Therefore, although the emissions location would change, there would be no net change in the projected level of radioactive emissions from Chemistry and Metallurgy Research activities.

Pajarito Site

Closure of the TA-18 Pajarito Site would eliminate SHEBA, the primary source of emissions from that site. Therefore, after permanent shutdown of SHEBA in about 2009, site-wide emissions would be reduced by 100 curies per year (of argon-41), resulting in total site-wide emissions of 30,500 curies per year of gaseous mixed activation products.

Tritium Facilities

TA-21 Structure DD&D would include buildings that are part of the Tritium Facilities. DD&D of structures at TA-21 would permanently eliminate these buildings as emissions sources, which would reduce projected tritium emissions by 550 curies per year to 1,850 curies per year after about 2009.

Los Alamos Neutron Science Center

Under the Expanded Operations Alternative, LANSCE emissions would remain the same as for the No Action Alternative. If the LANSCE Refurbishment Project were implemented, the facility and its operating systems and equipment would be refurbished, allowing for its continued use. This restoration of the facility could result in more operational time and therefore increase the emissions from normal operations. As described in the human health impacts of the No Action Alternative (see Section 5.6.1.1), the dose to the MEI from emissions at LANSCE would be limited by operational controls to 7.5 millirem per year.

Plutonium Facility Complex

Addition of capabilities and increased levels of operations under the Expanded Operations Alternative would not appreciably affect emissions from most Key Facilities. Increases in the level of activities at the Plutonium Facility Complex, however, including production of up to 80 pits per year, would cause a small increase in plutonium emissions. The higher level of activity would result in the annual emission of an additional 0.000019 curies per year of plutonium from the Plutonium Facility Complex, as shown in Appendix C, Table C–14.

Solid Radioactive and Chemical Waste Facilities

Implementing the Waste Management Facilities Transition Project (see Appendix H) could increase emissions temporarily. Implementation of the project may result in the simultaneous operation of the temporary remote-handled transuranic waste retrieval facility, the new TRU Waste Facility, and the existing Decontamination and Volume Reduction System Facility. If all three facilities operated at the same time, americium-241 emissions would increase to 1.1×10^{-5} curies per year and plutonium emissions would increase to 0.00089 curies per year. This increase could occur in the 2012 through 2015 timeframe until remote-handled transuranic waste retrieval is completed and the Decontamination and Volume Reduction System Facility is shut down in support of remediation of MDA G.

5.4.3 Noise Impacts

Noise (sound) results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. Propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is undesirable sound that interferes or interacts negatively with the human or natural environment. Noise can disrupt normal activities (for example, concentration or sleep), damage hearing, or diminish the quality of the environment.

Noise-level measurements used to evaluate the effects of nonimpulsive sound on humans are compensated by an A-weighting scale that accounts for the hearing response characteristics (frequency) of the human ear. Noise levels are expressed in decibels (dB); or in the case of A-weighted measurements, decibels A-weighted (dBA). The C-weighted scale is used in describing large amplitude impulsive sounds of short duration, and is expressed in decibels C-weighted (dBC). EPA has developed noise-level guidelines for different land use classifications (EPA 1974). The EPA guidelines identify a 24-hour exposure level of 70 dB as the level of environmental noise that will prevent any measurable hearing loss over a lifetime. Likewise, levels of 55 dB outdoors and 45 dB indoors are identified as the levels that prevent activity interference and annoyance.

Los Alamos County has promulgated a local noise ordinance that establishes noise level limits for residential land uses. Noise levels that affect residential receptors are limited to a maximum of 65 dBA during daytime hours and 53 dBA during nighttime hours between 9 p.m. and 7 a.m. Between 7 a.m. and 9 p.m., the permissible noise level can be increased to 75 dBA in residential areas, provided the noise is limited to 10 minutes in any 1 hour. Activities that do not meet the noise ordinance limits require a permit (LANL 2004c).

Noise standards related to protecting worker hearing are contained in LANL's *Noise and Temperature Stresses – Laboratory Implementation Requirements* (LANL 2003g). The occupational exposure limit for steady-state noise, defined in terms of accumulated daily (8-hour) noise exposure that allows for both exposure level and duration, is 85 dBA (LANL 2003g). When a worker is exposed for a shorter duration, the permitted noise level is increased. LANL administrative requirements also limit worker impulse/impact noise exposures that consist of a sharp rise in sound pressure level (high peak) followed by a rapid decay of less than 1 second in duration and greater than 1 second apart. No exposure of an unprotected ear in excess of a peak of 140 dBC is permitted (LANL 2004c).

Noise from facility construction or operations and associated traffic could affect human and animal populations. The region of influence for each facility includes the site and surrounding areas, as well as transportation corridors, where proposed activities might increase noise levels. Transportation corridors most likely to experience increased noise levels are those roads within a few miles of the site boundary that are expected to carry most of the site's employee and shipping traffic.

Noise impacts associated with the alternatives could result from construction and operations activities, including increased traffic. The impacts of proposed activities under each alternative were assessed according to the types of noise sources and the location of the facility site locations relative to the site boundary and noise-sensitive receptors. Assessments of potential traffic-related noise impacts were based on the likely increase in traffic volume. Evaluations of the possible impacts on wildlife were based on the possibility of sudden loud noises occurring during site activities under each alternative.

Table 5–13 summarizes the expected noise impacts for each of the three alternatives.

5.4.3.1 No Action Alternative

Common to all three alternatives is LANL's continued contribution to background noise generation within the Los Alamos County area. The background noise levels are expected to remain at or near current levels for most of the foreseeable future regardless of the alternative implemented. There is no single representative measurement of ambient noise available for the LANL site. For a description of existing noise levels, see Chapter 4, Section 4.4.5.

Background noise levels associated with LANL activities under any of the three alternatives would be unlikely to approach the upper limit for sound levels in the community based on the site operation activities associated with each alternative relative to the existing environment.

Los Alamos National Laboratory Site-Wide Impacts

The levels of noise and short-range ground vibrations generated by environmental restoration activities are consistent with those produced by most construction activities. Heavy equipment use (bulldozers, loaders, backhoes, and portable generators) typically produces noise with mean levels ranging from 81 to 85 dBA at 50 feet (15 meters). In comparison with these noise levels, normal conversation is usually conducted at a sound level of about 60 dBA (FICN 1992). If heavy machinery were operated over an 8-hour period, producing noise at levels above 85 dBA constantly, it would be considered unsafe for workers; however, such noise generally is produced for short or sporadic periods. While occasional short spurts of site activities could result in noise levels in excess of 85 dBA, these are expected to be well within the levels of noise considered safe for likely exposure time durations of less than 1 hour. Hearing protection is provided and worn by workers, as appropriate, according to their standard operating procedures. Additionally, some minor interior and outdoor construction activities are common across all alternatives. Noise produced by these activities would be noticed most by LANL workers at the site where these activities are being performed, and these workers would be provided with hearing protection as part of their standard operating procedures.

Table 5–13 Summary of Environmental Consequences for Noise at LANL

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
	Normal Operations – Noise levels from operations would continue to have little impact on the public, with the exception of sporadic noise from explosives detonation and traffic noise. *Construction* – Noise impacts from construction-type activities would occur from construction, demolition, and remediation activities, and would likely have little impact on the public, except for traffic noise impacts. *Land Conveyance and Transfer* – Minor increases in traffic noise could result from development. – Minor noise impacts could result from development. *Electrical Power System Upgrades* – Minor noise impacts would result from construction. *Wildfire Hazard Reduction Program* – Minor noise impacts would result from activities and disposition of flood and sediment retention structures. – Minor noise impacts would result from the Trails Management Project and the Security Perimeter Project.	Same as No Action Alternative.	Same as No Action Alternative, plus: *Security-Driven Transportation Modifications Project* – Minor noise impacts would result from road, bridge, and walkway construction. – Minor increases in traffic noise could result from use of the new roads, especially at the Royal Crest Mobile Home Park under one of the auxiliary actions. *MDA Remediation* – Minor noise impacts from remediation activities near the LANL boundary could cause some public annoyance. – Minor to moderate increase in truck and personnel vehicle traffic noise could result along East Jemez Road and at White Rock under the various remediation options.
Affected Technical Areas			
TA-3	– Minor changes in noise impacts would result from operation of new turbine generator. – Minor construction noise impacts would result from construction of three new office buildings. – Negligible operation noise impacts are expected from new office buildings.	Same as No Action Alternative.	Same as No Action Alternative, plus: – Minor construction equipment and traffic noise impacts would result from construction of the Physical Science Research Complex and the Replacement Office Buildings. – Negligible operational noise impacts would result from use of equipment at the Physical Science Research Complex and the Replacement Office Buildings.
TA-21	No change in noise impacts.	Same as No Action Alternative.	Minor construction equipment noise impacts would result from DD&D of structures. Some increase in traffic noise would result from waste shipments.
TA-54	Minor noise impacts would result from MDA H closure activities.	Same as No Action Alternative.	Same as No Action Alternative.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
TA-61	No change in noise impacts.	Same as No Action Alternative.	*Borrow Pit* – Noise impacts from operation of construction-type equipment to withdraw crushed tuff for MDA remediation and from increased truck traffic.
TA-72	No change in noise impacts.	Same as No Action Alternative.	– Minor construction equipment and traffic noise would result from construction of the Remote Warehouse and Truck Inspection Station. – Noise could be noticeable to the public along East Jemez Road from operation of the Remote Warehouse and Truck Inspection Station.
		Key Facilities	
Chemistry and Metallurgy Research Building (TA-3, TA-48, and TA-55)	– Little or no change in impacts would result from operation of the CMRR Facility and relocation of CMR activities to TA-55. – Minor construction equipment and traffic noise impacts would result from DD&D of the old facility at TA-3 and construction of the new facility at TA-55.	Minor reduction in noise impacts if the nuclear facility portion of the CMRR Facility is not constructed.	Same as No Action Alternative.
High Explosives Processing Facilities	– No change in operation noise impacts. – Minor construction equipment and traffic noise impacts would result from construction of the TA-16 Engineering Complex and demolition of structures.	Same as No Action Alternative.	Same as No Action Alternative.
High Explosives Testing Facilities	– No change in operation noise impacts. – Minor construction equipment and traffic noise impacts would result from construction of 15 to 25 new structures (new offices, laboratories, and shops) to replace about 59 structures currently used for dynamic experimentation operations and removal or demolition of vacated structures.	Minor reduction in operation noise impacts would result from 20 percent reduction in activities. Same as No Action Alternative for construction.	Same as No Action Alternative.
Tritium Facilities (TA-21)	No change in noise impacts.	Same as No Action Alternative.	– Minor construction equipment and traffic noise impacts would result from DD&D of all TA-21 tritium buildings as part of the project to decommission all of TA-21.
Pajarito Site (TA-18)	No change in noise impacts.	Minor reduction in operation noise impacts would result from shutdown of activities.	– Minor reduction in operation noise impacts would result from shutdown of activities. – Minor construction equipment and traffic noise impacts would result from DD&D of TA-18 buildings.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Target Fabrication Facility	No change in noise impacts.	Same as No Action Alternative.	Same as No Action Alternative.
Bioscience Facilities	No change in noise impacts.	Same as No Action Alternative.	– Negligible change in operation impacts would result from transfer of Bioscience Facilities operations to the new Science Complex. – Minor construction noise impacts from construction of the new Science Complex.
Radiochemistry Facility (TA-48)	No change in noise impacts.	Same as No Action Alternative.	– Minor construction equipment and traffic noise impacts from construction of the new Radiological Sciences Institute.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in noise impacts.	Same as No Action Alternative.	– Minor construction equipment and traffic noise impacts from construction of a replacement for the existing Radioactive Liquid Waste Treatment Facility at TA-50 and DD&D of the existing Radioactive Liquid Waste Treatment Facility.
LANSCE (TA-53)	No change in noise impacts.	Minor reduction in noise impacts from shutdown.	Negligible to minor noise impacts from refurbishment.
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No change in noise impacts.	Same as No Action Alternative.	– Minor noise impacts from retrieving transuranic waste from below ground storage. – Minor construction and traffic noise impacts from construction of a new TRU Waste Facility and new access control station, low-level radioactive waste compactor building, and low-level radioactive waste certification building.
Plutonium Facility Complex (TA-55)	No change in noise impacts.	Minor reduction in noise impacts if the nuclear facility portion of the CMRR Facility is not constructed.	– Minor construction equipment and traffic noise impact from minor facility modifications in support of increased pit production and the Plutonium Complex Refurbishment Project, as well as construction of radiography capabilities.

MDA = material disposal area; TA = technical area; DD&D = decontamination, decommissioning, and demolition; LANSCE = Los Alamos Neutron Science Center; CMRR = Chemistry and Metallurgy Research Replacement; CMR = Chemistry and Metallurgy Research Building.

Noise from LANL construction activities may be somewhat noticeable to nearby members of the public. Environmental restoration activities that occur near the Los Alamos townsite may be noticeable to the public but would be limited in duration. Because these activities are conducted during the daytime hours for short continuous durations, the noise levels and ground vibrations produced are unlikely to adversely impact the public or sensitive wildlife receptors and their habitats. If certain sensitive wildlife species are found to occupy habitat areas near locations where these types of activities need to occur, or if the occupancy status of these habitat areas is unknown, either these activities would need to be scheduled outside of the species' breeding season or other special protective measures would need to be planned and implemented (such as hand digging).

Specifically for the No Action Alternative, minor noise impacts would occur from construction activities, including construction related to previously approved projects such as the Electric Power System Upgrades, Wildfire Hazard Reduction Program, disposition of flood and sediment retention structures, Trails Management Program, and Security Perimeter Project. Management of construction fill would increase truck traffic. All of these construction projects would produce temporary increases in equipment and traffic noise.

Similarly, workers, the public, and sensitive wildlife receptors are unlikely to be adversely impacted by explosives testing, which is common to some degree among all of the three alternatives. Workers are allowed to experience impulsive/impact noise events up to a maximum of 140 dBC and are kept away from harmful noise levels and air blasts by gated exclusion zones that control their entry into explosives firing site detonation points. The public is not allowed within the fenced TAs that have firing sites, and noise levels produced by explosives tests are sufficiently reduced at locations where the public would be present to preclude hearing damage. Such tests would not be expected to adversely affect offsite sensitive receptors (such as those at Bandelier National Monument or at White Rock). Noises heard at that distance would be similar to thunder in their intensity, and air blast and ground vibrations are not expected to be present outside LANL at intensities great enough to adversely affect real properties. Sensitive wildlife species are unlikely to be adversely affected by "thunder-like" explosives testing events, given their continued presence in areas of the country that are known to be within higher-than-average lightning event areas and their continued presence on the LANL site over the past 10 years. In fact, the continued thriving of resident and long-term migratory populations of these sensitive species on the LANL site indicates that the level of noise generated by explosives testing under the No Action Alternative is at least tolerable to these particular species.

Implementing the No Action Alternative would likely result in the previously discussed operations-related effects that are common to all alternatives. Specifically for the No Action Alternative, a minor increase in vehicle noise could result from development that occurs under conveyance and transfer of land.

Technical Area Impacts

Minor and temporary construction-related noise impacts would occur from construction of three new office buildings at TA-3 and MDA H closure activities at TA-54. Workers in the vicinity of MDA H waste encapsulation equipment may require hearing protection. Minor operations-related noise impacts would result from operation of new office buildings at TA-3 and operation of the new turbine generator at TA-3.

Key Facilities Impacts

Minor construction-related noise impacts would occur from construction of the Chemistry and Metallurgy Research Replacement Facility at TA-55, demolition of facilities at TA-3, completion of the TA-16 Engineering Complex, demolition of structures at TA-16, construction of buildings at the new Twomile Mesa Complex site, and demolition of unneeded structures.

Minor operations-related noise impacts would occur from moving Chemistry and Metallurgy Research operations from TA-3 to TA-55 due to operation of heating, ventilation, and cooling systems and other equipment at new facilities, including new structures for dynamic explosion operations. Minor operations-related noise impacts also would occur from operation of a new dynamic explosion structure at TA-15 for high explosives testing.

5.4.3.2 Reduced Operations Alternative

Noise impacts resulting from activities associated with the No Action Alternative would still occur, except for those associated with reductions to operations considered part of the Reduced Operations Alternative.

Los Alamos National Laboratory Site-Wide Impacts

Construction-related noise impacts under the Reduced Operations Alternative would be similar to those under the No Action Alternative. Construction projects would result in temporary increases in noise from equipment and traffic.

The operations-related noise impacts of the Reduced Operations Alternative would be similar to those of the No Action Alternative. The primary noise, air blast waves, and ground vibration impacts from implementation of this alternative would be generated by the high explosives tests. There would be fewer of these explosions under the Reduced Operations Alternative, and the resulting noise would still result from occasional (rather than continuous) events. Noises associated with LANSCE and TA-18 operations would be eliminated by the shutdown of those facilities.

Technical Area Impacts

Construction- and operations-related noise impacts would be the same as those under the No Action Alternative.

Key Facilities Impacts

Noise impacts from construction equipment and traffic from Key Facilities would be the same as those under the No Action Alternative except in TA-55, where the nuclear facility portion of the Chemistry and Metallurgy Research Replacement Facility would not be constructed, and in TA-3 where the Chemistry and Metallurgy Research Building DD&D would be postponed. A minor reduction in operational noise impacts would occur from the reduction in high explosives testing and the shutdown of activities at TA-18 (Pajarito Site) and LANSCE at TA-53.

5.4.3.3 Expanded Operations Alternative

The same noise impacts associated with activities considered under the No Action Alternative would occur under the Expanded Operations Alternative.

Los Alamos National Laboratory Site-Wide Impacts

Under the Expanded Operations Alternative, interior and outdoor construction activities at LANL would increase. Individual activities would remain within the level of effects described for the No Action Alternative, but could be ongoing for a longer period. In addition to the construction activities discussed for the No Action Alternative, activities such as construction of new buildings in various TAs; DD&D of buildings; road, bridge, and walkway construction as part of the Security-Driven Transportation Modifications Project; and MDA remediation (described and discussed in Appendix I) would likely result in levels of noise and short-range ground vibrations similar to those associated with current construction and demolition activities. Workers would be primarily affected by these noises, although motorists could occasionally hear low levels of equipment noises along Pajarito Road under certain climatic conditions. The roadway, walkway, and bridge construction under the Security-Driven Transportation Modifications Project (Appendix J) would be short-term and similar to other roadway construction at LANL. Noise from increased activities at MDAs close to the site boundary, such as at TA-21, could increase public annoyance at nearby residences or businesses.

There would be no change in noise impacts to the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles, materials shipments, and a minor-to-moderate increase in truck traffic noise from MDA remediation, especially along East Jemez Road near the Royal Crest Mobile Home Park. Other proposed construction activities under this alternative include small-scale outdoor activities, interior work on existing buildings, construction of an addition to an existing building, construction of a new building in close proximity to others, and construction at specific TAs and Key Facilities, as described below. The effects of these construction activities would be primarily limited to involved workers and would not likely result in any adverse effects on sensitive wildlife species or their habitats.

The largest increases in traffic noise from construction activities would be associated with remediation of the MDAs. Estimated increases in traffic along Pajarito Road could be substantial during the years when remediation of MDA G occurs. A similar increase in traffic along NM 4 at White Rock could be expected. The associated increase in traffic noise may be noticeable to some residents at White Rock due to the increase in truck trips. As most of the truck trips are expected to occur during non-peak-traffic daytime hours, the truck noise levels would be higher during these hours. As most of the increase in traffic would be from personnel vehicles, much of the increased traffic and associated traffic noise would occur during peak traffic hours. Increases in traffic along East Jemez Road near the Royal Crest Mobile Home Park also could be substantial during the years when remediation of MDA G (under either the Capping or the Removal Option) occurs. The associated increased traffic noise due to the higher volume of truck and personnel vehicle trips may be noticeable to residents at the Royal Crest Mobile Home Park.

As discussed for the No Action Alternative, the primary noise from implementation of these alternatives would be generated by air blast waves and ground vibration impacts associated with high explosives tests, although these explosions and the resulting noise would be occasional (rather than continuous) events. The noise would be sporadic and would be mitigated by the distance of the tests to the nearest public receptors. The effects of these operational activities would be primarily limited to involved workers. They would not likely result in any adverse effect on sensitive wildlife species or their habitats, and would be similar to the effects discussed under the No Action Alternative.

A minor increase in vehicle noise could result from use of the new roads constructed under the Security-Driven Transportation Modifications Project, especially at the Royal Crest Mobile Home Park under one of the auxiliary actions being considered that would include a bridge across Sandia Canyon.

Technical Area Impacts

There would be no change in noise impacts to the public outside of LANL as a result of construction activities at specific TAs (TA-3, TA-18, TA-21, and TA-54), except for minor increases in traffic noise levels from construction employees' vehicles and materials shipments and in noise levels at nearby businesses from DD&D at TA-21. Construction noise impacts would result from the same activities as those under the No Action Alternative, plus construction of additional office buildings and the Physical Science Research Complex at TA-3, DD&D of TA-18 buildings, DD&D at TA-21, construction of the Science Complex, and construction of the Remote Warehouse and Truck Inspection Station. The effects of these construction activities would be primarily limited to involved workers and would not likely result in any adverse effects on sensitive wildlife species or their habitats.

Operational noise impacts would result from the same type of activities as those under the No Action Alternative, with minor changes to impacts from relocated and consolidated activities across the various TAs. Noise potentially noticeable to the public along East Jemez Road could occur from operations of the Remote Warehouse and Truck Inspection Station.

Key Facilities Impacts

There would be no changes in noise impacts to the public outside of LANL as a result of construction-type activities at Key Facilities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments. Construction noise impacts from Key Facilities would be the same as those under the No Action Alternative, with minor impacts resulting from DD&D of TA-21 and TA-18 buildings; construction of the new Science Complex, new Radiological Sciences Institute, and Institute for Nuclear Nonproliferation Science and Technology; replacement of portions of the Radioactive Liquid Waste Treatment Facility at TA-50; DD&D of the existing Radioactive Liquid Waste Treatment Facility; refurbishment at LANSCE; retrieval of transuranic waste from below ground storage at the Solid Radioactive and Chemical Waste Facilities; construction of a new TRU Waste Facility and associated buildings; and construction of a radiography facility and minor facility modifications at TA-55. The effects of these activities would be primarily limited to involved workers and would not likely result in any adverse effect on the public or on sensitive wildlife species or their habitats. Some of these activities such as the Radiological Sciences Institute construction could include blasting noise. Traffic noise would increase in the area around LANL from increased numbers of employee vehicles and shipments of materials and wastes, as discussed in the site-wide section above.

Operational noise impacts for Key Facilities would result from the same activities as those under the No Action Alternative, except for a minor reduction in operational impacts from the removal of activities from TA-18 and minor changes in impacts due to the transfer of the Bioscience Facilities operations to the new Science Complex and changes related to the operations of the Radiological Sciences Institute, the replacement Radioactive Liquid Waste Treatment Facility, the new TRU Waste Facility, and new radiography facility at TA-55. Noise impacts from Key Facilities operations associated with the Expanded Operations Alternative, therefore, would likely be about the same as those under the No Action Alternative.

5.5 Ecological Resources

Ecological resources include terrestrial resources, wetlands, aquatic resources, and protected and sensitive species. Biological data from the *1999 SWEIS* and other environmental documents, wetlands surveys, and plant and animal inventories of LANL were reviewed to identify the locations of plant and animal species and wetlands. Lists of protected and sensitive species potentially present on LANL were developed from sources at the Federal, state, and site levels.

Impacts to ecological resources could result from land disturbance, water use and discharge, human activity, and noise associated with project implementation. Each of these factors was considered when evaluating the potential impacts of proposed projects and activities. For those alternatives involving construction of new facilities, direct impacts to ecological resources were based on the acreage of land disturbed by construction. Indirect impacts from factors such as human disturbance and noise were evaluated qualitatively. Indirect impacts to ecological resources from erosion due to construction were evaluated qualitatively, recognizing that standard erosion and sediment control practices would be followed.

In evaluating the potential impacts on protected and sensitive species, it is important to consider both direct effects and effects that a proposed project could have on the species' habitat. Accordingly, LANL has established Areas of Environmental Interest for three species: Mexican spotted owl (*Strix occidentalis lucida*) (federally listed as threatened and state-listed as sensitive), bald eagle (*Haliaeetus leucocephalus*) (federally and state-listed as threatened), and the southwestern willow flycatcher (E*mpidonax traillii extimus*) (federally and state-listed as endangered) (LANL 2000b). Areas of Environmental Interest for these species include both core and buffer zones, each of which has certain restrictions aimed at protecting the species and their habitats. DOE has prepared a biological assessment for the continued operation of LANL (LANL 2006b) that evaluates potential impacts to the Mexican spotted owl, bald eagle, and southwestern willow flycatcher in terms of potential effects to the species and their designated Areas of Environmental Interest.[3] The results of the biological assessment, as well as the

---

[3] The biological assessment uses the phrases "reasonable and prudent measures" and "reasonable and prudent alternatives." In this SWEIS, the term reasonable and prudent measures includes both phrases used in the biological assessment.

U.S. Fish and Wildlife Service (USFWS) responses to the assessment (see Chapter 6), have been incorporated into this Final LANL SWEIS.

This section addresses the impacts of the No Action, Reduced Operations, and Expanded Operations Alternatives on Ecological Resources. A summary of these impacts is presented in **Table 5–14**.

5.5.1 No Action Alternative

The No Action Alternative was analyzed in terms of its impacts on the existing environment and on ecological resources (see Sections 4.4.5 [for effects of explosives-related noise on wildlife] and 4.5), including the actions that will be implemented, based on other NEPA compliance reviews issued since the *1999 SWEIS*. The impacts to ecological resources are described in terms of those projects that would impact the site as a whole and those that would affect specific TAs. Key Facilities are addressed separately. Only those projects that were determined to impact ecological resources are addressed below. Continuing the LANL environmental restoration program is not expected to adversely affect ecological resources.

Los Alamos National Laboratory Site-Wide Impacts

Five projects that have been approved, and for which NEPA documentation has been prepared since publication of the *1999 SWEIS*, have potential impacts across a number of TAs. These projects are addressed separately below.

Conveyance and transfer of land from DOE began in 2002; by the end of 2005, 2,259 acres (914 hectares) had been conveyed or transferred (see Chapter 4, Section 4.1.1). Additional acreage may be turned over by 2012. The land that has been or is to be conveyed or transferred falls within the pinyon-juniper woodland and ponderosa pine forest zones. One of the direct impacts of the conveyance and transfer is a change in responsibility for resource protection. An indirect impact, as determined by the analysis, is potential future development within the conveyed and transferred parcels. Approximately 770 acres (312 hectares) of relatively undisturbed habitat within the ponderosa pine forest and pinyon-juniper woodland zones could be developed, which could affect potential habitats for several federally listed threatened and endangered species, including the Mexican spotted owl. In some tracts, wetlands could be reduced or possibly lost, potentially increasing downstream and offsite sedimentation. Another indirect impact of the land conveyance and transfer could be a much less rigorous environmental review and protection process for future activities because neither the County of Los Alamos nor the Pueblo of San Ildefonso have regulations matching the Federal review and protection process. Cumulatively, development could impact biodiversity due to fragmentation of habitat and disruption of wildlife migration corridors (DOE 1999d).

Table 5–14 Summary of Environmental Consequences of Ecological Resource Changes at Los Alamos National Laboratory

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
	Land Conveyance and Transfer – 2,259 acres (914 hectares) of land within the pinyon-juniper woodland and ponderosa pine forest zones have been conveyed or transferred. – 770 acres (312 hectares) of habitat could be developed. – Transfer of resource protection responsibility could result in a less rigorous environmental and protection review process. *Electrical Power System Upgrades* – Minimal effects on vegetation. – Temporary impacts such as disturbance from construction activities, on wildlife. – Potentially positive impact from providing perching sites for larger birds. *Wildfire Hazard Reduction Program* – Short-term disturbance of wildlife due to forest thinning activities. – Recreate more natural historic forest conditions. – Increased forest health could benefit the Mexican spotted owl and other species. *Disposition of Flood Retention Structures* – Short-term disturbance of wildlife due to construction activities. – Potentially minor impacts on downstream wetlands. *Trails Management Program* – Short-term disturbance of wildlife due to implementation activities. – Where trails are closed, some increase in diversity of wildlife.	Same as No Action Alternative	Same as No Action Alternative, plus: *MDA Remediation Project* – Minimal temporary impact on wildlife during capping or waste removal. – Capping would reduce biointrusion and complete removal would eliminate it. – Capping would limit revegetation efforts, while there would be no restrictions under the Removal Option. – Possible loss of habitat at borrow pit in TA-61, including undeveloped buffer and core habitat for the Mexican spotted owl. Extension of the borrow pit would require consultation with the USFWS. – In a few cases remediation activities may affect, but are not likely to adversely affect, the Mexican spotted owl, bald eagle, and southwestern willow flycatcher. *Security-Driven Transportation Modifications Project* – Parking lot construction and placement of pedestrian and vehicle bridges would remove about 30 acres (12 hectares) of natural vegetation. – Auxiliary Action A would disturb up to 25.4 acres (10.6 hectares) of undeveloped core and buffer Mexican spotted owl habitat. – Auxiliary Action B would disturb up to 65.8 acres (26.6 hectares) of undeveloped core and buffer; a new section of road would remove 1.3 acres (0.6 hectares) of additional natural habitat. – Construction may affect, but is not likely to adversely affect, the bald eagle. – Bridges and traffic over the core zone of the Sandia-Mortandad Canyon Mexican spotted owl Areas of Environmental Interest could cause long-term impacts. Section 7 consultation with the USFWS would be needed.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Affected Technical Areas			
TA-3	No change in impacts to ecological resources.	Same as No Action Alternative.	*Replacement Office Buildings* – Clear 13 acres (5.3 hectares) of mixed conifer forest. – Short-term construction impacts on wildlife. – Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle.
TA-21	No change in impacts to ecological resources.	Same as No Action Alternative.	*TA-21 Structure DD&D* – Short-term construction impacts on wildlife in adjacent areas. – DD&D activities may affect, but is not likely to adversely affect, the Mexican spotted owl.
TA-61	No change in impacts to ecological resources.	Same as No Action Alternative.	*Borrow Pit* – Loss of wildlife habitat from expanding operations to process tuff for MDA remediation. Consultation with the USFWS would be required.
Remote Warehouse and Truck Inspection Station (TA-72)	No change in impacts to ecological resources.	Same as No Action Alternative.	*Remote Warehouse and Truck Inspection Station Project* − 4 acres (1.6 hectares) of ponderosa pine forest and pinyon-juniper woodland would be cleared. − Short-term construction impacts on wildlife. − Construction may affect, but is not likely to adversely affect, the bald eagle.
Key Facilities			
Chemistry and Metallurgy Research Building (TA-3, TA-48, and TA-55)	Limited acreage of ponderosa pine forest cleared with loss and displacement of wildlife.	Same as No Action Alternative.	Same as No Action Alternative.
High Explosives Testing Facilities (TA-6, TA-22, and TA-40)	Short-term impacts on wildlife from construction of new facilities and demolition of old structures.	Same as No Action Alternative, plus: – Reduction in the number of times animals would be subjected to stress resulting from explosives testing.	Same as No Action Alternative.
Pajarito Site (TA-18)	No change in impacts to ecological resources.	Same as No Action Alternative	– Minor impact to wildlife during demolition. – DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl and southwestern willow flycatcher. – Restoration of site could create a more natural habitat and benefit wildlife, potentially including the Mexican spotted owl.

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Radiochemistry Facility (TA-48)	No change in impacts to ecological resources.	Same as No Action Alternative.	*Radiological Sciences Institute* – Minor impact to wildlife during construction and demolition. – 12.6 acres (5 hectares) of ponderosa pine forest cleared. – Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. – DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in impacts to ecological resources.	Same as No Action Alternative.	– Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle. – Implementation of the evaporation tank option would reduce wetlands and riparian habitat in Mortandad Canyon and the abundance and diversity of Mexican spotted owl prey species, requiring Section 7 consultation with the USFWS.
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No change in impacts to ecological resources.	Same as No Action Alternative.	*Waste Management Facilities Transition Project* − Short-term impacts on wildlife from new construction and demolition in TA-54 under both options. − Construction at TA-54 may affect, but is not likely to adversely affect, the southwestern willow flycatcher. − Construction of a TRU Waste Facility at a generic site could impact portions of Mexican spotted owl Areas of Environmental Interest and would require Section 7 consultation with the USFWS. − TRU Waste Facility construction could result in the loss of 2.5 to 7 acres (1.0 to 2.8 hectares) of ponderosa pine forest or open field.
LANSCE (TA-53)	No change in impacts to ecological resources.	Wetland reduction possible due to shut down.	Same as No Action Alternative.
Bioscience Facilities	No change in impacts to ecological resources.	Same as No Action Alternative.	*Science Complex Project* − Options 1 and 2 would remove 5 acres (2 hectares) of ponderosa pine forest. − Under Option 3 less than 5 acres (2 hectares) of grassland and forest would be cleared. − Short-term construction impacts on wildlife. − Construction may affect, but is not likely to adversely affect, the Mexican spotted owl and bald eagle.

MDA = material disposal area; TA = technical area; DD&D = decontamination, decommissioning, and demolition; LANSCE = Los Alamos Neutron Science Center; USFWS = U.S. Fish and Wildlife Service.

Electric power line upgrades were determined to have minimal effects on vegetation along the power line right-of-way. Construction-related impacts on wildlife would include displacement due to increased noise and human activity; however, some species would likely return to the new habitat within the proposed corridor, including deer and elk. Further, the power line may provide additional perching sites for larger birds that occupy or use the area through which it passes. Adverse effects on habitats for bald eagles, southwestern willow flycatchers, and Mexican spotted owls due to the proposed placement of structures, roads, and laydown areas in existing roadways or disturbed areas would not be expected. Timing of construction and maintenance actions to avoid adverse effects on sensitive species or their habitats would ensure that these species were not impacted (DOE 2000a).

In the long term, the Wildfire Hazard Reduction Program would create conditions at LANL that are consistent with a more natural historic ecological process accompanied by improved health and vigor and increased biological diversity for wildlife. In the short term, treatment measures would temporarily displace local wildlife such as deer, elk, birds, and small mammals; however, wildlife would return to treated forests and their numbers would likely increase over the long term. Sensitive species also would be expected to benefit from a general improvement in forest health. For example, reducing the risk of severe, high-intensity wildfires supports the recovery goals for the Mexican spotted owl (DOE 2000e).

The future disposition of certain flood and sediment retention structures built after the Cerro Grande Fire could have minor short-term effects on ecological resources. The demolition of the flood retention structure in Pajarito Canyon would disturb vegetation and could result in sedimentation of downstream wetlands. In addition, noise and other effects of demolition activities could temporarily disperse animals that use the area. Revegetation and implementation of best management practices would minimize impacts to terrestrial resources and wetlands. Constraints on the timing of activities and noise levels may be required if Mexican spotted owls were found in the area. Removal of the steel diversion wall upstream of TA-18 could cause short-term effects on plants and animals. Noise and activity constraints during the breeding season of the Mexican spotted owl would prevent adverse effects on the nearby Area of Environmental Interest if the area were to become occupied by that species. Activities taking place at the low-head weir, located in Los Alamos Canyon, as well as the road reinforcements in Twomile Canyon, Pajarito Canyon, and Water Canyon were not found to affect ecological resources (DOE 2002j).

No long-term or permanent changes to ecological resources would be expected from implementing the LANL Trails Management Program. Short-term effects on animals that live along trail reaches, however, could result from trail construction, maintenance, or closure activities. In areas where trails would be closed, some increase in animal diversity might occur. Sensitive species, including the Mexican spotted owl, and their critical habitats are unlikely to be adversely affected by activities associated with the Trails Management Program (DOE 2003b).

Management of construction fill would not be expected to affect ecological resources. Construction fill would be stored in previously existing borrow areas in TA-16 and TA-61.

Technical Area Impacts

TA impacts on ecological resources would be essentially unchanged from current conditions under the No Action Alternative.

Key Facilities Impacts

Since publication of the *1999 SWEIS*, NEPA compliance has been completed for two currently active projects related to Key Facilities that could affect ecological resources: the Chemistry and Metallurgy Research Replacement Facility construction at TA-55 and the Twomile Mesa Complex Consolidation at TA-22.

Chemistry and Metallurgy Research Building

The Chemistry and Metallurgy Research Replacement Facility would be built within TA-55 on both previously disturbed land and within a small area of ponderosa pine forest. A total of about 28 acres (11 hectares) of natural vegetation would be removed, some from previously disturbed land. Where construction would occur on previously disturbed land, there would be little or no impact to terrestrial resources. Construction also would remove some previously undisturbed ponderosa pine forest, causing the loss of less mobile wildlife such as reptiles and small mammals and temporarily displacing more mobile species such as birds and large mammals. Indirect impacts from construction, such as noise or human disturbance, could also affect wildlife living adjacent to the construction zone. The project would have no impact on wetlands or aquatic resources at LANL. Although TA-55 includes a portion of the buffer zone of the Pajarito Canyon Mexican spotted owl Area of Environmental Interest, construction of the Chemistry and Metallurgy Research Replacement Facility would not be expected to adversely affect it. Operational impacts were determined to be minimal (DOE 2003d). DD&D of the existing Chemistry and Metallurgy Research Building would allow revegetation of that site; however, as the site is within TA-3, infill building at a later date would likely occur.

High Explosives Testing Facilities

Construction of new facilities associated with the consolidation of activities at the Two-Mile Mesa Complex within TA-22 and the associated demolition of numerous structures within a number of TAs across LANL were determined to impact ecological resources only minimally. Small mammals and birds would be temporarily displaced by construction activities, but they would likely return to the area after construction was completed. Movement of large mammals is not likely to be altered. There would be no impacts to wetlands or sensitive species (DOE 2003e).

5.5.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Under the Reduced Operations Alternative, impacts on ecological resources would be the same as those for the No Action Alternative (see Section 5.5.1).

Key Facilities Impacts

Activity levels at certain Key Facilities would change. High explosives processing and testing would be reduced by 20 percent. LANSCE would cease operation and be placed into a safe shutdown mode. Operations would cease at the Pajarito Site (TA-18), and that facility would be shut down. As there would be no change in impacts on ecological resources associated with the closure of LANSCE or TA-18 facilities, this action is not addressed further.

High Explosives Testing Facilities

Under the Reduced Operations Alternative, high explosives testing at LANL would be reduced by 20 percent. Although animals may adjust to constant noise levels, they do not readily adjust to intermittently high noise levels. Startle or fright is the immediate behavioral reaction to transient, unexpected, or unpleasant noise such as explosives testing (EPA 1980). Thus, although testing would be reduced, animals residing near test sites would still experience stress with the occurrence of each test. The overall number of times per year that this stress would be experienced, however, would be lessened.

5.5.3 Expanded Operations Alternative

The Expanded Operations Alternative reflects proposals that would expand the overall operations level at LANL above those established for the No Action Alternative. Thus, this alternative includes the ecological resource impacts for those actions addressed under that alternative (see Section 5.5.1), as well as the potential impacts of a number of new projects. Not all new projects or activities would affect these resources because many would involve actions within or modifications to existing structures, or the construction of new facilities within previously developed areas of LANL. For example, an increase in pit production would not require new construction and hence would not affect ecological resources. Only those projects that would likely impact ecological resources are addressed below.

Los Alamos National Laboratory Site-Wide Impacts

There are two options (capping and removal) related to remediation of MDAs at LANL. Under the Capping Option, terrestrial resources would be disrupted as the MDAs are cleared of existing vegetation and then capped. Provision of material for the caps could result in the loss of some habitat adjacent to the active portion of the borrow pit in TA-61 due to the need to enlarge the existing borrow area. At most sites, however, capping would have minimal biota impact because the MDAs are grassy areas enclosed within a fence that excludes most wildlife species except birds and very small animals. Noise and human presence during remediation could disturb wildlife in adjacent areas, but proper equipment maintenance and restrictions preventing workers from entering adjacent undisturbed areas would lessen these impacts. The caps would be designed to prevent or reduce biointrusion, which would reduce the ecological risks associated with reintroduction of contaminants into the environment. Once capped and revegetated, the MDAs would provide habitat similar to that existing prior to remediation. This option would not directly impact any wetlands or aquatic resources at LANL.

Impacts of MDA and PRS remediation activities to the Mexican spotted owl, bald eagle, and southwestern willow flycatcher were evaluated in a biological assessment prepared by DOE. This assessment determined that, provided reasonable and prudent measures are implemented, remediation activities may affect, but are not likely to adversely affect, the Mexican spotted owl (within MDAs N, Z, A, and AB), bald eagle (within MDA D), and southwestern willow flycatcher (within MDAs G and L). Activities at other MDAs and PRSs at LANL should not impact these species (LANL 2006b). The USFWS has concurred with the findings of the biological assessment (see Chapter 6, Section 6.5.2). Since expansion of the borrow pit could result in the removal of undeveloped buffer and core habitat for the Mexican spotted owl, consultation with the USFWS would be required prior to this activity.

Impacts to ecological resources under the MDA Removal Option would be similar to those described for the Capping Option. While remedial actions would create a disruptive environment for local wildlife in the short term, long-term impacts would likely be beneficial in terms of ecological risk because wastes would be removed. In addition, there would be no restrictions on the types of plants that could be introduced, which would permit reestablishment of more natural conditions that would, in turn, provide habitat for area wildlife (see Appendix I).

Most actions associated with implementing the Security-Driven Transportation Modifications Project would have little or no impact on ecological resources; however, the construction of the two parking lots, a portion of the new road across TA-63, and the highway and pedestrian bridges over the Ten Site branch of Mortandad Canyon would affect undeveloped ponderosa pine forest, open land, and wildlife. Other project elements would largely take place in currently developed areas. As no wetlands exist within Pajarito Corridor West and aquatic resources are not present on the mesa, impacts to these resources would not occur.

The parking lot in TA-63, the road across the eastern edge of TA-63, and the pedestrian and highway bridges fall within buffer habitat of the Mexican spotted owl Areas of Environmental Interest; a portion of the parking lot is within core habitat. A biological assessment performed by DOE determined that up to 18.8 acres (7.6 hectares) of buffer and 1 acre (0.4 hectares) of core Mexican spotted owl habitat could be lost and that the project would generate excess noise or light. The biological assessment concluded that even if reasonable and prudent measures are implemented to mitigate impacts, project activities may affect, and are likely to adversely affect, the Mexican spotted owl (LANL 2006b). However, following review of the biological assessment, the USFWS concluded that impacts to the spotted owl from construction activities associated with the Security-Driven Transportation Modifications Project would be insignificant and discountable, and would not result in adverse effects (see Chapter 6, Section 6.5.2). Additional USFWS consultation would be needed, however, if a land bridge, rather than a span bridge, were constructed.

Land disturbed by the Security-Driven Transportation Modifications Project does not fall within Areas of Environmental Interest for either the bald eagle or southwestern willow flycatcher. However, because the bald eagle forages over all of LANL and some habitat degradation is associated with the project, the biological assessment concluded that provided appropriate reasonable and prudent measures are implemented, the project may affect, but is not likely to adversely affect, the bald eagle. Because the southwestern willow flycatcher Area of Environmental Interest is more than 2 miles (3.3 kilometers) from the project site, the biological assessment concluded that the proposed project would have no effect on this species

(LANL 2006b). The USFWS has concurred with the biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Auxiliary Action A for the Security-Driven Transportation Modifications Project involves construction of a two-lane bridge within a 1,000-foot (300-meter)-wide corridor across Mortandad Canyon and a new two-lane road from the north end of the new bridge westward through TA-60 to connect TA-35 with TA-3. Auxiliary Action B involves construction of a new two-lane bridge that would be constructed within a 1,000-foot (300-meter)-wide corridor across Sandia Canyon and a new two-lane road from the new bridge to connect with East Jemez Road. Construction of the roadways would have minimal impacts on habitat because they generally would follow the existing rights-of-way that have already been disturbed. The road that would be constructed under the second action, however, would require clearing and grading approximately 1.3 acres (0.5 hectares) of ponderosa pine forest. No wetlands or aquatic resources would be directly affected by roadway construction.

Under both auxiliary actions, road and bridge construction would take place within the buffer zone of the Sandia-Mortandad Canyon and Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. Additionally, they would pass through the core zone of the Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest. The biological assessment prepared by DOE determined that Auxiliary Action A would disturb up to 25.3 acres (10.2 hectares) of undeveloped core habitat and 0.1 acres (0.4 hectares) of undeveloped buffer habitat. Under Auxiliary Action B, construction would directly impact up to 37.1 acres (15 hectares) of undeveloped core habitat and 28.7 acres (11.6 hectares) of undeveloped buffer habitat. Further, under both actions construction would cause temporary increases in light and noise which would be permanent once the bridge was operational. The biological assessment concluded that even if reasonable and prudent measures are implemented to mitigate impacts, project activities may affect, and are likely to adversely affect, the Mexican spotted owl (LANL 2006b). Upon review of the biological assessment, the USFWS determined that it could not adequately analyze the affects of the proposed actions since the exact location and design of the bridges have not been determined. Instead the agency requested that DOE submit a request for consultation when plans are finalized (see Chapter 6, Section 6.5.2).

The biological assessment determined that with reasonable and prudent measures, the project may affect, but is not likely to adversely affect, the bald eagle. This determination was made based on the fact that some foraging habitat degradation would be associated with construction. Since the closest southwestern willow flycatcher Area of Environmental Interest is more than 2.3 miles (3.7 hectares) from the nearest construction area, the biological assessment determined that there would be no effect to this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Technical Area Impacts

Two projects are planned that could impact ecological resources within TA-3 and TA-21. These are addressed below.

Technical Area 3

Construction related to the Replacement Office Building Project would involve clearing and grading 13 acres (5.3 hectares) of mixed conifer forest within TA-3, resulting in loss of less mobile wildlife such as reptiles and small mammals and displacing more mobile species such as birds or large mammals. Construction of the new buildings and parking lot would not impact wetlands because none are located in or near the construction zone. Potential impacts to the Mexican spotted owl were evaluated in a biological assessment prepared by DOE. This assessment noted that although 11.2 acres (4.5 hectares) of buffer habitat would be disturbed, if all reasonable and prudent measures are taken, actions associated with the construction may affect, but are not likely to adversely affect, the Mexican spotted owl. The Area of Environmental Interest for the bald eagle does not include any part of TA-3. However, since some bald eagle foraging habitat degradation could be associated with the project, the biological assessment concluded that provided reasonable and prudent measures are implemented, the project may affect, but is not likely to adversely affect, the bald eagle. The nearest southwestern willow flycatcher Area of Environmental Interest is more than 4.6 miles (7.4 kilometers) from the project site. Thus, the biological assessment concluded that the proposed project would have no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to these three species (see Chapter 6, Section 6.5.2).

Operation of the Replacement Office Building complex would likely have minimal impact on terrestrial resources within or adjacent to TA-3 (see Appendix G.2).

Technical Area 21

DD&D of structures at TA-21 would occur within the highly disturbed industrial portion of the TA, which contains little wildlife habitat. Demolition-related disturbances to wildlife would likely be intermittent and localized. After DD&D of the buildings and structures, the site would be contoured and revegetated. Revegetation would have only relatively short-term benefits to wildlife, however, because both the parcel conveyed to Los Alamos County and the parcel retained by DOE could be developed in the future. Elimination of two NPDES-permitted outfalls associated with TA-21 operations would reduce the quantity of surface water discharged to the adjacent canyons.

TA-21 falls within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. Because TA-21 is highly disturbed, no suitable foraging or nesting habitat would be lost as a result of DD&D activities. Because noise levels would increase as a result of demolition activities the biological assessment prepared by DOE concluded that provided reasonable and prudent measures are implemented, DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl. Since no bald eagle nesting or foraging habitat would be lost as a result of DD&D activities and the southwestern willow flycatcher Area of Environmental Interest is more than 2.6 miles (4.2 kilometers) from TA-21, the biological assessment determined that the proposed project would have no effect on either species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to these three species (see Chapter 6, Section 6.5.2).

Key Facilities Impacts

Four projects related to Key Facilities at LANL are planned that could affect ecological resources.

Radiochemistry Facility

Although construction of some of the new facilities associated with the Radiological Sciences Institute would take place on previously disturbed land, it would be necessary to clear about 12.6 acres (5.1 hectares) of ponderosa pine forest at TA-48, which would directly and indirectly impact area wildlife. Construction of the Radiological Sciences Institute would not directly impact wetlands located in Mortandad Canyon or the small wetland situated between TA-48 and TA-55, and best management practices would reduce the potential for indirect impacts. There would be no impact to aquatic resources from construction and operation of the Radiological Sciences Institute.

Portions of TA-48 are located within core and buffer zones of the Sandia-Mortandad Canyon and Pajarito Canyon Mexican spotted owl Areas of Environmental Interest. However, only a small portion of the Radiological Sciences Institute may be built within buffer habitat. Thus, the biological assessment prepared by DOE concluded that with the application of reasonable and prudent measures, the project may affect, but is not likely to adversely affect, the Mexican spotted owl. Areas of Environmental Interest for the bald eagle do not include any part of TA-48 or TA-55. Since some bald eagle foraging habitat degradation is possible with construction of the Radiological Sciences Institute, the biological assessment concluded that with reasonable and prudent measures the project may affect, but is not likely to adversely affect, the bald eagle. The nearest southwestern willow flycatcher Area of Environmental Interest is over 3 miles (4.8 kilometers) from the project site. Thus, it was determined that there would be no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to these three species (see Chapter 6, Section 6.5.2).

Removal of existing buildings and structures at TA-48, as well as those to be replaced by the Radiological Sciences Institute, would generate increased noise and levels of human disturbance. These impacts would be temporary, however, and would likely have minimal effect on wildlife because these structures exist within previously disturbed areas and wildlife in adjacent areas is accustomed to human activity. As wetlands do not exist in the immediate area of any of the buildings to be replaced by the new Radiological Sciences Institute, there would be no direct impacts on this resource. Of the buildings to be demolished in connection with the Radiological Sciences Institute project, only those located in TA-35 are located in developed core habitat for the Mexican spotted owl. The removal of these buildings could produce increased noise levels in undeveloped core habitat. However, the biological assessment concluded that demolition may affect, but is not likely to adversely affect, the Mexican spotted owl, provided that reasonable and prudent measures are followed. DD&D activities would have no effect on the bald eagle and southwestern willow flycatcher (LANL 2006b). The USFWS has concurred with the biological assessment as it relates impacts to these three species (see Chapter 6, Section 6.5.2).

Radioactive Liquid Waste Treatment Facility

No impacts to terrestrial resources or wetlands would be expected from implementing any of the alternatives for the Radioactive Liquid Waste Treatment Facility upgrade because it is located within a highly developed industrial area of TA-50. However, the evaporation tanks and pipeline that are proposed as an auxiliary action to this project would be located in undeveloped core and buffer habitat of the Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest. The biological assessment prepared by DOE determined that the tanks and pipeline would remove 3.1 acres (1.3 hectares) of undeveloped buffer habitat and 2.3 acres (0.9 hectares) of undeveloped core habitat. It was also determined that construction of the Radioactive Liquid Waste Treatment Facility would likely raise noise levels in the core zone. The biological assessment concluded that with the application of reasonable and prudent measures the project may affect, but is not likely to adversely affect, the Mexican spotted owl. The bald eagle Area of Environmental Interest is not located near the proposed project site; however, because the entire LANL site is considered potential bald eagle foraging habitat there may be some habitat degradation associated with the project. Provided reasonable and prudent measures are implemented, the biological assessment concluded that construction may affect, but is not likely to adversely affect, the bald eagle. The proposed project is not within or upstream of the southwestern willow flycatcher Area of Environmental Interest; thus, the project would not effect this species (LANL 2006b). The USFWS has concurred with the DOE biological assessment as it relates to these three species (see Chapter 6, Section 6.5.2). Implementation of the evaporation tank option would likely reduce the extent of perennial and intermittent stream reaches, associated wetlands, and riparian habitat, which would reduce the abundance and diversity of prey species for the Mexican spotted owl. Significant adverse impacts to the Mexican spotted owl, however, are not expected.

Solid Radioactive and Chemical Waste Facilities

Under both the options proposed as part of Waste Management Facilities Transition activities within TA-54, including new construction and removal of the white-colored domes, all activities would occur within developed areas. Thus, there would be little to no impact on ecological resources. Although TA-54 includes a portion of the southwestern willow flycatcher Area of Environmental Interest, the area within which project related activities would take place is located about 450 feet (137 meters) from the core habitat. Provided reasonable and prudent measures are implemented, the biological assessment prepared by DOE concluded that the project may affect, but is not likely to adversely affect, the southwestern willow flycatcher. With respect to the bald eagle and Mexican spotted owl, the biological assessment determined that there would be no effect on either species as a result of implementing the proposed project. This is the case since the site does not include any portion of Areas of Environmental Interest for these species, foraging habitat would not be disturbed, and noise levels would be low (LANL 2006b). The USFWS has concurred with this assessment as it relates to these three species (see Chapter 6, Section 6.5.2).

The proposed TRU Waste Facility could be located within a generic area in the Pajarito Road corridor selected from among a number of TAs, and would disturb about 2.5 to 7 acres (1 to 2.8 hectares) of land. In most cases this would involve the removal of ponderosa pine forest or open field habitat; however, the generic site within TA-54 West is developed. Impacts to wetlands and aquatic resources from this project would not be expected.

At least some portion of either the core or buffer zone of Mexican spotted owl Areas of Environmental Interest would be affected by construction of the new facility within all generic sites except in TA-48, TA-51, and TA-54 West. For those generic sites where the new facility has the potential to affect the spotted owl, either directly or indirectly (for example, by excess noise or light), it would be necessary to conduct a biological assessment and initiate formal consultation with the USFWS. None of the generic sites are within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Pajarito Site

DD&D of facilities at TA-18 would have little impact on wildlife habitat because the facilities are located within areas that are developed and fenced. Animals could be intermittently disturbed by activity and noise during the demolition period. Implementation of best management practices during demolition would prevent potentially sediment-laden runoff from reaching the wetland located at the eastern end of TA-18. Ultimately, previously disturbed areas would be restored using native species, which would benefit area wildlife.

DD&D of buildings and structures at TA-18 would not directly impact the Mexican spotted owl because all activities would take place within developed areas. However, the biological assessment performed by DOE noted that noise levels in the core zone would be elevated above background levels. The biological assessment concluded that with the implementation of reasonable and prudent measures, DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl. With respect to the bald eagle, DD&D of TA-18 facilities would have no effect since the project would not remove any bald eagle foraging habitat. While the project would take place upstream from the southwestern willow flycatcher Area of Environmental Interest, it was determined that with the application of reasonable and prudent measures, the project may affect, but is not likely to adversely affect, the southwestern willow flycatcher (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to these three species (see Chapter 6, Section 6.5.2).

Biosciences Facilities

Construction of the Science Complex would involve clearing and grading approximately 5 acres (2 hectares) of ponderosa pine forest under the Northwest TA-62 and Research Park Site options, which would result in loss and displacement of wildlife. Indirect impacts from construction, such as noise or human disturbance, could also impact wildlife. Construction of the new buildings and parking structure would not impact wetlands because none are located in or near the construction zone under either option. Operation of the Science Complex would minimally impact terrestrial resources because wildlife residing in the area has already adapted to levels of noise and human activity associated with development in the general area. Impacts to ecological resources would be minimal under the South TA-3 option because the area is already partially developed and is within the more developed part of TA-3.

Under the Northwest TA-62 Option a portion of the project area falls within the core and buffer zone of the Los Alamos Canyon Area of Environmental Interest for the Mexican spotted owl. The biological assessment prepared by DOE determined that construction would remove some undeveloped core habitat and buffer habitat. Further, the project would potentially increase noise levels in the core zone. The biological assessment noted that provided all reasonable and prudent measures are implemented, the project may affect, but is not likely to adversely affect, the Mexican spotted owl. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher are not located near the proposed Northwest TA-62 Science Complex location. However, because the bald eagle forages over all of LANL and some habitat degradation associated with construction could occur, the biological assessment concluded that with reasonable and prudent measures, the project may affect, but is not likely to adversely affect, the bald eagle. The nearest southwestern willow flycatcher Area of Environmental Interest is not within or downstream of the project site; thus, there would be no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to these three species (see Chapter 6, Section 6.5.2). Although the Research Park Site Option was not addressed in the biological assessment, the site is not within an Area of Environmental Interest for the Mexican spotted owl, bald eagle, or willow flycatcher. Thus, impacts to these species under this option would not be expected.

Warehouse and Truck Inspection Station

The proposed project would include clearing and grading approximately 4 acres (1.6 hectares) of ponderosa pine forest and pinyon-juniper woodland, which would result in loss and displacement of wildlife. Indirect impacts from construction, such as noise or human disturbance, could also impact wildlife. Operation of the proposed Remote Warehouse and Truck Inspection Station would not likely pose significant adverse effects to area wildlife. The new facility would not be located within Areas of Environmental Interest for the Mexican spotted owl, bald eagle, or southwestern willow flycatcher. However, because the bald eagle forages over all of LANL and some habitat degradation associated with construction could occur, the biological assessment prepared by DOE concluded that with appropriate reasonable and prudent measures, the project may affect, but is not likely to adversely affect, the bald eagle. The biological assessment further concluded that there would be no effect on the Mexican spotted owl or southwestern willow flycatcher (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

5.6 Human Health

5.6.1 Radiological Impacts on the Public

People can be exposed to radiation through a variety of ways. Airborne radioactive particles can be inhaled. Radioactive particles can be ingested if they are on the surface of food or if the food was produced in areas that are contaminated with radioactive material that can be taken up by plants and animals. The body can be directly exposed to radiation from radionuclides in air emissions or from proximity to radioactive materials that have been deposited on the ground. Radiation also can enter the body through skin breaks. Estimates were made of the amount of radioactive materials to which the public could be exposed due to LANL radioactive air emissions (see Section 5.4.2). Using these estimates, radiation doses from LANL operations to the public and at certain receptor locations were calculated (details can be found in Appendix C).

The total annual radiation dose received by an individual is a combination of the potential dose received from LANL operations and the doses received from other radiation sources such as naturally occurring background radiation, medical radiation, and radiation from other nuclear activities. A challenge in measuring dose is that no person has the same actual exposure rate as any other. Because of this, health impacts analyses often evaluate the upper bound for individual exposure, which is expressed as the potential dose to the hypothetical MEI. For this analysis, the MEI is a hypothetical person who is assumed to remain in place outdoors without shelter and without taking any protective action for the entire period of exposure. In reality, no one would receive a dose approaching that of an MEI, but the concept is useful as an expression of the upper bound of any possible dose to an individual.

Historical data and capabilities were reviewed for the *1999 SWEIS* to determine which LANL facilities would be analyzed as Key Facilities. For this new SWEIS, changes to those capabilities and past emissions determined which facilities would remain designated as Key Facilities. **Table 5–15** lists those Key Facilities used in the human health analyses of this SWEIS.

Table 5–15 List of Facilities Modeled for Radionuclide Air Emissions from Los Alamos National Laboratory

Key Facility Name	*Technical Area/Building*
Chemistry and Metallurgy Research Building	TA-3-29
Sigma Complex	TA-3-66
Machine Shops	TA-3-102
High Explosives Processing Facilities	TA-11
High Explosives Testing Facilities	TA-15/36
Tritium Facilities [a]	TA-16
Pajarito Site	TA-18
Radiochemistry Facility	TA-48
LANSCE	TA-53
Solid Radioactive and Chemical Waste Facilities [b]	TA-54
Plutonium Facility Complex	TA-55
Non-Key Facilities	TA-21

TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] This facility includes the Weapons Engineering Tritium Facility (TA-16). The Tritium Science Fabrication Facility and Tritium System Test Assembly at TA-21 continue to have emissions while awaiting DD&D, and are included under the non-Key Facilities.

[b] Includes MDA G and the Decontamination and Volume Reduction System.

Some facilities that have historically low emission rates are unmonitored. These unmonitored point sources receive periodic confirmatory measurements by LANL personnel to verify that emissions remain low. The *1999 SWEIS* analyzed air emissions data from TA-50-1 (Radioactive Liquid Waste Treatment Facility) and confirmed that air emissions were “insignificant relative to other sources at LANL” (LANL 1997b), so the public dose from those emissions was not analyzed. For this new SWEIS, air emissions data from the Radioactive Liquid Waste Treatment Facility were again reviewed for the period from 1999 to 2004. This review of actual radiological air emissions showed a decreasing trend since 1992, with a low of 7.9×10^{-8} curies per year recorded in 2004. The six-year average for TA-50 emissions during that period

(1.1×10^{-7} curies) is far less than emissions from LANSCE (2,700 curies), the major contributor to the public dose. It is anticipated that air emissions data would remain the same for the purposes of analyses presented in this new SWEIS, and therefore would result in insignificant health-related impacts to the public compared to other sources.

To calculate these doses for this new SWEIS, the Clean Air Act Assessment Package – 1988 (CAP-88) software was used. CAP-88 is an EPA-approved computer model for calculating the effective dose equivalent to members of the public, as required by emission monitoring and compliance procedures for DOE facilities [40 CFR 61.93 (a)]. CAP-88 uses modified Gaussian plume equations to estimate the average dispersion of radionuclides released to the air from up to six emitting sources. The program computes radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food, and intake rates to people from ingestion of food produced in the assessment area.

For this SWEIS, an estimated dose to the facility-specific MEI was calculated for each modeled facility. The location of each facility-specific MEI is where the dose from that facility's emissions to a member of the public would be largest, and is based on wind direction and meteorological data for that facility. **Table 5–16** shows the distance and direction from each facility to its facility-specific MEI. Doses from all modeled facilities were calculated at the facility-specific MEI location; thus, the dose to the facility-specific MEI represents the estimated dose to an individual from the specific facility and all other modeled facilities. The LANL site-wide MEI is the single highest facility-specific MEI; therefore, any other facility-specific MEI doses would be less than the LANL site-wide MEI for the alternative under analysis.

Table 5–16 Distance and Direction from Key Facilities to the Facility-Specific Maximally Exposed Individual

Key Facility	*MEI Distance Feet (meters)*	*MEI Direction*
Chemistry and Metallurgy Research Building (TA-3–29)	3,575 (1,090)	N
Sigma Complex (TA-3–66)	3,560 (1,085)	N
Machine Shops (TA-3–102)	3,380 (1,030)	N
High Explosives Processing Facilities (TA-11)	4,300 (1,311)	S
High Explosives Testing Facilities (TA-15/36)	7,415 (2,260)	NE
Tritium Facilities (TA-16)	2,885 (879)	SSE
Pajarito Site (TA-18)	2,820 (860)	NE
Radiochemistry Facility (TA-48)	2,920 (890)	NNE
LANSCE (TA-53)	2,625 (800)	NNE
Solid Radioactive and Chemical Waste Facilities (TA-54)	1,195 (364)	NE
Plutonium Facility Complex (TA-55)	3,690 (1,125)	N
Non-Key Facilities (TA-21)	1,050 (320)	N

MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

Population dose estimates were made for the entire population within a 50-mile (80-kilometer) radius of LANL by summing the estimated doses to all people within that radius. The population dose from each facility was modeled independently for each alternative. The total dose from all facilities for one alternative represents the projected population dose from implementing that alternative.

In addition to dose, estimates of risk to the public and the MEI were calculated. Scientists and decisionmakers quantify relationships among risks by using mathematical probabilities. In this SWEIS, risks are defined in terms of the number of additional latent cancer fatalities (excess LCFs due to the estimated dose) from LANL operations. The number of additional LCFs is calculated as the product of the dose in units of person-rem and the risk factor (0.0006 LCF per person-rem). These estimates are intended to be conservative measures of the potential public health impacts of the three alternatives for use in the decisionmaking process; they do not necessarily accurately represent actual anticipated fatalities.

Tables 5–17 and **5–18** summarize the projected public doses resulting from normal operations under each alternative for both an MEI near LANL property and the general population within 50 miles (80 kilometers) of LANL. The potential impact from shutdown of LANSCE operations under the Reduced Operations Alternative would substantially decrease the dose to the general public and to the MEI. Under all of the alternatives, the MEI would receive a smaller dose than the exposure limits set by DOE and EPA.

Table 5–17 Summary of Projected Doses to the Maximally Exposed Individual from Normal Operations at Los Alamos National Laboratory (millirem per year)

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site-Wide			
Dose from MDA remediation only to LANL Site-Wide MEI	Not applicable	Not applicable	less than 0.42 [b]
Key Facilities [a], includes contributions from:			
CMR Building	0.011	0.0034	0.011
Sigma Complex	0.0041	0.0060	0.0041
Machine Shops	0.00032	0.00045	0.00032
High Explosives Processing Facilities	1.3×10^{-6}	1.8×10^{-6}	1.3×10^{-6}
High Explosives Testing Facilities	0.25	0.72	0.25
Tritium Facilities	0.0036	0.0045	0.0036
Pajarito Site	0.0070	0.0080 [c]	0.0070 [c]
Radiochemistry Facility	0.00029	0.00050	0.00029
LANSCE [d]	7.5	0	7.5
Solid Radioactive and Chemical Waste Facilities	0.0012	0.0012	0.0012 [e]
Plutonium Facility Complex	0.012	0.024	0.012
Non-Key Facility (TA-21)	0.012	0.0071	0.012 [f]
Total LANL Site-Wide MEI Dose	7.8	0.78	Less than 8.2 [b]

MDA = material disposal area, MEI = maximally exposed individual, CMR = Chemistry and Metallurgy Research, LANSCE = Los Alamos Neutron Science Center, TA = technical area.

[a] Under the No Action and the Expanded Operations Alternatives, the LANL site-wide MEI would be located near LANSCE. Under the Reduced Operations Alternative, the LANL site-wide MEI would be located near the High Explosives Testing (Firing Sites) at TA-36.

[b] This dose could be smaller depending on which MDA is being remediated, whether the MDA is being capped or removed, the number of MDAs being remediated at one time, and whether exhumation occurs under an enclosure (see Appendix I).

[c] Dose would be zero following shutdown of Pajarito Site (TA-18) after about 2009.

[d] The maximum dose to the MEI as a result of emissions from LANSCE would be limited to 7.5 millirem per year using administrative controls.

[e] This dose could increase to 0.0018 millirem per year if the Decontamination and Volume Reduction System, the new TRU Waste Facility, and remote-handled transuranic waste retrieval and processing activities operated simultaneously (estimated to occur from 2012 through 2015).

[f] Dose would be zero following decontamination, decommissioning, and demolition of TA-21 after about 2009.

Table 5–18 Summary of Projected Doses to the General Public Within 50 Miles (80 kilometers) of Los Alamos National Laboratory from Normal Operations (person-rem per year)

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site-Wide			
Dose from MDA remediation	Not applicable	Not applicable	Less than 6.2 [a]
Key Facilities, includes contributions from:			
CMR Building	0.43	0.11	0.43
Sigma Complex	0.16	0.16	0.16
Machine Shops	0.01	0.01	0.01
High Explosives Processing Facilities	0.00005	0.00004	0.00005
High Explosives Testing Facilities	6.4	5.2	6.4
Tritium Facilities	0.09	0.09	0.09
Pajarito Site	0.23	0.23 [b]	0.23 [b]
Radiochemistry Facility	0.01	0.01	0.01
LANSCE	22	0	22
Solid Radioactive and Chemical Waste Facilities	0.04	0.04	0.04 [c]
Plutonium Facility Complex	0.19	0.19	0.20
Non-Key Facility (TA-21)	0.09	0.09	0.09 [d]
Total Dose to General Population	**30**	**6.1**	**Less than 36.2 [a]**

MDA = material disposal area, CMR = Chemistry and Metallurgy Research, LANSCE = Los Alamos Neutron Science Center, TA = technical area.

[a] This dose could be smaller depending on which MDAs are being remediated, whether the MDA are being capped or removed, the number of MDAs being remediated at one time, and whether exhumation occurs under an enclosure (see Appendix I).

[b] Dose would be zero following shutdown of Pajarito Site (TA-18) after about 2009.

[c] This dose could increase to 0.06 person-rem per year if the Decontamination and Volume Reduction System, the new TRU Waste Facility, and remote-handled transuranic waste retrieval and processing activities operated simultaneously (estimated to occur from 2012 through 2015).

[d] Dose would be zero following decontamination, decommissioning, and demolition of TA-21 after about 2009.

5.6.1.1 No Action Alternative

Annual doses to the general public and the MEI under the No Action Alternative are generally projected to remain at levels similar to those projected in the *1999 SWEIS* Expanded Operations Alternative. The projected doses for the MEI and population are dominated by estimated emissions from operations at LANSCE. The projected doses also reflect the expected relocation of certain tritium capabilities from the Chemistry and Metallurgy Research Building to the Plutonium Facility Complex as well as the change in operating levels as the Tritium Facilities (TA-21) begin DD&D.

Los Alamos National Laboratory Site-Wide Impacts

The projected annual collective dose to the population living within a 50-mile (80-kilometer) radius of LANL could be as high as 30 person-rem for the No Action Alternative. Nearly all of this dose (greater than 99 percent) would result from Key Facilities operations; the remaining contribution would come from non-Key Facility operations. Overall, the projected dose of 30 person-rem would result in no additional fatalities in the affected population (0.018 LCFs). The doses to the general public and an MEI under the No Action Alternative are presented in

Table 5–19. To put the doses into perspective, comparisons with natural background radiation levels are included in the table.

Table 5–19 Annual Radiological Impacts on the Public from Los Alamos National Laboratory Operations under the No Action Alternative

	Population within 50 Miles (80 kilometers) [a]	*Maximally Exposed Individual*
Dose	30 person-rem	7.8 millirem (LANSCE MEI) [b]
Latent cancer fatality risk [c]	0.018	4.7×10^{-6}
Regulatory dose limit [d]	Not applicable	10 millirem
Dose as a percent of regulatory limit	Not applicable	78
Dose from background radiation [e]	135,000 person-rem	400 millirem
Dose as a percent of background dose	0.02	2

LANSCE = Los Alamos Neutron Science Center, MEI = maximally exposed individual.
[a] The population estimated to be living within 50 miles (80 kilometers) of each Key Facility is unique for each facility. The year 2000 estimates range from 271,568 to 404,913, depending on the facility used.
[b] As a mitigating measure, operational controls at LANSCE would limit the MEI dose to 7.5 millirem per year.
[c] Based on a risk estimate of 0.0006 LCF per person-rem.
[d] 40 CFR Part 61 establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.
[e] The annual individual dose from natural background radiation at LANL ranges from a low of about 300 to a high of about 500 millirem (see Appendix C).

Under this alternative, the LANL site-wide MEI would be located approximately 2,625 feet (800 meters) north-northeast of LANSCE. This is the location where the dose resulting from emissions from all Key Facilities would be the highest. The annual dose to the MEI under this alternative could be up to 7.8 millirem. This projected dose corresponds to an increased risk of the MEI developing a fatal cancer due to LANL operations under the No Action Alternative of about 1 in 213,000 (4.7×10^{-6}) per year.

Specific Receptors

In addition to potential impacts to the public from the air exposure pathway, the risk to individuals from ingestion of water, foodstuffs, and soils is analyzed in Appendix C. These three individual scenarios, collectively referred to as “specific receptors,” include a Los Alamos County resident whose entire diet consists of locally produced foodstuffs, a user of outdoor recreational resources, and a special pathways receptor who relies heavily on fish and wildlife for subsistence. Using the average consumption rates, **Table 5–20** presents the projected doses to these individuals and the associated risks of developing a fatal cancer. Doses from a high consumption rate were also analyzed and detailed in their respective tables in Appendix C. The total doses to each receptor as a result of the potential consumption at these higher rates would be increased by a factor of less than three.

Table 5–20 Annual Ingestion Pathway Dose for Average Consumption Rates by Specific Receptors

	Dose (millirem)	*Cancer Fatality Risk* [a]
Offsite county resident	2.7	1.6×10^{-6}
Recreational resources user	4.0	2.4×10^{-6}
Special pathways receptor	4.5	2.7×10^{-6}

[a] Based on a risk estimate of 0.0006 LCF per person-rem.

The associated LCF risks resulting from the doses shown in Table 5–20 would be about 1 in 230,000 for the offsite county resident, 1 in 180,000 for the recreational resources user, and 1 in 156,000 for the special pathways receptor per year. These doses from ingestion would be almost entirely due to naturally occurring radioactivity in the environment and contamination in water and soils from worldwide fallout and past LANL operations. The contribution to ingestion pathway doses from current and projected future LANL operations tends to be extremely small by comparison, largely due to the more stringent effluent control and waste management practices now in use. Accordingly, these ingestion pathway dose and risk values are expected to remain essentially unchanged for some time and would apply to all three alternatives.

Technical Area Impacts

No measurable doses to the population or the site-wide MEI are expected to result from TA impacts under the No Action Alternative outside those associated with Key Facilities operations (as discussed below).

Key Facility Impacts

Los Alamos Neutron Science Center

Nearly all of the calculated MEI dose (96 percent) under the No Action Alternative would be attributable to gaseous mixed activation products from operations at LANSCE. Because of the close proximity of the LANSCE facility to the LANL site boundary, gaseous mixed activation product emissions remain the largest source of offsite dose from the airborne pathway. As a mitigating measure, administrative controls have been established at LANSCE that regulate beam operations as emissions levels increase. These controls require operational changes to prevent the generation of excessive radioactive air emissions so that the maximum dose to the LANL site-wide MEI from air emissions at LANSCE is 7.5 millirem per year, or less. The remainder of the dose to the LANL site-wide MEI as a result of LANL operations at all other Key Facilities (0.3 millirem per year) is small compared to that from operations at LANSCE.

5.6.1.2 Reduced Operations Alternative

Under the Reduced Operations Alternative, a major decrease in doses to the public compared to those under the No Action Alternative would result from lack of radiological air emissions from LANSCE after potential shutdown. Doses lower than those under the No Action Alternative also would be expected from reductions in high explosives processing and testing operations, and from reduced emissions from the Chemistry and Metallurgy Research Building. In 2009, shutdown of Pajarito Site (TA-18) operations would further reduce doses to the public.

Los Alamos National Laboratory Site-Wide Impacts

The projected annual collective dose to the population living within a 50-mile (80-kilometer) radius of LANL, as shown in **Table 5–21,** could be as high as 6.1 person-rem under the Reduced Operations Alternative. Nearly all of this dose (greater than 98 percent) would come from Key Facilities operations, and the remaining contribution would come from non-Key Facility operations. Overall, the projected annual collective dose of 6.1 person-rem would produce no additional fatalities in the affected population (0.0038 LCFs).

Table 5–21 Annual Radiological Impacts on the Public from Los Alamos National Laboratory Operations under the Reduced Operations Alternative

	Population within 50 Miles (80 kilometers) [a]	*Maximally Exposed Individual*
Dose [b]	6.1 person-rem	0.78 millirem (TA-36 MEI)
Latent cancer fatality risk [c]	0.0037	4.7×10^{-7}
Regulatory dose limit [d]	Not applicable	10 millirem
Dose as a percent of regulatory limit	Not applicable	7.8
Dose from background radiation [e]	135,000 person-rem	400 millirem
Dose as a percent of background dose	0.005	0.2

TA = technical area, MEI = maximally exposed individual, MDA = material disposal area.

[a] The population estimated to be living within 50 miles (80 kilometers) of each Key Facility is unique for each facility. The year 2000 estimates range from 271,568 to 404,913, depending on the facility used.

[b] Shutdown of TA-18 in about 2009 would result in a decrease in the population dose of 0.23 person-rem and a negligible decrease in the MEI dose.

[c] Based on a risk estimate of 0.0006 LCF per person-rem.

[d] 40 CFR Part 61 establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.

[e] The annual individual dose from natural background radiation at LANL ranges from a low of about 300 to a high of about 500 millirem (see Appendix C).

The LANL site-wide MEI under this alternative would be located 7,415 feet (2,260 meters) northeast of the High Explosives Testing Facilities at TA-36. This is the location where the dose resulting from emissions from all Key Facilities would be the highest. The estimated dose to this MEI would be 0.78 millirem per year for the foreseeable future. This projected dose corresponds to an increased risk of the MEI developing a latent fatal cancer as a result of LANL operations under the Reduced Operations Alternative of about 1 in 2.1 million (4.7×10^{-7}) per year.

Specific Receptors

The risk to the public specific receptors from ingestion of foodstuffs and water under the Reduced Operations Alternative does not differ from that described under the No Action Alternative, as most of the risk is attributable to existing levels of contamination, not future operations at LANL.

Technical Area Impacts

No measurable doses to the population or the site-wide MEI are expected to result from TA impacts under the Reduced Operations Alternative other than those associated with Key Facilities operations (discussed below).

Key Facility Impacts

Los Alamos Neutron Science Center

Under this alternative, operations at LANSCE would not be active and high explosives processing and testing would be reduced by 20 percent, resulting in a 79 percent reduction in the total projected dose to the population compared to the dose for the No Action Alternative.

High Explosives Testing Facilities

Long-lived uranium isotope emissions from the reduced level of activities at the High Explosives Testing Facilities at TA-15 and TA-36 would produce the majority of the population dose (80 percent). Because the location of the LANL site-wide MEI under the Reduced Operations Alternative would change from the location of the MEI associated with the No Action Alternative, the dose contributions from each Key Facility to the new MEI location would be different. For instance, although there is a 20 percent reduction in high explosives testing under the Reduced Operations Alternative, the dose to the LANL site-wide MEI from operations at the High Explosives Testing Facilities under this alternative is projected to be 0.72 millirem per year, compared to a dose of 0.25 millirem from high explosives testing under the No Action Alternative. In fact, more than 90 percent of the dose to the MEI under the Reduced Operations Alternative would come from emissions of uranium isotopes produced at the High Explosives Testing Facilities.

Pajarito Site

After about 2009, a decrease in the population dose of 0.23 person-rem per year would result from permanent shutdown of operations at the Pajarito Site (TA-18). The population dose from the Reduced Operations Alternative would therefore decline by approximately 4 percent.

Chemistry and Metallurgy Research Building

Limited operation of the Chemistry and Metallurgy Research Building under this alternative would decrease the dose to the population surrounding LANL population by 0.32 person-rem, which is reflected in the estimated population dose of 6.1 person-rem per year.

5.6.1.3 Expanded Operations Alternative

Under the Expanded Operations Alternative, there would be increased levels of activities at certain facilities in addition to construction projects, as well as some reduced activities. Operations resulting from LANSCE's refurbishment could increase air emissions, including radiological emissions (and consequential dose), due to enhanced operational availability of the accelerator facilities. There also would be an increase in pit production within the Plutonium Facility Complex (TA-55), up to 80 pits per year, which would produce additional radiological air emissions. Under this alternative, there could be an additional temporary or one-time dose to the public from removal of waste from the MDAs, which would last until MDA exhumations are completed. Actions proposed under this alternative that would result in smaller doses include completion of DD&D of buildings at TA-21 and shutdown of SHEBA operations at TA-18.

Los Alamos National Laboratory Site-Wide Impacts

The projected annual collective dose to the population living within a 50-mile (80-kilometer) radius of LANL, as shown in **Table 5–22,** could be as high as 36 person-rem for the Expanded Operations Alternative; 30 person-rem of that total dose would come from operations at the Key Facilities and the remaining 6 person-rem from removal activities at the various MDAs. Overall, the projected dose of 36 person-rem would result in no additional fatalities in the affected population (0.022 LCFs).

Table 5–22 Annual Radiological Impacts on the Public from Los Alamos National Laboratory Operations under the Expanded Operations Alternative

	Population within 50 Miles (80 kilometers) [a]	***MEI***
Dose [b]	36 person-rem	8.2 millirem (LANSCE MEI) [c]
Latent cancer fatality risk [d]	0.022	4.9×10^{-6}
Regulatory dose limit [e]	Not applicable	10 millirem
Dose as a percent of regulatory limit	Not applicable	82
Dose from background radiation [f]	135,000 person-rem	400 millirem
Dose as a percent of background dose	0.027	2.1

LANSCE = Los Alamos Neutron Science Center, MEI = maximally exposed individual, MDA = material disposal area.

[a] The population estimated to be living within 50 miles (80 kilometers) of each Key Facility is unique for each facility. The year 2000 estimates range from 271,568 to 404,913, depending on the facility used.

[b] These reflect the additional doses to the public from remediation of the larger MDAs and the simultaneous operation of the Decontamination and Volume Reduction System, the new TRU Waste Facility, and remote-handled transuranic waste retrieval and processing activities. The shutdown of TA-18 and TA-21 in about 2009 would result in a decrease in population dose of 0.32 person-rem and a negligible decrease in MEI dose.

[c] As a mitigating measure, operational controls at LANSCE would limit the MEI dose to 7.5 millirem per year. Population and MEI doses are projected at 6.2 person-rem and 0.42 millirem respectively, and are attributable to MDA remediation.

[d] Based on a risk estimate of 0.0006 LCF per person-rem.

[e] 40 CFR Part 61 establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.

[f] The annual individual dose from natural background radiation at LANL ranges from a low of about 300 to a high of about 500 millirem.

Under this alternative, the LANL site-wide MEI would be located 2,625 feet (800 meters) north-northeast of LANSCE. This is the location where the dose resulting from emissions from all Key Facilities would be the highest. Including the additional dose from remediation activities at the MDAs under this Alternative could bring the MEI dose to about 8.2 millirem. This projected dose corresponds to an increased risk of developing a latent fatal cancer for the MEI from LANL operations under the Expanded Operations Alternative of about 1 in 203,000 (4.9×10^{-6}) per year.

The various effects of radiological air emissions from the major MDA remediation activities, canyon cleanups, and other Consent Order actions could range from small long-term to temporary short-term doses to the public under the Expanded Operations Alternative. Under the MDA Capping Option, although the waste would remain in place, the long-term doses to the public would be reduced. The potential for radionuclides to be dispersed into the air would be reduced by the improved covers, which also would reduce doses. The MDA Removal Option would result in lower long-term risks to the public because the bulk of the contamination would be removed from the site. In the short term, however, the release of radionuclides into the air during removal could result in higher radiological doses to the public. If that removal took place under an enclosure, radiological air emissions would be filtered before exiting the structure, resulting in lower short-term doses to the public.

Under the MDA Removal Option, various radiological air emissions could be released depending on the inventory of radionuclides at the MDA being remediated and whether the removal was performed under an enclosure. These removal activities would be completed within a finite time of a few months to several years, depending on the MDA. For that specified amount of time, there would be an additional dose to the public resulting from emissions released during the removal of the MDA. There are several large MDAs to be remediated. The total estimated dose to the public (6.2 person-rem per year) within 50 miles (80 kilometers) of operations at LANL under this alternative is based on a conservative assumption that all MDAs would be exhumed at the same time.

The same factors—the inventory of radionuclides present in a given MDA and whether or not an enclosure is used—would affect the dose to the MEI. In addition, the location of the MDA being remediated could affect the dose an MEI would receive. The impacts of remediating the MDAs on the LANL site-wide MEI were analyzed in Appendix I. Removal activities at each MDA could contribute to the dose received by the LANL site-wide MEI under the Expanded Operations Alternative, who is assumed to be located northeast of LANSCE near the East Gate. Assuming *all* the large MDAs were remediated at the same time, the portion of the estimated dose to the LANL site-wide MEI contributed by MDA removal activities would be no more than 0.42 millirem in any given year.

Specific Receptors

The risk to the public specific receptors from ingestion of foodstuffs and water under the Expanded Operations Alternative would not differ from that described under the No Action Alternative, as most of the risk is attributable to the existing levels of contamination, not future operations at LANL.

Technical Area Impacts

No measurable doses to the population or the site-wide MEI are expected to result from TA impacts under the Expanded Operations Alternative apart from those associated with Key Facilities operations (discussed below) or MDA remediation activities (discussed above).

Key Facility Impacts

Under the Expanded Operations Alternative, impacts to the public from activities at the Key Facilities, including both increases in some activities and decreases in others, would be similar to those under the No Action Alternative. The change in the location of emissions from the Chemistry and Metallurgy Research Building in TA-3 to the Chemistry and Metallurgy Research Replacement Facility in TA-55 would have little effect on doses to the public compared to impacts from operations at LANSCE. Increased pit production at the Plutonium Facility Complex in TA-55 would cause a small increase in emissions, but the resulting doses to the public would be relatively small compared to the contribution from activities at LANSCE. Similarly, if the evaporation tank auxiliary action were implemented under the Radioactive Liquid Waste Treatment Facility Upgrade, the doses that would result from the tank air emissions (primarily tritium) would be small and bounded by the impacts from other key facilities.

Los Alamos Neutron Science Center

Over 60 percent of the projected population dose (22.3 person-rem per year) would result from radiological air emissions from LANSCE (TA-53). Similar to the No Action Alternative, the majority of the dose to the LANL site-wide MEI under the Expanded Operations Alternative would result from emissions of gaseous mixed activation products from operations at LANSCE.

Because of the close proximity of LANSCE to the LANL site boundary, gaseous mixed activation product emissions remain the greatest source of offsite dose via the airborne pathway. If the LANSCE Refurbishment Project were implemented, the dose from air emissions at LANSCE to the LANL site-wide MEI could potentially increase. As described in the No Action Alternative (see Section 5.6.1.1), however, the dose to the LANL site-wide MEI from air emissions at LANSCE would be limited by operational controls to 7.5 millirem per year.

High Explosives Testing Facilities

An additional 18 percent of the dose (6.4 person-rem per year) to the public would come from operations at the High Explosives Testing Facilities (TA-15 and TA-36).

Solid Radioactive and Chemical Waste Facilities

Implementation of the Waste Management Facilities Transition Project would result in relatively small additional impacts to the population near LANL. From 2012 through 2015, there would be a potential for simultaneous operation of the Decontamination and Volume Reduction System, the new TRU Waste Facility, and remote-handled transuranic waste retrieval and processing activities. Resulting impacts to the population from operations of these systems during this time would be negligible (an additional 0.02 person-rem per year) and are included in Table 5–22. Long-term impacts to the public would include a reduction in dose due to eventual removal of stored wastes in Area G.

Plutonium Facility Complex

The higher level of activity at the Plutonium Facility Complex associated with increased pit production also would result in a small increase in the dose to the public to 0.20 person-rem per year. The higher level of activity at the Plutonium Facility Complex associated with increased pit production would cause a negligible increase in the dose to the LANL site-wide MEI (less than 0.001 millirem).

Pajarito Site and Tritium Facilities

The estimated population dose would decrease slightly (by 0.32 person-rem per year) due to the permanent elimination of emissions from activities at the Pajarito Site at TA-18 and the Tritium Facility at TA-21 which is expected to occur in about 2009. The lack of activity at the Pajarito Site (TA-18) and the Tritium Facility (TA-21) would have a small effect (a decrease of 0.02 millirem per year) on the dose to the MEI compared to the dose from operations at LANSCE (7.5 millirem per year).

5.6.2 Chemical Impacts on the Public

5.6.2.1 No Action Alternative

Key Facilities

The combined cancer risk due to all carcinogenic pollutants from all TAs, as analyzed in the *1999 SWEIS*, was dominated by chloroform emissions expected from the Bioscience Facilities (formerly the Health Research Laboratory) (see **Tables 5–23** and **5–24**). Assuming that 100 percent of the chloroform used was emitted (and assuming no change in other carcinogenic pollutant emissions compared to those evaluated), the estimated combined incremental cancer risk at the Los Alamos Medical Center would be slightly above the guideline value of 1 in a million (1.0×10^{-6}). In other words, one person in a population of a million would develop cancer if this population were exposed to this concentration over a lifetime, a level of concern established in the Clean Air Act. It is known, however, that less than 100 percent of the chloroform used is emitted as a toxic air pollutant (as much as 25 pounds per year [8 liters per year] were disposed of as liquid chemical waste); thus, the incremental cancer risk under the No Action Alternative would be less than the guideline value. In addition, recent use of chloroform has been about 30 percent of the use projected for the Expanded Operations Alternative described in the *1999 SWEIS*. Based on the information discussed above, toxic air pollutants released under this new SWEIS No Action Alternative are not expected to cause air quality impacts that would affect human health and the environment.

Table 5–23 Estimated Annual Emission Rates of Carcinogenic Pollutants that Could Be Released from the Health Research Laboratory of the Technical Area 43 Facilities

Pollutants	*Stack ID*	*Annual Average Emission Rates*	
		Pounds per Year	*Grams per Second*
Acrylamide	Building 247	0.00586	8.44×10^{-8}
	Building 124/126	0.00586	8.44×10^{-8}
	N. Side FH	0.00586	8.44×10^{-8}
	S. Side FH	0.00586	8.44×10^{-8}
Chloroform	Building 247	2.2	0.0000317
	Building 124/126	21.3	0.000307
	N. Side FH	21.3	0.000307
	S. Side FH	21.3	0.000307
Formaldehyde	Building 247	0.173	0.0000025
	Building 124/126	1.68	0.0000241
	N. Side FH	1.68	0.0000241
	S. Side FH	1.68	0.0000241
Methylene Chloride	N. Side FH	0.946	0.0000136
	S. Side FH	0.946	0.0000136
Trichloroethylene	N. Side FH	10.2	0.000147

Source: DOE 1999a.

Table 5–24 Results of the Dispersion Modeling Analysis of Carcinogenic Pollutants from the Health Research Laboratory at Technical Area 43

Carcinogenic Pollutants	*Estimated Annual Concentration (micrograms per cubic meter)*
Acrylamide	0.0000115
Chloroform	0.0304
Formaldehyde	0.0024
Methylene Chloride	0.00078
Trichloroethylene	0.00334

Source: DOE 1999a.

Public health consequences from emissions of beryllium, lead, and depleted uranium from the High Explosives Testing Facilities (see Table 5−9) were analyzed by calculating hazard indices for lead and depleted uranium and calculating the excess LCFs from beryllium. A hazard index equal to or above 1 is considered consequential from a human toxicity standpoint. Beryllium has no established EPA reference dose from which to calculate the hazard index. The worst-case hazard indices for lead and depleted uranium were less than 0.000015 and 0.000065, respectively. The excess LCFs from beryllium were estimated to be 1 in 2,780,000 (3.6×10^{-7}) (DOE 1999a). Use of foam to control emissions from the High Explosives Testing Facilities would further reduce these emissions and health effects by about 50 to 95 percent (LANL 2006a).

Emissions from beryllium sources currently at the Beryllium Technology Facility in the Sigma Complex (TA-3) and Plutonium Facility Complex (TA-55) (see Table 5–10) are controlled by HEPA filtration with a removal efficiency of 99.95 percent. The maximum cancer risk of beryllium releases from TA-3 using its unit risk factor is approximately 1 in 415 million (2.41×10^{-9}), which is below the guideline value of 1 in a million (1.0×10^{-6}). In other words, one person in a population of a million would develop cancer if this population were exposed to this concentration over a lifetime, a level of concern established in the Clean Air Act. The maximum combined cancer risk of beryllium releases from TA-55 using its unit risk factor is approximately 1 in 4.3 billion (2.35×10^{-10}), which is also below the guideline value of 1 in a million (1.0×10^{-6}) (DOE 1999a).

5.6.2.2 Reduced Operations Alternative

Key Facilities

Public risk resulting from chemical releases under the Reduced Operations Alternative would be approximately the same as those associated with the No Action Alternative. There would be a reduction in risks associated with high explosives processing and testing activities because these activities would be reduced by 20 percent under this alternative. There also would be minor reductions in risk to the public as a result of shutting down operations at LANSCE and the Pajarito Site (TA-18) under this alternative.

5.6.2.3 Expanded Operations Alternative

Key Facilities

Public risk resulting from chemical releases under the Expanded Operations Alternative would be approximately the same as those associated with the No Action Alternative, except for a small increase (2.5 percent) in risk due to high explosives processing activities.

5.6.3 Worker Health

Worker risks associated with continued operations at LANL include radiological (ionizing and non-ionizing) risks, chemical exposure risks, and risk of injury during normal operations. The consequences to worker health from implementing the No Action, Reduced Operations, and Expanded Operations Alternatives are discussed below.

DOE has developed new regulations to require non-nuclear DOE contractors to comply with relevant Occupational Safety and Health Administration safety and health standards. Noncompliance could result in monetary fines. This is the first DOE regulation to provide for the protection of non-nuclear contractor workers. This new rule, 10 CFR Part 851, goes into effect on February 7, 2007, to allow 1 year for contractor and site management compliance training (DOE 2006a).

5.6.3.1 No Action Alternative

Ionizing Radiation Consequences

Table 5–25 presents the projected worker exposure from normal operations under the No Action Alternative. This projection is larger than the average annual worker dose shown in Chapter 4, Section 4.6.2.1, because it includes the dose associated with achieving a production level of 20 pits per year at TA-55, as well as the dose from increased levels of activity associated with additional personnel working in the new Chemistry and Metallurgy Research Replacement Facility. This projected collective worker dose represents the dose to the LANL workforce for the foreseeable future under the No Action Alternative.

Table 5–25 Projected Worker Radiation Exposure under the No Action Alternative

Collective worker dose (person-rem per year)	280
Number of workers with measurable dose	2,018
Excess LCF risk per year among worker population	0.17 [a]
Average individual worker measurable dose (millirem)	139
Excess LCF risk per year for average individual worker	0.000083 [a]
DOE limit on annual worker radiation exposure (millirem)	5,000
LANL average individual worker dose as a percentage of DOE limit (percent)	2.8

LCF = latent cancer fatality.
[a] Based on a risk estimate of 0.0006 LCF per person-rem (see Appendix C).

Worker exposures to radiation and radioactive materials in radiological control areas would be controlled using established procedures that require doses to be kept as low as reasonably achievable (ALARA). Potential hazards would be evaluated as part of the radiation worker and occupational safety programs at LANL. Nonroutine construction activities may require special work permits and worker protection measures for specific locations and activities.

DOE limits set the standard for worker exposure at 5,000 millirem per year whole body dose equivalent. In 10 CFR Part 835, DOE requires the ALARA process to be applied to reduce worker exposure to ionizing radiation. DOE has set an administrative control level of 2,000 millirem per year for an individual worker exposure (DOE 1999e). This level can be intentionally exceeded only with higher-level management approvals.

Under the No Action Alternative, the average individual worker dose of 139 millirem per year represents an increased risk of developing a latent fatal cancer of approximately 1 in 12,000 (8.3×10^{-5}) per year of operations. In addition to the 2,018 workers expected to receive a measurable dose, under the No Action Alternative, over 11,000 LANL workers or approximately

85 percent of the workforce would not likely receive any measurable dose during a year of normal operations.

Non-ionizing Radiation Consequences

Under the No Action Alternative, negligible effects on LANL worker health from normal operations of non-ionizing radiation sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves would likely continue.

Biohazardous Material Exposure Consequences

Under the No Action Alternative, there would be negligible effects on LANL worker health from normal operations of the existing Biosafety Level 1 and 2 facilities. As explained in Appendix C, workers are protected by a combination of microbiological safety practices, safety equipment acting as primary barriers, and facilities that provide secondary barriers to preclude contamination or infection by biohazardous material.

Chemical Exposure Consequences

Occasional reportable, but minor, chemical exposures could occur at the rate of one to three incidents annually due to worker exposure to airborne asbestos, lead paint particles, crystalline silica, fuming perchloric acid, hydrofluoric acid, or acids or alkalis (via skin contact).

Operation of the Beryllium Technology Facility in the Sigma Complex presents a potential risk of worker exposure to beryllium. Other uses of beryllium at LANL include metals applications, which present little risk. The annual worker risk associated with high-explosives-testing-related applications of beryllium (evaluated as a carcinogen in the *1999 SWEIS*) at LANL was estimated to be less than 1 in 2.7 million (3.6×10^{-7}). This estimate is still valid under the No Action Alternative of this SWEIS.

Occupational Injuries and Illness

Occupational injury and illness rates under the No Action Alternative are projected to follow the patterns observed from 1999 through 2005, as reported in Chapter 4, Section 4.6.2.1. Using LANL's average rates during this period, there would be 2.40 recordable cases and 1.18 cases when workers missed days or their activities were restricted or transferred due to an occupational injury or illness for every 200,000 hours worked. These rates are well below industry averages, which in 2004 were 4.8 recordable cases and 2.5 cases where days were missed as a result of an occupational injury or illness (BLS 2005). Assuming that LANL's employment levels remain at current levels as expected (see Section 5.8.1.1), there would be approximately 311 recordable cases of occupational injury and illness and approximately 153 cases that resulted in days away or restricted or transferred duties per year. No fatalities would be expected under this alternative.

5.6.3.2 Reduced Operations Alternative

Ionizing Radiation Consequences

As shown in **Table 5–26**, under the Reduced Operations Alternative, involved workers would be exposed to lower cumulative doses of ionizing radiation from normal operations at LANL than under the No Action Alternative due to the potential shutdown of LANSCE and TA-18 operations.

Table 5–26 Projected Worker Exposure to Radiation under the Reduced Operations Alternative

Collective worker dose (person-rem per year)	257
Number of workers with measurable dose	1,659
Excess LCF risk per year among worker population	0.15 [a]
Average individual worker measurable dose (millirem per year)	155
Excess LCF risk per year for average individual worker	0.000093 [a]
DOE limit on annual worker radiation exposure (millirem per year)	5,000
LANL average individual worker dose as a percentage of DOE limit (percent)	3.1

LCF = latent cancer fatality.
[a] Based on a risk estimate of 0.0006 LCFs per person-rem (see Appendix C).

The average dose received by workers is projected to increase slightly from 139 millirem per year to 155 millirem per year under the Reduced Operations Alternative compared to the No Action Alternative. This is due to a decrease in the number of workers who would receive less than the average dose under this alternative. The average individual worker dose of 155 millirem per year represents an increased risk of developing a latent fatal cancer of approximately 1 in 10,750 (9.3×10^{-5}) per year of operation. Similar to the No Action Alternative, 1,659 workers would be expected to receive a measurable dose, but over 11,000 LANL workers or over 87 percent of the workforce would not be expected to receive any measurable dose during a year of normal operations under the Reduced Operations Alternative.

Non-ionizing Radiation Consequences

Under the Reduced Operations Alternative, negligible effects on LANL worker health from non-ionizing radiation sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves would likely continue.

Biohazardous Material Exposure Consequences

Under the Reduced Operations Alternative, effects on LANL worker health from normal operations would not be substantially different from those under the No Action Alternative.

Chemical Exposure Consequences

Under the Reduced Operations Alternative, chemical exposure consequences to workers would likely be small and not substantially different than those under the No Action Alternative.

Occupational Injuries and Illness

Under the Reduced Operations Alternative, the number of occupational injuries and illnesses would likely be smaller than those observed under the No Action Alternative due to a smaller projected workforce, as discussed in Section 5.8.1.2. Using LANL's average rates, there would be approximately 300 recordable cases of occupational injury and illness and approximately 147 cases that result in days away or restricted or transferred duties per year, compared to 311 and 153, respectively, under the No Action Alternative. No fatalities would be expected under this alternative.

5.6.3.3 Expanded Operations Alternative

Ionizing Radiation Consequences

As shown in **Table 5–27**, the expansion of certain radiologically intensive operations at LANL would increase cumulative worker dose and annual average worker exposure under the Expanded Operations Alternative. Operations expected to expand under this alternative include pit production, remediation of a number of large MDAs, and DD&D of a number of TAs. In the long run, DD&D of the TAs and closure of many facilities such as those associated with the MDAs at LANL and older waste management facilities in TA-54, Area G, should reduce workers' annual radiation exposures.

Table 5–27 Projected Worker Exposure to Radiation under the Expanded Operations Alternative

	With MDA Removal Option	*With MDA Capping Option*
Collective worker dose (person-rem per year)	543	407
Number of workers with measurable dose	3,849	2,344
Excess LCF risk per year among worker population	0.33 [a]	0.24 [a]
Average individual worker measurable dose (millirem per year)	141	174
Excess LCF risk per year for average individual worker	8.5×10^{-5} [a]	0.00010 [a]
DOE limit on annual worker radiation exposure (millirem per year)	5,000	5,000
LANL average individual worker dose as a percentage of DOE limit (percent)	2.8	3.5

MDA = material disposal area, LCF = latent cancer fatality.
[a] Based on a risk estimate of 0.0006 LCFs per person-rem (see Appendix C).

The largest factors affecting worker dose under this alternative are increased pit production at TA-55 from 20 plutonium pits per year to up to 80 pits per year and remediation of the MDAs. The contribution to the collective worker dose from production of 20 pits per year is 90 person-rem per year under the No Action Alternative compared to 220 person-rem from production of up to 80 pits per year under the Expanded Operations Alternative. Remediation of the MDAs under this alternative also is expected to add to the site-wide collective worker dose. If the MDA

Removal Option were pursued, it would add an average of 137 person-rem per year to the site-wide collective worker dose. If the MDA Capping Option were pursued, it would add an average of just over 1 person-rem per year to the site-wide collective worker dose. DD&D activities across the site would add another 6 person-rem per year to the site-wide collective worker dose. Conversely, cessation of SHEBA operations at TA-18 would reduce LANL's site-wide collective worker dose under the Expanded Operations Alternative by 10 person-rem per year.

Under the Expanded Operations Alternative – MDA Removal Option, the average individual worker dose of 141 millirem per year represents an increased risk of developing a latent fatal cancer of approximately 1 in 11,800 (8.5×10^{-5}) per year of operations. Under the Expanded Operations Alternative – MDA Capping Option, the average individual worker dose of 174 millirem per year represents an increased risk of developing a latent fatal cancer of approximately 1 in 10,000 (1.0×10^{-4}) per year of operations.

Waste management workers, who currently receive an average dose of approximately 163 millirem annually, would receive a lower annual dose under the Expanded Operations Alternative after 2015. By the end of 2015, all legacy transuranic waste would be removed from the site and shipped to the Waste Isolation Pilot Plant (WIPP). Direct penetrating radiation levels in Area G, which currently measure above background levels in certain areas, would decrease to within background levels by this time. Waste management workers would still process newly generated transuranic waste at the proposed new TRU Waste Facility (to be built in either TA-50 or TA-63), but their exposures would be smaller than those currently observed because management of the newly generated waste would not be as time-intensive as currently required. Workers associated with retrieval of remote-handled transuranic waste from below-ground storage between 2011 and 2015 could see increases in radiation exposure, but their exposures would be monitored and engineering and administrative controls would be used to ensure their exposures are ALARA and within administrative control levels.

Non-ionizing Radiation Consequences

Under the Expanded Operations Alternative, negligible effects on LANL worker health from non-ionizing radiation sources, infrared radiation from instrumentation and welding, lasers, magnetic and electromagnetic fields, and microwaves would likely continue.

Biohazardous Material Exposure Consequences

Under the Expanded Operations Alternative, effects on LANL worker health from normal operations would not be substantially different from those under the No Action Alternative.

Chemical Exposure Consequences

Under the Expanded Operations Alternative, chemical exposure consequences to workers would likely be small and not substantially different from those under the No Action Alternative.

Occupational Injuries and Illness

As shown in **Table 5–28**, the projected number of annual occupational injuries and illnesses would be higher under the Expanded Operations Alternative compared to the No Action Alternative. This is due to two main factors. First, the size of the workforce is expected to continue to grow under this alternative, as discussed in Section 5.8.1.3. Second, more construction, DD&D, and remediation work is expected under the Expanded Operations Alternative, and these activities have higher incidence rates of occupational injuries and illnesses than the other types of work being performed at LANL.

While both total recordable cases and cases resulting in days away or restricted or transferred duties would be 12 to 13 percent higher under the Expanded Alternative compared to the No Action Alternative, no fatalities are expected under this alternative.

Table 5–28 Annual Projected Occupational Injuries and Illnesses Under the Expanded Operations Alternative

	Total Recordable Cases	*Cases Resulting in Days Away, Restricted, or Transferred*
General Laboratory Operations [a]	291.4	143.2
Construction	21.3	10.4
Remediation (MDA Removal Option)	35.1	17.1
Decontamination, decommissioning, and demolition	2.4	1.2
Total	350.2	171.9

MDA = material disposal area.
[a] Based on LANL averages of 2.40 total recordable cases and 1.18 cases resulting in days away, restricted, or transferred per 200,000 hours worked.

5.7 Cultural Resources

Potential impacts to cultural resources were assessed under the No Action, Reduced Operations, and Expanded Operations Alternatives. Cultural resources include archaeological resources, historic buildings and structures, and traditional cultural properties. Information used for impact assessment was derived from the results of systematic cultural resource inventories on LANL.

The analysis of impacts to cultural resources addressed potential direct and indirect impacts at each site from construction and operation. Direct impacts included those resulting from groundbreaking activities associated with new construction, building modifications, and demolition, as appropriate. Indirect impacts included those associated with reduced access to resource sites, as well as with increased stormwater runoff, traffic, and visitation to sensitive areas. The locations of known cultural resources were compared to the areas of potential effect from LANL activities. The potential for these activities to impact cultural resources was then assessed.

A summary of impacts is presented in **Table 5–29**.

Table 5–29 Summary of Environmental Consequences on Cultural Resources

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
	Land Conveyance and Transfer – Conveyance or transfer of known cultural resources out of the responsibility and protection of DOE. – Potential damage to cultural resources on conveyed or transferred parcels due to future development. – Potential impacts on protection and accessibility to American Indian sacred sites. *Trails Management Program* – Enhanced protection of cultural resources	Same as No Action Alternative	Same as No Action Alternative plus: *MDA Remediation Project* – No direct impacts expected for either Capping or Removal Options. – Potential indirect adverse effects on resources located in vicinity of some MDAs and PRSs. *Security-Driven Transportation Modifications Project* – No direct impacts. – Potential indirect adverse effects on historic site located in vicinity of TA-63 and the proposed bridge over Mortandad Canyon. – Pedestrian and vehicle bridges under all options could impact canyon views from traditional cultural properties.
Affected Technical Areas			
TA-3	No change in impacts to cultural resources.	Same as No Action Alternative	*Physical Science Research Complex* – Two historic buildings, one eligible for the National Register of Historic Places and one that will be assessed for eligibility, would be removed. *Replacement Office Buildings* – Potentially adverse effects on nearby historic trail.
TA-21	No change in impacts to cultural resources.	Same as No Action Alternative	*TA-21 Structure DD&D* – Adverse effects on National Register of Historic Place-eligible historic buildings and structures.
Key Facilities			
Chemistry and Metallurgy Research Building (TA-3, TA-48, and TA-55)	Resulted in excavation of an archaeological site in TA-50.	Same as No Action Alternative	Same as No Action Alternative
High Explosives Processing Facilities (TA-16)	Adverse effect from demolition and remodeling of historic buildings.	Same as No Action Alternative	Same as No Action Alternative
High Explosives Testing Facilities (TA-6, TA-22, and TA-40)	Adverse effects from demolition and remodeling of historic buildings.	Same as No Action Alternative	Same as No Action Alternative

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Pajarito Site (TA-18)	No change in impacts to cultural resources.	Same as No Action Alternative	Potentially adverse effect from demolition of historic buildings.
Radiochemistry Facility (TA-48)	No change in impacts to cultural resources.	Same as No Action Alternative	*Radiological Sciences Institute Project* – Potentially adverse effects on two archeological sites located near Radiochemistry Building. – Potentially adverse effect from demolition of Radiochemistry Building and other potentially historic buildings.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in impacts to cultural resources.	Same as No Action Alternative	– Changes to the existing Radioactive Liquid Waste Treatment Facility could alter its original appearance. – Minimal impact on historic buildings possibly requiring documentation to resolve adverse effects.
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No change in impacts to cultural resources.	Same as No Action Alternative	– Potential indirect effects on cultural resources located in vicinity of project associated activities in TA-54. – Removal of domes would positively impact views from traditional cultural properties located on adjacent lands of the Pueblo of San Ildefonso. – Potential impact to cultural resources from construction of TRU Waste Facility. – TRU Waste Facility could be visible from lands of the Pueblo of San Ildefonso.
LANSCE (TA-53)	No change in impacts to cultural resources.	Same as No Action Alternative	– Potentially adverse effect to LANSCE or other historic buildings experiencing internal modifications.
Radiography Facility (TA-55)	No change in impacts to cultural resources.	Same as No Action Alternative	– Same as No Action Alternative.
Bioscience Facilities	No change in impacts to cultural resources.	Same as No Action Alternative	*Science Complex Project* – Under all options, an eligibility assessment of the buildings to be replaced by the new Science Complex would be required. – Potentially adverse effects on three prehistoric archeological sites under Option 1. – No adverse effects to cultural resource sites under Options 2 and 3.
Remote Warehouse and Truck Inspection Station (TA-72)	No change in impacts to cultural resources.	Same as No Action Alternative	– Potentially adverse effects on three archeological sites.

MDA = material disposal area; PRS = potential release site; TA = technical area; DD&D = decontamination, decommissioning, and demolition; LANSCE = Los Alamos Neutron Science Center.

5.7.1 No Action Alternative

The No Action Alternative was analyzed in terms of the existing environment as it relates to cultural resources (see Chapter 4, Section 4.7), as well as several actions that are planned, but have may not been fully implemented. These actions were analyzed in the *1999 SWEIS* or in other NEPA compliance reviews issued since the *1999 SWEIS*. Impacts to cultural resources are described in terms of those projects that impact the site as a whole and those that affect specific TAs. Key Facilities are addressed separately.

Los Alamos National Laboratory Site-Wide Impacts

Two projects have been approved since publication of the *1999 SWEIS* that could impact cultural resources across a number of TAs. These projects involve the conveyance and transfer of certain parcels of land and the management of the trails system at LANL. Site-wide projects that have been determined to have no impact on cultural resources include electrical power system upgrades, the Wildfire Hazard Reduction Program, disposition of Cerro Grande Fire structures, and the Security Perimeter Project (DOE 1999d, 2000a, 2000e, 2002j, 2003a, 2003b; NNSA 2004a, 2005a). Continuing the LANL environmental restoration program that existed before the 2005 Consent Order is expected to have little or no impact on cultural resources. Management of construction fill would not be expected to have an impact on cultural resources because the fill would be stored in existing borrow areas at TA-16 or TA-61.

The conveyance and transfer of 10 tracts of land would have both direct and indirect impacts on cultural resources. To date, eight parcels have been entirely or partly conveyed or transferred (see Chapter 4, Table 4–2). Direct impacts have included the transfer of known cultural resources and historic properties out of the responsibility and protection of DOE, including resources eligible for the National Register of Historic Places. It should be noted that a data recovery plan was implemented to resolve the adverse effects of conveying three tracts to the County of Los Alamos for future development that include 49 archaeological sites that are eligible for the National Register of Historic Places. In addition, 34 archaeological sites are included within three protective easements at a single tract to be conveyed to the county for recreational purposes (LANL 2002b). The disposition of each of these tracts affects their protection and accessibility as Native American sacred sites that are needed for the practice of traditional religion. In addition, the disposition of the tracts would potentially affect the treatment and disposition of any human remains, funerary objects, sacred objects, and objects of cultural patrimony that may be discovered on the tracts. Indirect impacts of the conveyance and transfer of land include potential future development of 826 acres (334 hectares) and use of the tracts for recreational purposes. This action could result in the physical destruction, damage, or alteration of cultural resources located on the tracts and in adjacent areas, as well as disturbance of traditional religious practices (DOE 1999d).

The Trails Management Program would enhance protection of cultural resources at LANL. Management activities would be coordinated with LANL archaeologists in consultation with appropriate Native American Tribes to minimize damages to any cultural resources present along the trail reaches. Where activities associated with trail maintenance or use would adversely affect a trail, that trail could be closed to all or certain users until the involved segment of trail could be rerouted around the cultural resources. Alternatively, certain trail segments could be closed periodically for Native American use. If work necessary to close a trail to all user groups would adversely affect a cultural resource, a data recovery plan would be prepared and the State Historic Preservation Officer and appropriate Native American Tribes would be consulted before such work commenced. New trails would not be constructed in locations where the activities of trail users or maintenance workers would adversely affect cultural resources (DOE 2003b).

Technical Area Impacts

Technical Area 3

One project within TA-3, the installation of combustion turbine generators, underwent a NEPA compliance review since issuance of the *1999 SWEIS* and was not fully implemented. The analysis presented in the project-specific EA determined that there would be no impact on cultural resources from implementation of this project (DOE 2002l).

Technical Area 54

Within TA-54, the proposed implementation of corrective measures at MDA H underwent a NEPA compliance review since issuance of the *1999 SWEIS*. The analysis presented in the EA for MDA H remediation supported NNSA's determination that implementation of corrective measures would not significantly impact cultural resources (DOE 2004e).

Key Facilities Impacts

Since issuance of the *1999 SWEIS*, NEPA compliance documentation was prepared for three currently active projects related to Key Facilities: Chemistry and Metallurgy Research Replacement Facility construction at TA-55, Weapons Manufacturing Support Facility consolidation and refurbishment at TA-16, and Two-Mile Mesa Complex consolidation at TA-22. Each of these projects was determined to have some potential impacts on cultural resources.

Chemistry and Metallurgy Research Building

A NEPA compliance review determined that construction of the new Chemistry and Metallurgy Research Replacement Facility at TA-55 would have no adverse impacts on cultural resources (DOE 2003d). A parking lot associated with the complex to be located in TA-50 will impact an archaeological site, the "Romero Cabin Site," which was originally excavated in the 1980s. Implementation of a data recovery plan to resolve the adverse effects of construction of the parking lot at the cabin site was completed in 2005.

High Explosives Processing Facilities

The planned consolidation and refurbishment of the TA-16 Weapons Manufacturing Support Facility will not affect the one prehistoric archaeological site that is located in the area. Demolition and remodeling of various buildings, however, which is a part of the project, will adversely affect historic structures, many of which were constructed in the 1950s, that are eligible for the National Register of Historic Places. A Memorandum of Agreement between NNSA and the State Historic Preservation Officer to resolve these adverse effects will be prepared following the State Historic Preservation Officer's concurrence with the National Register of Historic Places eligibility assessment of these structures. The Advisory Council on Historic Preservation will be notified of the Memorandum of Agreement and will have an opportunity to comment (DOE 2002l).

The planned consolidation and construction that is part of the Two-Mile Mesa Complex Project at TA-22 will not impact any recorded prehistoric or historic sites. Demolition of various historic buildings as a part of that action, however, will adversely affect historic structures that are potentially eligible for the National Register of Historic Places. As noted above for the TA-16 Weapons Manufacturing Support Facility, a Memorandum of Agreement between NNSA and the State Historic Preservation Officer to resolve these adverse effects will be prepared following the State Historic Preservation Officer's concurrence with the National Register of Historic Places eligibility assessment. The Advisory Council on Historic Preservation will be notified of the Memorandum of Agreement and will have an opportunity to comment (DOE 2003e).

5.7.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Under the Reduced Operations Alternative, the same impacts to cultural resources as those discussed under the No Action Alternative (see Section 5.7.1) would occur.

Key Facilities Impacts

Activity levels at certain Key Facilities would change. High explosives processing and testing would be reduced by 20 percent. LANSCE would cease operation and be placed into a safe shutdown mode, and buildings at the Pajarito Site (TA-18) would undergo safe shutdown as well. As a result, the Pajarito Site would be dropped from the list of Key Facilities. As there would be no change in cultural resources associated with the reduction in high explosives processing and testing or the closure of LANSCE and TA-18, these actions are not addressed further.

5.7.3 Expanded Operations Alternative

The Expanded Operations Alternative includes proposals that would expand overall operations levels at LANL above those established for the No Action Alternative. Thus, under the Expanded Operations Alternative, the same impacts to cultural resources as those discussed under the No Action Alternative (see Section 5.7.1) would occur. Additionally, some of the new projects proposed under the Expanded Operations Alternative would potentially impact cultural resources. Not all new projects or activities would affect these resources, however, because many would involve actions within or modifications to existing structures, or the construction of new facilities within previously developed areas of LANL. For example, an increase in pit production would not require new construction and hence would not affect cultural resources. Only those projects that could impact cultural resources are addressed below.

Los Alamos National Laboratory Site-Wide Impacts

There are two options (Capping and Removal) for remediation of MDAs at LANL. The cultural resources impacts for both options would be generally similar. The surfaces of the MDAs would be disturbed whether they are capped or contamination is removed. Because no archaeological resources are located within any of the MDAs, neither option would directly impact such sites. Risk of impacts to cultural resources during remediation of any of the hundreds of other PRSs at LANL would depend on the situation and the corrective measure implemented, if any. Unlike the MDAs, many of the PRSs (such as firing sites) contain only surface or near-surface contamination that could be recovered relatively easily.

Indirect impacts to cultural resources from remedial actions are possible due to increased erosion resulting from clearing, capping, removal, or contamination recovery operations; from locating temporary remediation support facilities near the remediation sites; and from workers or equipment in the work area. In those cases where archaeological resource sites and historic buildings and structures are located near work areas, site boundaries would be marked and the site would be fenced, as appropriate. As one example, a building eligible for the National Register of Historic Places is located within the solid waste management units comprising Firing Site R-44 in TA-15. If remediation of R-44 were required by the New Mexico Environment Department, however, it would take place in a manner that protects the building.

Most actions associated with implementing the Security-Driven Transportation Modifications Project would have little or no impacts on cultural resources because no known cultural sites are located within any of the areas to be disturbed. A historic site is situated near an area to be disturbed within TA-63; however, direct impacts would be unlikely. Prior to any disturbance, site boundaries would be marked and the site would be fenced, as appropriate. If previously unknown resources were identified during ground-disturbing activities, the procedures in *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (*Cultural Heritage Management Plan*) would be followed (LANL 2006f). The proposed vehicle and pedestrian bridges over Ten Site Canyon would be highly visible from both nearby and distant locations. Thus, they may degrade views of the canyon from sites identified by Native American and Hispanic communities as traditional cultural properties.

Under Auxiliary Actions A and B of the Security-Driven Transportation Modifications Project, bridges would be built over Mortandad Canyon and Sandia Canyon, respectively. As the corridors where the bridges would be constructed do not contain any known cultural resource sites, it is unlikely that construction of the bridges (or associated roadways) would directly impact such resources. There are a number of prehistoric sites and one historic site located to the east and west of the proposed Mortandad Canyon bridge corridor. Due to the relative proximity of these resources to the bridge corridor, it may be necessary to mark and fence sites, as appropriate. No cultural resource sites are located near the Sandia Canyon bridge corridor. In the event that a previously unknown resource is identified during ground-disturbing activities associated with the proposed options, the procedures in LANL's *Cultural Heritage Management Plan* (LANL 2006f) would be followed. As noted above for the road and pedestrian bridges over Ten Site Canyon, construction of the bridges could degrade views of the canyon from sites identified by Native American and Hispanic communities as traditional cultural properties (see Appendix J).

Technical Area Impacts

Three projects are being proposed that would potentially impact cultural resources within TA-3 and TA-21. These projects are related to the Physical Science Research Complex and the Replacement Office Buildings in TA-3 and TA-21 Structure DD&D.

Technical Area 3

The proposed site of the Physical Science Research Complex is in an already-developed area of TA-3. Building TA-3-0028, a potentially significant historic building, would be removed. Prior to its demolition, it would be assessed for inclusion in the National Register of Historic Places. The current Administration Building (TA-3-0043) has been formally declared as eligible for the National Register of Historic Places and a Memorandum of Agreement has been signed regarding required documentation prior to its removal.

Although no cultural resource sites that are eligible for the National Register of Historic Places are located in TA-3 in the vicinity of the Replacement Office Buildings, a historic trail located to the south of the parking lot must be managed until formally determined otherwise. Due to its proximity to the proposed project, there could be potentially adverse effects to the trail from construction. Appropriate measures, such as fencing, would be implemented to resolve any potentially adverse effects.

Technical Area 21

Decontamination and demolition of buildings and structures at TA-21 would directly affect those associated with the Manhattan Project and Cold War years that are eligible for the National Register of Historic Places. In total, there are 15 historic buildings and structures in TA-21; however, a number of these are located within the parcel that was conveyed to Los Alamos County. Regarding those historic buildings and structures that would be affected, NNSA, in conjunction with the State Historic Preservation Officer, has developed documentation measures to resolve adverse effects to eligible properties. Prior to demolition, these measures would be incorporated into a formal Memorandum of Agreement between NNSA and the New Mexico Historic Preservation Division. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Key Facilities Impacts

Four projects are proposed that are related to Key Facilities at LANL under the Expanded Operations Alternative.

Pajarito Site

Prehistoric resources (specifically, 40 cavates and a rock shelter) and historic resources (specifically the Ashley Pond Cabin) are located on the Pajarito Site (TA-18). These resources would continue to be protected during DD&D activities. Three LANL-associated buildings located within TA-18 have been identified as eligible for the National Register of Historic Places, including the Slotin Building (18-1) and two other buildings (18-2 and 18-5). However, there are additional buildings within the TA that have yet to be assessed for eligibility to the National

Register of Historic Places. Prior to any DD&D activities, these buildings would have to be evaluated. Those that are candidates for long-term retention would be protected during DD&D activities, whereas others would be documented to resolve the adverse effects. As noted previously, NNSA, in conjunction with the State Historic Preservation Officer, has developed documentation measures to resolve adverse effects on eligible properties at LANL. Appropriate measures would be defined in a Memorandum of Agreement between NNSA and the New Mexico Historic Preservation Division prior to any DD&D activities. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Radiochemistry Building

Construction of the Radiological Sciences Institute would not directly impact prehistoric cultural resources because none are located within areas to be disturbed by construction. One prehistoric site, however, is located across the access road from the existing Radiochemistry Building, which is itself is considered a historic structure. New construction in the area of the prehistoric site would require the site boundaries to be marked and the site to be fenced.

Before demolition could begin on parts of the Radiochemistry Building or other structures to be replaced by the Radiological Sciences Institute, NNSA, in conjunction with the State Historic Preservation Officer, would implement documentation measures to resolve any adverse effects to eligible properties. These measures would be incorporated into a formal Memorandum of Agreement between NNSA and the New Mexico Historic Preservation Division. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment. Impacts from construction and operation of the Radiological Sciences Institute on traditional cultural properties are unlikely because most development would take place within previously disturbed portions of TA-48. Potential views of TA-48 from any traditional cultural properties located in the vicinity would remain largely unchanged (see Appendix G, Section G.3.3.2).

Radioactive Liquid Waste Treatment Facility

Under the construction options for upgrades to the Radioactive Liquid Waste Treatment Facility, one or more treatment buildings would be constructed near the existing facility and the East and North Annexes would be demolished. Effects to cultural resources would be minimal. Under one of the auxiliary actions, which could be applied to any of the options, evaporation tanks and pipelines would be constructed. Impacts to cultural resources in the vicinity of the pipeline and evaporation tanks would be avoided during the siting process. If the pipeline alignment were to encroach on archaeological sites near the evaporation tanks, however, the archaeological sites would require testing or excavation. These options would have minimal effects on historic buildings because removal of later annexes to Radioactive Liquid Waste Treatment Facility would not likely affect the original historic fabric of the building. Changes to the process area of Radioactive Liquid Waste Treatment Facility, however, would require historic documentation before any equipment is removed from the building. The environmental consequences to cultural resources would be the same if the upgraded treatment capabilities were housed in one or multiple structures.

The New Construction and Renovation Option for the Radioactive Liquid Waste Treatment Facility involves renovation of the existing facility in addition to construction of one or more treatment buildings. This option also would result in minimal adverse effects on cultural resources. If the auxiliary action of construction of evaporation tanks and pipeline were implemented, the impacts to cultural resources would be the same as described above. However, changes to the structure of the existing Radioactive Liquid Waste Treatment Facility would alter the original historic appearance of the building. Removal of equipment, modification of the building, and demolition of the annexes would require documentation and consultation with the New Mexico Historic Preservation Office. For all options, mitigation plans would have to be implemented before or during implementation of the project.

Solid Radioactive and Chemical Waste Facilities

Impacts to cultural resources from Waste Management Facilities Transition activities would be similar under both options: Option 1, Accelerated Actions for Meeting the Consent Order or Option 2, Interim Actions Necessary for Meeting the Consent Order. All activities taking place in TA-54, including new construction and removal of the domes, would occur within developed areas. Thus, there would be no direct impacts on cultural resources. But because a number of cultural resource sites are located nearby, a potential exists for indirect impacts to these resources. To ensure these resources would not be affected under either alternative, cultural resource site boundaries would be marked and fenced, as appropriate. Although archaeological resources are located in the generic area considered for the TRU Waste Facility, only those in TA-50, TA-54-West, and TA-66 have the potential to be directly affected by construction of the TRU Waste Facility. Direct and indirect impacts to archaeological resources would require notifying appropriate LANL personnel and implementing the requirements of the LANL Cultural Resources Management Plan (LANL 2006f). Mitigation measures, including avoidance, would be taken to ensure that construction activity, traffic and ground disturbances would not result in damage to the resources. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division to resolve adverse effects. The Advisory Council on Historic Preservation would have an opportunity to comment on the Memorandum of Agreement. Construction of the TRU Waste Facility would not impact any National Register of Historic Places-eligible buildings or structures. However, if the TRU Waste Facility were built within generic sites in TA-51, TA-52, or TA-54-West, it would be visible from San Ildefonso Pueblo lands. Thus, impacts to traditional cultural properties are possible if the new facility were built within these TAs. Impact potential is reduced within TA-54-West because construction would take place within a developed area. Removal of the white-colored domes at TA-54 would positively impact views from Pueblo of San Ildefonso lands, which border the TA to the north.

Los Alamos Neutron Science Center

The LANSCE accelerator building has been determined to be eligible for the National Register of Historic Places. Although project-related modifications would not affect the external appearance of the structure, it would be necessary to determine the potentially adverse effects and document existing conditions, as appropriate. Additionally, any other significant historic buildings at TA-53 that could experience internal modifications would have to be evaluated for National Register of Historic Places eligibility status; these buildings must be considered potentially eligible until formally assessed.

Science Complex

Three archaeological sites are situated near the proposed Northwest TA-62 location, and each has been determined to be eligible for the National Register of Historic Places. These three sites are at risk of indirect adverse effects from construction of the Science Complex. Mitigation measures would be taken as appropriate to resolve any adverse effects in conjunction with the State Historic Preservation Office and Advisory Council on Historic Preservation. There would be no adverse effects on cultural resources from construction of the Science Complex under the Research Park Site or South TA-3 Site options. Under all options, the buildings to be replaced by the Science Complex would have to be evaluated for their historic importance prior to being demolished.

Remote Warehouse and Truck Inspection Station

The Remote Warehouse and Truck Inspection Station could impact the three recorded prehistoric archaeological sites at the proposed location. Mitigation measures would be taken in conjunction with the State Historic Preservation Office and Advisory Council on Historic Preservation, as appropriate, to ensure that construction activity, traffic, and ground disturbances do not damage the sites. The Mortandad Trail located east of the proposed project site leads to the Mortandad Cave Kiva National Historic Landmark and is closed to public access except for organized tours. Although the proposed project would not affect normal access to the trail, it would incorporate fencing around the perimeter of the Warehouse and Truck Inspection Station to protect sensitive areas, including the Mortandad Cave Kiva National Historic Landmark, from unauthorized increased visitation.

5.8 Socioeconomics and Infrastructure

This section discusses the environmental effects of LANL operations on the socioeconomic region of influence and LANL site infrastructure. The effects are described for each of the alternatives.

5.8.1 Socioeconomics

The primary (direct) and secondary (indirect) impacts of LANL activities on employment, salaries, and procurement are analyzed in this SWEIS. The primary impacts were determined by analyzing projected changes in employment (in terms of full-time equivalents at LANL). Changes in employment were projected based on information regarding changes in activities at the Key Facilities. Employment for the rest of LANL was assumed to remain the same.

Projected changes in employment were distributed among the tri-county area (the three counties closest to LANL: Los Alamos County, Rio Arriba County, and Santa Fe County). Employment changes would likely result in additional, secondary changes in employment, salaries, and expenditures in the area, as well as changes in demands for social services. These secondary impacts would occur within a regional economy because jobs added in a primary industry such as LANL would create local opportunities for new employment in supporting industries. Analysis of these secondary economic and social impacts of LANL activities across the alternatives was conducted using the multipliers developed by the U.S. Department of Commerce, Bureau of

Economic Analysis's Regional Input-Output Modeling System (RIMS II) for the tri-county area to predict total LANL socioeconomic impacts in the area (DOC 2006d)[4]. For example, if LANL were to expand employment by 100 full-time workers who resided in the tri-county area, the secondary effect would be the addition of approximately 106 new secondary jobs in the tri-county labor market. On the other hand, if LANL were to reduce employment by 100 full-time workers, the reverberating effect across the tri-county economy would be the loss of 106 other jobs.

The projected changes in employment were used to determine whether there would be significant impacts in the tri-county area on the need for housing units, construction requirements at LANL, changes in local government finances, and the need for public services.

Table 5–30 summarizes the expected socioeconomic changes for each of the proposed alternatives.

5.8.1.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

LANL Employment

LANL continues to be a major economic force within the region of influence consisting of Santa Fe, Los Alamos, and Rio Arriba Counties (the tri-county area). Chapter 4, Table 4–28, shows the percentage of LANL employees residing in the region of influence. As shown in this table, approximately 11.5 percent of the total number of persons employed in the region of influence are affiliated with LANL, and this level has remained relatively steady over a number of years.

At the end of 2005, LANL employed 13,504 individuals, nearly 19 percent more than the employment projection of 11,351 presented in the *1999 SWEIS*. From 1996 through 2005, employment at LANL increased by approximately 2.2 percent per year. During the same period, employment in the region of influence increased by an average of 2.5 percent annually. Under the No Action Alternative, it is assumed that LANL employment levels would no longer increase but would remain steady at the 2005 level.

Assuming LANL continues to directly employ 13,504 employees, it is estimated that approximately 11,560 of these employees would live within the region of influence based on existing residence rates (LANL 2006g). The existence of these direct jobs would be expected to result in the creation of another 12,240 indirect jobs for a total number of jobs related to LANL operations in the region of influence of approximately 23,800 jobs; about 21 percent of the total number of people expected to be employed in the region of influence in 2007.

---

[4] The LANL site specific multiplier was developed using a weighted average of RIMS II detailed industry multipliers for the tri-county area made up of the following industries: scientific research and development, environmental and other technical consulting services, construction, and investigative and security services.

Table 5–30 Summary of Socioeconomic Consequences

No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site		
LANL Employment		
2005 levels of employment assumed to remain steady at 13,504 employees, 11,560 of whom would be expected to reside in the region of influence creating another 12,240 indirect jobs in the region of influence.	A decrease of 500 employees from 2005 levels would be expected to result in the loss of about 530 indirect jobs in the region. Loss of 1,030 jobs in the region would be less than 1 percent of total civilian workforce.	An employment increase of 2.2 percent per year from 2007 to 2011 would result in an additional 600 to 1,890 employees working at LANL and creation of another 640 to 2,000 indirect jobs. This growth rate is consistent with the projected regional growth rate.
Housing		
No new housing units would be needed specific to changes in LANL's employment level.	Additional housing units could become available in the tri-county area as a result of the projected decrease in LANL's employment level. These would likely offset the need for additional housing units in the region because the population would still be expected to grow, though at a slower rate (about 1.5 percent versus 2.3 percent).	Additional housing units would be required in the tri-county area due to the projected increases in LANL's employment level and in the regional population. More LANL employees could be expected over time to reside in Rio Arriba, Santa Fe, or other surrounding counties, compared to Los Alamos County, where a shortage of available housing would likely continue. The number of housing units needed would depend on the number of workers relocating from outside the area. Overall, the number of units needed would likely be small compared to overall needs in the tri-county area.
Construction		
Completion of previously approved construction projects would likely draw workers already living in the region who historically work from job-to-job.	Same as No Action Alternative.	An increase in the number of construction projects would likely draw workers already in the region who historically work from job-to-job.
Local Government Finance		
Annual gross receipts tax yields would likely remain at current levels in real terms.	Annual gross receipts tax yields directly and indirectly associated with LANL employment could decrease by approximately 1.1 percent.	Annual gross receipts tax yields directly and indirectly associated with LANL employment are projected to increase by between 1.3 and 3.9 percent from 2007 through 2011 above 2005 levels in real terms due to increases in LANL's workforce during that timeframe.
Services		
Demand for services such as police, fire, and hospital beds would likely remain at current levels in proportion to LANL employment. The regional population is projected to increase even if LANL employment remains flat, so the demand for regional services would continue to increase, but the increase would not be driven by LANL employment growth.	Demand for services associated with LANL employment would likely decrease in proportion to the number of out-of-work LANL-related employees forced to leave the region. The regional population is still projected to increase, however, in spite of the small decreases in LANL employment envisioned in this alternative, so demand for services would likely increase as well, though at a slower pace than under the No Action Alternative.	Demand for services associated with LANL employment would likely increase in proportion to the number of additional LANL-related jobs added to the region. The number of additional school-age children associated with these increases is projected at between 440 and 1,400 in the tri-county area, resulting in an estimated need for increased public school funding from the state of $3.2 million to $11 million between 2007 and 2011. Most of the additional services would be required in Rio Arriba, Santa Fe, and other surrounding counties because the population in Los Alamos County is projected to increase by a very small rate compared to the other counties.

Completion of construction projects previously approved under completed NEPA compliance reviews would likely draw workers who already live in the region of influence and historically work from job-to-job in the region. Thus, this sector of employment associated with LANL is not expected to grow as a result of the No Action Alternative.

Housing

No new housing units beyond current regional trends are likely to be needed under the No Action Alternative, because LANL employment levels would be expected to stay at current levels.

Local Government Finance

Under this alternative, the tri-county area's annual gross receipts tax yields would be expected to grow at the same level as the population. Changes in tax rates are assumed to be driven by the need to increase service levels to meet public demand in the case of a tax increase or a determination that service levels can reduced in some way in the case of a tax cut.

Services

Annual school enrollment trends in the tri-county area would likely continue due to projected population growth that is unrelated to LANL. Demands for police, fire, and other municipal services directly resulting from LANL employment needs would be expected to remain at current levels, because LANL employment levels would be expected to stay at current levels.

5.8.1.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

LANL Employment

Under the Reduced Operations Alternative, employment at LANL could decrease by approximately 3.7 percent, or 500 employees, as a result of closing LANSCE, reducing high explosives processing and testing by 20 percent, and cessation of TA-18 activities. This would equate to a projected employment level of about 13,000 in 2007 under this alternative. As a result of this decrease in employment at LANL, a loss of about 530 indirect jobs also is projected.

If all of these displaced workers remained in the region of influence in 2007 and were unable to find new employment immediately, regional unemployment rates would be expected to increase by approximately 0.8 percent. As these projected decreases are less than 1 percent of the total civilian labor force for the region of influence, the changes would not be expected to result in any significant change in the regional economy. Similar swings in LANL employment were seen recently with no apparent impacts on the regional economy. For example, employment levels at LANL decreased by approximately 3 percent from 1999 to 2000, while the number of persons employed in the region of influence increased by 4 percent during the same period. A similar decrease was seen from 2003 to 2004 when LANL employment decreased by 2.6 percent, while the number of persons employed in the region of influence increased by 1.2 percent.

Under this alternative, LANL would be expected to directly employ approximately 13,000 employees. It is estimated that approximately 11,140 of these employees would live within the region of influence based on existing residence rates (LANL 2006g). The existence of these direct jobs would be expected to result in another 11,790 indirect jobs for a total number of jobs related to LANL operations in the region of influence of approximately 22,920 jobs; about 20 percent of the total number of people expected to be employed in the region of influence in 2007. The anticipated construction impacts would be the same as under the No Action Alternative.

Housing

In the event all of the persons affected by the projected reduction in LANL's workforce moved out of the region, available housing units in the region of influence would likely increase. This would not be expected to have a significant adverse impact on the region, however, because the population is expected to grow at the same time, so available units would likely fill new demands. The immediate impacts on the housing market in Los Alamos County would likely be greater than in Santa Fe or Rio Arriba Counties because a greater percentage of LANL employees reside in Los Alamos County. Given the lack of available units in Los Alamos County, however, any available units would likely be desired by others who may have wanted to move into the county but were unable due to lack of available housing. Thus, any initial increase in available units would likely be offset by pent-up demand. (In 2000, only 5.5 percent of the housing units in Los Alamos County were vacant, compared to over 13 percent in the State of New Mexico and 9 percent across the United States [DOC 2006a]).

Local Government Finance

Under the Reduced Operations Alternative, the tri-county annual gross receipts tax yields associated with LANL operations (both direct and indirect) would be expected to decrease by approximately 1.1 percent if all of the affected employees relocated outside of the region. Any reduction in tax revenues associated with the potential loss of LANL employees, however, would likely be offset by the continued growth in the regional workforce outside of LANL, similar to the increases seen in 2000 and 2004.

Services

Annual school enrollment in the tri-county area could decrease due to out-migration of affected LANL employees and their families, as well as indirect personnel and their families. The potential loss would likely be offset by the continued influx of non-LANL employees into the region as the region is expected to continue to grow, though at a slower rate.

Demands for police, fire, and other municipal services are not expected to be impacted by the projected employment changes under this alternative because affected LANL employees and their families represent less than 1 percent of the regional demand.

5.8.1.3 Expanded Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

LANL Employment

Under the Expanded Operations Alternative, employment at LANL would continue to rise due to both increased pit production and increased remediation and DD&D activities. In addition, work at LANL would likely increase beyond current operations in areas that cannot be easily identified at this time, but could be tied to expanding research efforts such as homeland security. Similar increases have been seen in recent years.

If LANL's employment rate were to continue increasing at the same level experienced from 1996 through 2005 (2.2 percent annually), approximately 15,400 individuals could be employed at LANL by the end of 2011, as shown in **Table 5–31**, which would be an increase of about 1,890 above the 2005 level. In addition to direct employees associated with LANL, approximately 2,000 positions would likely be created indirectly as a secondary impact on the region's payrolls by the end of 2011.

Table 5–31 Projected Los Alamos National Laboratory Employment under the Expanded Operations Alternative

Year	*Projected LANL Employees*	*LANL Employees Residing in ROI*	*Number of Indirect Jobs in ROI Related to LANL Employment*	*Total Number of Jobs Related to LANL in ROI*	*ROI Employed*	*LANL as a Percent of ROI Employed*
2007	14,107	12,080	12,782	24,862	112,435	22.1
2008	14,418	12,347	13,065	25,412	115,207	22.1
2009	14,736	12,619	13,352	25,971	118,047	22.0
2010	15,061	12,898	13,648	26,546	120,957	21.9
2011	15,394	13,182	13,948	27,130	123,939	21.9

ROI = region of influence.

Under this alternative, LANL would be expected to directly employ between approximately 14,100 employees in 2007 and 15,400 employees in 2011. Between 12,080 and 13,182 of these employees would live within the region of influence based on existing residence rates (LANL 2006g). The existence of these direct jobs would be expected to result in another 12,782 to 13,948 indirect jobs for a total number of jobs related to LANL operations in the region of influence of approximately 24,862 to 27,130 jobs; about 22 percent of the total number of people expected to be employed in the region of influence from 2007 through 2011.

Under the Expanded Operations Alternative, construction and remediation efforts at LANL would increase; however, similar to the No Action Alternative, these projects would likely be staffed by workers who are already present in the region of influence and historically work construction jobs in the region. Thus, this sector of employment associated with LANL is expected to grow as a result of the Expanded Operations Alternative, but at a rate comparable with the operational growth rate.

Housing

An increase in LANL employment along with associated increase in indirect hires, would likely increase the need for housing in the region of influence. Although available housing is currently limited in Los Alamos County, construction of new housing is planned within the next year. These units would likely be filled quickly and a larger percentage of LANL-related housing needs would still need to be accommodated by workers relocating to Santa Fe, Rio Arriba, or other nearby counties, in keeping with the trend in recent years.

Additional housing needs would not be expected to exceed regional growth projections because the region is already expected to grow by approximately 2.3 percent annually between 2000 and 2010 (LANL 2004c).

Local Government Finance

Under this alternative, the tri-county area's annual gross receipts tax yields would be expected to increase by between 1.3 and 3.9 percent in real terms as a result of the addition of workers to LANL's workforce from 2007 through 2011. Any increases in tax revenues needed to offset the cost of additional services to support the associated increased population under the Expanded Operations Alternative would be covered by these new employees.

Services

Annual school enrollment in the tri-county area due to increases in LANL-related employment (direct and indirect) is projected to increase by between 435 and 1,360 students from 2007 to 2011 under the Expanded Operations Alternative. Additional annual funding assistance from the State of New Mexico of about $3.2 million to $11 million would be required for public school operations because of these enrollment increases, which would be part of an expected increase of about 6,000 to 10,000 in school-age children in the tri-county area during that period.

In Los Alamos County, the school district would likely be able to absorb the anticipated new enrollment levels because the levels would not be expected to change significantly from current levels due to the lack of available housing units. If Los Alamos County approves plans to build additional homes, the need for additional schools would need to be evaluated. In Rio Arriba County and the cities of Española and Santa Fe, this increase would be greater, as a larger portion of LANL's workforce would likely reside in these areas.

The demand for police, fire, and other municipal services would likely increase in proportion to the increase in population expected in each county.

5.8.2 Infrastructure

Site infrastructure includes the utility systems required to support construction and/or modification and operation of LANL facilities. It includes the capacities of the electric power transmission and distribution system, natural gas and liquid fuel (fuel oil, diesel fuel, and gasoline) supply systems, and the water supply system. The region of influence for utility infrastructure resources includes the LANL site, including the affected TAs and the individual facilities and utility systems (electric power, natural gas, and water) that serve LANL.

Descriptions of these utility systems, along with analyses of historic trends in LANL usage and other demands within the region of influence that supports this analysis, are provided in Chapter 4, Section 4.8.2.

In general, potential infrastructure impacts were assessed by comparing projections of utility resource requirements under each alternative against utility system capacities. While many LANL facilities do not meter utility use, annual site-wide demands are known and were used to make projections for each of the alternatives considered in this SWEIS. In addition, base trends in site-wide infrastructure requirements to date, as well as within the larger region of influence, were identified and extrapolated to make predictions for future years. The data were then adjusted for LANL project-specific actions within specific TAs and at Key Facilities considered under each alternative. Any projected demand for infrastructure resources exceeding its availability can be regarded as an indicator of impact. Where projected demand approaches or exceeds capacity, further analysis for that resource is warranted. It should be noted that utility projections include considerable inherent uncertainty as demands for electric power, natural gas, and water can be greatly affected by climate conditions from year to year. As such, the further into the future such projections are made, the greater the uncertainty in the projection.

Projected site utility infrastructure requirements under the Proposed Action and alternatives are summarized in **Table 5–32**.

5.8.2.1 No Action Alternative

Annual utility infrastructure requirements for current LANL operations and for other Los Alamos County users that rely upon the same utility system, along with current utility system capacities, are presented in **Table 5–33**. Values from 2005 are presented as a reference baseline for comparing projections for the three proposed alternatives in this SWEIS. Under the Expanded Operations Alternative analyzed in the *1999 SWEIS* (DOE 1999a) and selected in the subsequent ROD, LANL operations were projected to require 782,000 megawatt-hours of electricity (electrical energy) with a peak load demand of 113 megawatts, 1,840,000 decatherms of natural gas, and 759 million gallons (2.87 billion liters) of water annually. LANSCE alone was projected to require 437,000 megawatt-hours of electricity with a peak load demand of 63 megawatts, and 265 million gallons (1.03 billion liters) of water (DOE 1999a). LANSCE operations historically have accounted for up to one-quarter to one-half of LANL's total water and electrical power demand, respectively (LANL 2004c, 2006a). LANSCE projections in the *1999 SWEIS* included operation of the Low-Energy Demonstration Accelerator, which operated from late 1998 until it was shut down in December 2001 and later decommissioned (LANL 2006g). Operation of this facility was forecast to more than double LANSCE's electric peak load demand and its water demand for cooling tower operation (LANL 2006a), but it will not be a factor in future LANSCE operations. The *1999 SWEIS* did not project natural gas consumption for LANSCE or forecast utility infrastructure requirements for other Los Alamos County users.

Table 5–32 Summary of Environmental Consequences on Site Infrastructure

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
LANL Site			
Total Alternative (annual)	*Electricity requirements* 645,000 megawatt-hours total (495,000 megawatt-hours for LANL); 49 percent of system capacity. *Electric Peak Load* 111 megawatts total (91.2 megawatts for LANL); 74 percent of system capacity. *Natural gas requirements* 2,215,000 decatherms total (1,197,000 decatherms for LANL); 27 percent of system contract supply capacity. *Water requirements* 1,621 million gallons total (380 million gallons for LANL); 90 percent of system available water rights.	*Electricity requirements* 516,000 megawatt-hours total (366,000 megawatt-hours for LANL); 39 percent of system capacity. *Electric Peak Load* 80.6 megawatts total (60.4 megawatts for LANL); 54 percent of system capacity. *Natural gas requirements* 2,181,000 decatherms total (1,163,000 decatherms for LANL); 27 percent of system contract supply capacity. *Water requirements* 1,544 million gallons total (303 million gallons for LANL); 85 percent of system available water rights.	*Electricity requirements* 827,000 megawatt-hours total (677,000 megawatt-hours for LANL); 63 percent of system capacity. *Electric Peak Load* 144 megawatts total (124 megawatts for LANL); 96 percent of system capacity. *Natural gas requirements* 2,331,000 decatherms total (1,313,000 decatherms for LANL); 29 percent of system contract supply capacity. *Water requirements* 1,763 million gallons total (522 million gallons for LANL); 98 percent of system available water rights.
MDA Remediation (10-year total)	No change in utility demands	Same as No Action Alternative	Up to 70 million gallons of liquid fuels and 58 million gallons of water for remediation activities.
Security-Driven Transportation Modifications (project total)	No change in utility demands	Same as No Action Alternative	Up to 4.0 million gallons of liquid fuels and 20 million gallons of water for construction.
Affected Technical Areas			
TA-3	TA-3 Co-Generation Complex upgrades would have a positive incremental impact on site electrical energy and peak load capacity, but natural gas consumption could increase to support higher electricity generation. Negligible short-term increase in utility demands from constructing new office buildings, with no net increase in operational demands.	Same as No Action Alternative	Replacement Office Buildings–1.8 million gallons of liquid fuels and 9.6 million gallons of water for construction and an additional 0.356 million gallons of liquid fuels and 11.3 million gallons of water for DD&D; no net increase in utility demands for operations. Physical Science Research Complex–2.6 million gallons of liquid fuels and 14.4 million gallons of water for construction and an additional 0.129 million gallons of

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
			liquid fuels and 4.1 million gallons of water for DD&D; no net increase in utility demands for operations.
TA-18	No change in utility demands	Elimination of utility demands in TA-18 from Pajarito Site shutdown with a negligible decrease in site-wide demands.	DD&D of TA-18 Structures–activities are expected to require 0.273 million gallons of liquid fuels and 8.4 million gallons of water. As activities would be staggered over an extended period of time, overall increase in utility demands would be minimal.
TA-21	No change in utility demands	Same as No Action Alternative	DD&D of TA-21 Structures–activities are expected to require 0.043 million gallons of liquid fuels and 1.3 million gallons of water. As activities would be staggered over an extended period of time, overall increase in utility demands would be minimal.
TA-54	Negligible short-term increase in utility demands from MDA H closure activities.	Same as No Action Alternative	Same as No Action Alternative
TA-61	No change in utility demands	Same as No Action Alternative	Negligible temporary increase in utility demands, especially liquid fuels and water, from excavation.
Key Facilities			
Chemistry and Metallurgy Research Building (TA-3, TA-48, and TA-55)	Negligible short-term increase in utility demands from DD&D of old facility at TA-3 and construction of new facility at TA-55. Little or no change in utility demands from CMRR Facility operation when moved to TA-55.	No incremental change from transfer of nonnuclear activities to TA-55.	Same as No Action Alternative
Sigma Complex (TA-3)	No change in utility demands	Same as No Action Alternative	Same as No Action Alternative
Machine Shops	No change in utility demands	Same as No Action Alternative	Same as No Action Alternative
Materials Science Laboratory	No change in utility demands	Same as No Action Alternative	Same as No Action Alternative
Metropolis Center	No change in utility demands	Same as No Action Alternative	Moderate to major increase in electrical energy, peak load, and water demands over the No Action due to increased operational levels.
High Explosives Processing Facilities (TA-16)	Negligible short-term increase in utility demands from TA-16 Engineering Complex activities and demolition of structures.	Same as No Action Alternative	Potential negligible increase in operational utility demands.
High Explosives Testing Facilities (TA-6, TA-22, and TA-40)	Negligible to minor short-term increase in utility demands from construction of 15 to 25 new structures within the Twomile Mesa Complex and removal or demolition of vacated structures.	Same as No Action Alternative	Same as No Action Alternative

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Pajarito Site (TA-18)	No change in utility demands	Elimination of utility demands in TA-18 from Pajarito Site shutdown with a negligible decrease in site-wide demands.	DD&D of TA-18 Structures–activities are expected to require 0.273 million gallons of liquid fuels and 8.4 million gallons of water. As activities would be staggered over an extended period of time, overall increase in utility demands would be minimal.
Tritium Facilities (TA-21)	No change in utility demands	Same as No Action Alternative	TA-21 Structures DD&D activities are expected to require 0.043 million gallons of liquid fuels and 1.3 million gallons of water. As activities would be staggered over an extended period of time, overall increase in utility demands would be minimal.
Target Fabrication Facility	No change in utility demands	Same as No Action Alternative	Same as No Action Alternative
Bioscience Facilities	No change in utility demands	Same as No Action Alternative	Science Complex–4.3 million gallons of liquid fuels and 23 million gallons of water for construction; no net increase in utility demands for operations.
Radiochemistry Facility (TA-48)	No change in utility demands	Same as No Action Alternative	Radiological Science Institute–4.2 million gallons of liquid fuels and 22.4 million gallons of water for construction and an additional 0.101 million gallons of liquid fuels and 3.1 million gallons of water for DD&D; no net increase in utility demands for operations.
Radioactive Liquid Waste Treatment Facility (TA-50)	No change in utility demands	Same as No Action Alternative	Radioactive Liquid Waste Treatment Facility–1.04 million gallons of liquid fuels and 7.5 million gallons of water for construction and related DD&D; no net increase in utility demands for operations.
LANSCE (TA-53)	Moderate increase in operational utility demands from increase in annual hours of operation.	Moderate to major decrease in infrastructure utility demands in TA-53 and sitewide due to shut down of operations with a minor reduction within the Los Alamos region.	LANSCE Refurbishment–Negligible, short-term increase in utility demands from refurbishment. Moderate increase in electrical energy, peak load, and water demands over the No Action due to increased operational levels.
Solid Radioactive and Chemical Waste Facilities (TA-50 and TA-54)	No change in utility demands	Same as No Action Alternative	Waste Management Facilities Transition–Up to 0.893 million gallons of liquid fuels and 4.9 million gallons of water for TRU Waste Facility construction; negligible incremental increase in utility demands for operations.

	No Action Alternative	***Reduced Operations Alternative***	***Expanded Operations Alternative***
Plutonium Facility Complex (TA-55)	No change in utility demands	Negligible increase in utility demands from transfer of nonnuclear activities at CMR Building to TA-55.	Plutonium Facility Complex Refurbishment Negligible short-term increase in utility demands for construction and related DD&D; minor incremental increase in utility demands for operations to support increased pit production. Radiography Facility–0.042 million gallons of liquid fuels and 0.234 million gallons of water for construction; no net increase in utility demands for operations.
Remote Warehouse and Truck Inspection Station (TA-72)	No change in utility demands	Same as No Action Alternative	Up to 0.420 million gallons of liquid fuels and 2.0 million gallons of water for construction; negligible incremental increase in utility demands for operations.

MDA = material disposal area; TA = technical area, DD&D = decontamination, decommissioning, and demolition; CMRR = Chemistry and Metallurgy Research Replacement; LANSCE = Los Alamos Neutron Science Center, CMR = Chemistry and Metallurgy Research.
Note: To convert gallons to liters, multiply by 3.78533.

Table 5–33 Baseline Infrastructure Requirements and System Capacities for the Los Alamos National Laboratory Region of Influence

Resource	*System Capacity*	*Current Requirement (2005 [a])*		*Total Requirement*
		LANL	*Other Los Alamos County Users*	
Electricity				
Energy (megawatt-hours per year)	1,314,000 [b]	421,413	129,457	550,870
Peak load demand (megawatts)	150 [b]	69.5	18.3	87.8
Fuel				
Natural gas (decatherms per year)	8,070,000 [c]	1,187,855	943,559	2,131,414
Water (million gallons per year)	1,806 [d]	359	1,034	1,393

[a] Electric and fuel data for 2005 are fiscal year basis while water data are calendar year basis (see Sections 4.8.2.1, 4.8.2.2, and 4.8.2.3).
[b] Electrical energy and peak load capacity reflect the current import capacity of the electric transmission lines that deliver electric power to the Los Alamos Power Pool, as well as completion of upgrades at the TA-3 Co-Generation Complex, which will add 40 megawatts (350,400 megawatt-hours) of generating capacity. Values do not reflect completion of a new transmission line and other ongoing electrical power system upgrades.
[c] Reflects contractually limited capacity of the natural gas system serving the Los Alamos area (see Section 4.8.2.2).
[d] Equivalent to the total water rights from the regional aquifer managed by Los Alamos County.
Note: A decatherm is equivalent to 1,000 cubic feet.
Sources: Arrowsmith 2006, LANL 2006g.

While demand for key infrastructure resources (electricity, natural gas, and water) within the region of influence has generally followed an upward trend, there are notable exceptions. For electricity, total LANL demand increased by approximately 14 percent between 1999 and 2005, while other Los Alamos County user demands increased by 22 percent. In contrast, LANL natural gas consumption declined by nearly 17 percent between 1999 and 2005, but demand within the County increased by about 8 percent over roughly the same period. The decline at LANL is attributable to warmer-than-normal seasonal temperatures that have persisted since the early 1990s and a switch from district heating plants to more efficient systems at individual LANL facilities. Total LANL demand for water also decreased by nearly 21 percent between 1999 and 2005, but this was offset by an approximately 18 percent increase in demand among other Los Alamos County users, who account for the largest portion of total water use in the region of influence.

Los Alamos National Laboratory Site-Wide Impacts

Projected annual utility infrastructure requirements under the No Action Alternative are presented in **Table 5–34**. The No Action Alternative represents a future baseline that includes projects that have already been implemented to some degree (and may already be reflected in the current baseline values), are in the process of being implemented, or would be implemented fully between now and 2011. These projects are independent of subsequent project decisions at LANL, and their ongoing activities add to the overall increasing trend in utility infrastructure demand in the Los Alamos area as a whole.

Table 5–34 Projected Site Infrastructure Requirements under the No Action Alternative

Resource	LANL Requirements	Other Requirements [a]	Total Requirements	Percent of Capacity [b]
Electricity				
Energy (megawatt-hours per year)	495,000	150,000	645,000	49
Peak load demand (megawatts)	91.2	20.2	111	74
Fuel				
Natural gas (decatherms per year)	1,197,000	1,018,000	2,215,000	27
Water (million gallons per year)	380	1,241	1,621	90

[a] Projections through 2011 for electrical energy, peak load, natural gas, and water also include projected usage for other Los Alamos County users that rely upon the same utility system as LANL.
[b] A calculation based on the system capacity as shown in Table 5–33.
Note: A decatherm is equivalent to 1,000 cubic feet.
Sources: Projections based on Arrowsmith 2005, 2006, Glasco 2005, DOE 2002i, LANL 2000f, 2001e, 2002e, 2003h, 2004c, 2005f, 2006a, 2006g.

These infrastructure resource projections are made for operations levels at LANL Key Facilities actually approaching the operational levels forecast in the *1999 SWEIS* and associated ROD. The levels of operations forecast in the *1999 SWEIS* have not been realized to date, however, and LANL operational demands have trended well below the *1999 SWEIS* projections as a result (see Table 5–34). Some of the discrepancy between forecast and actual trends in infrastructure demands also reflect the rather conservative bounding approach used in the original estimates. As such, the projections made in this SWEIS, to the extent possible, account for those key factors that would prevent LANL operations from practically realizing the infrastructure resource demands forecast in the *1999 SWEIS*. Factors considered for LANSCE operations were previously discussed. While funding shortfalls have limited hours of operation at LANSCE and thus reduced utility demands, aging equipment physically limits the total operational availability of LANSCE such that the levels of operations forecast in the *1999 SWEIS* would not be reasonably foreseeable under the No Action Alternative for this SWEIS. Nonetheless, projections under the No Action Alternative do assume that easing of budgetary constraints and resumption of isotope production (as occurred in 2005) would result in an overall increase in annual hours of operation, with LANSCE utility demands approaching those recorded in years immediately prior to release of the *1999 SWEIS*.

No infrastructure capacity constraints are expected from implementation of the No Action Alternative in the short term because LANL operational and Los Alamos area demands on key infrastructure resources (electricity, natural gas, and water) have trended below previously forecasted levels. Under this alternative, total annual electricity, electric peak load, natural gas, and water requirements would be about 49 percent, 74 percent, 27 percent, and 90 percent, respectively, of the capacity of the utility systems that serve LANL.

Total peak load demand is projected to require 74 percent of the Los Alamos Power Pool's peak load capacity by 2011. This projection includes the generating capacity of the TA-3 Co-Generation Complex with an electric generating capacity of at least 40 megawatts after a new turbine became operational in September 2007. Ongoing upgrades to the electrical power transmission and distribution system, including construction of a third transmission line, would allow the import of additional power and support a higher electric peak load.

Natural gas is abundant in New Mexico, and the region has a high import capacity. Ongoing upgrades to the natural gas distribution system by the Public Service Company of New Mexico should ensure the adequacy and reliability of natural gas (see Chapter 4, Section 4.8.2.2). Completion of upgrades to the TA-3 Co-Generation Complex could make its use more attractive for electrical energy production by LANL than in the past; thus, the Complex could support an increase in natural gas consumption over time. Regardless, maintenance of an adequate capacity margin is forecast under the No Action Alternative.

Total water demand within the region of influence could approach 90 percent of Los Alamos County-managed rights to withdraw water from the regional aquifer, although projections indicate that LANL operational demands would remain within the site's annual water use ceiling quantity (542 million gallons [2,050 million liters]) under the No Action Alternative (see Chapter 4, Section 4.8.2.3). As described in Section 4.8.2.3, Los Alamos County has completed feasibility studies for accessing up to 391 million gallons (1,500 million liters) of water per year from the San Juan-Chama Transmountain Diversion Project; however, the earliest that this water could be made available for use would be 2010 (Glasco 2005).

Technical Areas Impacts

Under the No Action Alternative, construction and related DD&D requirements for electricity, fuels and water in the affected TAs are expected to be negligible, including those for Replacement Office Building construction, continued upgrades to the Co-Generation Complex in TA-3, and MDA H remediation and closure activities in TA-54. In the short term, these activities would entail short-term spikes in utility infrastructure resource demands on a TA basis, but would have negligible impacts on the capacities of affected utility systems and on the overall trend in utility resource demands.

Technical Area 3

New facility operations in TA-3 would likely have a negligible impact on overall trends in infrastructure resource requirements because the new facilities generally would replace older, less resource-efficient facilities. Further, upgrades at the TA-3 Co-Generation Complex would positively impact the Los Alamos Power Pool's electric power availability by increasing LANL's onsite generating capacity and improving the reliability of the complex, as discussed above. The completed upgrades, however, could contribute to higher natural gas consumption if the facility were required to provide more electricity in the future, as previously discussed.

Key Facilities Impacts

Completion of programmed construction projects and related DD&D activities, including the Chemistry and Metallurgy Research Replacement Facility at TA-55, the Weapons Manufacturing Support Facility at TA-16, and new Dynamic Experimentation Complex facilities within the Twomile Mesa Complex (part of TA-6, TA-22, and TA-40), would entail short-term spikes in utility resource demands. These activities would have a negligible impact on the capacity of affected utility systems and on the overall trend in utility resource demands.

Operation of these new facilities would not be expected to cause a measurable overall increase in utility infrastructure demands because modern facilities would replace antiquated, less resource-efficient facilities, creating an economy of scale in operational efficiency. For example, completing construction of the 15 to 25 new buildings within the Two-Mile Mesa Complex would replace about 59 structures currently used for such operations.

5.8.2.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Projected annual utility infrastructure requirements under the Reduced Operations Alternative are presented in **Table 5–35**. Utility infrastructure demand resulting from actions under the No Action Alternative would continue, with certain operational reductions, under this alternative. Reductions in the levels of high explosives processing and testing activities would have negligible-to-minor impacts on overall utility infrastructure requirements, but most other ongoing projects and activities included under the No Action Alternative also would move forward under the Reduced Operations Alternative. The entire LANSCE complex and TA-18 Pajarito Site, however, would be placed into safe shutdown mode under this alternative, although not all activities and associated utility demands would cease. LANSCE accelerator and support operations currently demand a relatively large share (about 22 and 15 percent in 2005) of LANL's electricity and water, respectively. As such, shutdown of LANSCE as part of the Reduced Operations Alternative would measurably reduce site-wide infrastructure resource demands compared to both the No Action Alternative and current operations. Under this alternative, total annual electricity, electric peak load, natural gas, and water requirements would be reduced to about 39 percent, 54 percent, 27 percent, and 85 percent, respectively, of the capacity of the utility systems that serve LANL.

Table 5–35 Projected Site Infrastructure Requirements under the Reduced Operations Alternative

Resource	*LANL Requirements*	*Other Requirements* [a]	*Total Requirements*	*Percent of Capacity* [b]
Electricity				
Energy (megawatt-hours per year)	366,000	150,000	516,000	39
Peak load demand (megawatts)	60.4	20.2	80.6	54
Fuel				
Natural gas (decatherms)	1,163,000	1,018,000	2,181,000	27
Water (million gallons per year)	303	1,241	1,544	85

[a] Projections through 2011 for electrical energy, peak load, natural gas, and water also include projected usage for other Los Alamos County users that rely on the same utility system as LANL.
[b] A calculation based on the system capacity as shown in Table 5–33.
Note: A decatherm is equivalent to 1,000 cubic feet.
Sources: Projections based on Arrowsmith 2005, 2006, Glasco 2005, DOE 2002i, LANL 2000f, 2001e, 2002e, 2003h, 2004c, 2005f, 2006a, 2006g.

Technical Area Impacts

Operational demands on utility infrastructure under this alternative would be similar to those under the No Action Alternative on a TA basis (except for TA-53) because base requirements would not be appreciably reduced due to high explosives processing and testing reductions.

Key Facilities Impacts

Los Alamos Neutron Science Center

Shutdown of LANSCE operations is projected to result in a moderate-to-major reduction in electrical energy, electric peak load demand, and water use at TA-53 compared to the demand under the No Action Alternative. This would specifically represent reductions of approximately 125,000 megawatt-hours in total electricity, 30.3 megawatts in electric peak load, and 73 million gallons (276 million liters) in water demand annually at LANSCE as compared to operational levels projected for the No Action Alternative. This action alone would result in a minor overall reduction in utility demands within the region of influence. Natural gas demand within the region would not be measurably affected on a percentage basis because LANSCE's operational demand for natural gas is a small percentage of that used by LANL as a whole and usage by LANL and other Los Alamos County users is affected more by weather and onsite electricity generation needs.

Pajarito Site

Shutdown of the Pajarito Site (TA-18) would result in a negligible site-wide decrease in operational utility needs.

5.8.2.3 Expanded Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Projected annual utility infrastructure requirements under the Expanded Operations Alternative are presented in **Table 5–36**. On a site-wide basis, numerous additional projects involving new facility construction, facility renovation, facility DD&D, and site closure activities affecting many TAs would occur under this alternative. Infrastructure requirements for these actions would be additive to those for actions identified as part of the No Action Alternative. Although these new activities collectively would result in a spike in utility resource demands, principally for liquid fuels and water, their contribution to the overall trend in site-wide or Los Alamos area demands would be minor due to the extended timeframe over which projects such as the MDA Remediation Project would be implemented. Liquid fuels, mainly diesel fuel and gasoline, would be required to operate heavy equipment, vehicles, and other worksite equipment; however, unlike natural gas, which is the principal heating fuel used at LANL, liquid fuels are not considered limiting resources because they can be procured from offsite sources and supplied at the point of use as needed.

For a number of new projects at LANL that involve DD&D of existing facilities whose capabilities would be replaced by newly constructed facilities, an economy of scale in operational efficiency would be achieved, resulting in a net decrease in utility demands. This economy of scale would tend to moderate the overall trend toward increasing utility demands at LANL and by Los Alamos County users that rely upon the same utility systems. Still, other projects would entail operational expansions that would result in a minor-to-moderate overall increase in demand for electricity, particularly in electric peak load demand, as well as water compared to projected demand under the No Action Alternative. Only minor increases in natural gas demand are forecast. Under the Reduced Operations Alternative, total annual electricity, electric peak load, natural gas, and water requirements would be about 63 percent, 96 percent, 29 percent, and 98 percent, respectively, of the capacity of the utility systems that serve LANL.

Table 5–36 Projected Site Infrastructure Requirements under the Expanded Operations Alternative

Resource	*LANL Requirements*	*Other Requirements* [a]	*Total Requirements*	*Percent of Capacity* [b]
Electricity				
Energy (megawatt-hours per year)	677,000	150,000	827,000	63
Peak load demand (megawatts)	124	20.2	144	96
Fuel				
Natural gas (decatherms)	1,313,000	1,018,000	2,331,000	29
Water (million gallons per year)	522	1,241	1,763	98

[a] Projections through 2011 for electrical energy, peak load, natural gas, and water also include projected usage for other Los Alamos County users that rely upon the same utility system as LANL.
[b] A calculation based on the system capacity as shown in Table 5–33.
Note: A decatherm is equivalent to 1,000 cubic feet.
Sources: Projections based on Arrowsmith 2005, 2006, Glasco 2005, DOE 2002i, LANL 2000f, 2001e, 2002e, 2003h, 2004c, 2005f, 2006a, 2006g.

The electric peak load capacity of the Los Alamos Power Pool could be approached due to increased operational demands at LANL combined with the trend of increasing demand that is forecast to persist for other Los Alamos County users. The predicted spike in electric peak load demand at LANL is primarily attributable to the Metropolis Center Increase in Levels of Operations and the proposed LANSCE Refurbishment Projects. Under the Expanded Operations Alternative, LANSCE operations would potentially require 208,000 megawatt-hours of electricity annually with a peak load demand of 51 megawatts, as compared to about 139,000 megawatt-hours of electricity with a peak load demand of 34 megawatts under the No Action Alternative. The Metropolis Center would require about 131,400 megawatt-hours of electricity annually with a peak load demand of 18 megawatts, as compared to about 44,000 megawatt-hours of electricity with a peak load demand of 6 megawatts under the No Action Alternative. As discussed for the No Action Alternative, ongoing upgrades to the electrical power transmission and distribution system, including construction of a third transmission line, would allow the import of additional power and support a higher electric peak load.

As previously described, heating demand and associated natural gas consumption at LANL has steadily declined in recent years despite higher overall activity levels at the site, mainly due to higher-than-normal seasonal temperatures. While this trend could be partly reversed by implementing the Expanded Operations Alternative for this SWEIS, including operation of the TA-3 Co-Generation Complex for electric power generation, the capacity of the Los Alamos area natural gas delivery system is expected to be adequate for the foreseeable future.

In recent years, combined LANL and county water demands have consumed between 80 and 90 percent of the currently developed water rights. Under the Expanded Operations Alternative, increased operations at LANL, combined with projected growth in the rest of Los Alamos County, could approach the county-managed rights to withdraw water from the regional aquifer. LANSCE operations would potentially require 119 million gallons (450 million liters) of water annually, as compared to up to about 77 million gallons (291 million liters) under the No Action

Alternative. The Metropolis Center could require up to 51 million gallons (193 million liters) of water annually, as compared to about 19 million gallons (72 million liters) under the No Action Alternative. Nevertheless, LANL operational demands are projected to remain within the site's annual water use ceiling quantity (542 million gallons [2,050 million liters]) under the Expanded Operations Alternative. As discussed under the No Action Alternative (see Section 5.8.2.1) and detailed in Chapter 4, Section 4.8.2.3, supplementing the Los Alamos County water supply system with San Juan-Chama water will be essential to ensuring that the region has adequate water supplies under this alternative and in the future.

Technical Area Impacts

Construction and related DD&D requirements for utility infrastructure resources, including electricity, fuels, and water, are expected to be negligible to minor for most actions, including construction of the Physical Science Research Complex and Replacement Office Buildings projects in TA-3 and the TA-18 and TA-21 Structure DD&D Projects. Implementation of the TA-21 Structure DD&D Project, which would include the natural-gas fired TA-21 steam plant, also would result in a negligible-to-minor reduction in LANL natural gas consumption because the plant's natural gas demand historically was smaller than 10 percent of site-wide demand and has decreased appreciably in recent years as NNSA missions in TA-21 have been relocated or discontinued.

Key Facilities Impacts

A number of project actions undertaken as part of this alternative would enhance the operational capabilities of Key Facilities, causing a net increase in infrastructure resource demands to support the increased level of operations. Specifically, the Metropolis Center Increase in Levels of Operations and LANSCE Refurbishment Projects would result in a minor-to-moderate increase in LANL infrastructure resource requirements and requirements within the region of influence to support higher levels of operations as described above. Increased pit production at TA-55 under this alternative would cause a minor increase in LANL infrastructure requirements because existing Plutonium Facility Complex operations currently constitute a relatively small percentage (generally 3 to 5 percent) of LANL's total demands. A very conservative estimate is that increased pit production at TA-55 could require an additional 8,500 megawatt-hours of electricity, 1.4 megawatts in electric peak load, 28,000 decatherms of natural gas, and 8.2 million gallons (31 million liters) of water annually.

5.9 Waste Management

Waste management impacts were evaluated based on the quantities of waste generated by Key Facilities, non-Key Facilities, and LANL's environmental restoration activities. Waste generation rates were used to measure the impacts on the LANL waste management infrastructure and local environment. Other impacts associated with waste management are addressed in the following sections: Air Quality (Section 5.4); Worker Health (Section 5.6.3); Transportation (Section 5.10); and Facility Accidents (Section 5.12). Waste management practices related to handling, treating, storing, and preparing for transport and disposal are described in Chapter 3 of this SWEIS.

Waste quantities were compiled by waste type and included process wastewaters (sanitary liquid waste, high-explosives-contaminated liquid waste, and industrial effluents); solid waste; and radioactive (including radioactive liquid) and chemical wastes. Due to the large number of construction and demolition projects now underway or planned at LANL, additional categories of construction and DD&D waste were included in the impacts analysis. LANL's environmental restoration wastes are presented as a separate category in this SWEIS.

Impacts associated with waste management were evaluated in the *1999 SWEIS* based on historical waste generation rates, projections of future waste generation, and the infrastructure in place to manage the wastes. With the exception of liquid waste, solid (sanitary) waste, and low-level radioactive waste, all LANL wastes were assumed to be disposed of offsite. For purposes of the transportation analysis (see Section 5.10) all wastes are assumed to be disposed of offsite.

In this analysis, the *1999 SWEIS* projections were reviewed and adjusted as needed to develop bounding values for the waste quantities associated with each alternative. As discussed in Chapter 4, Section 4.9, the *1999 SWEIS* projections adequately covered waste generated through facility operations; exceedances were the result of one-time events such as chemical cleanouts, maintenance, remediation, and cleanup following the Cerro Grande Fire.

In addition to wastes generated onsite, LANL historically has received small quantities of low-level radioactive and transuranic waste from offsite locations. Some of these wastes are generated by LANL activities at other locations and some by other DOE facilities that do not have the capability to manage the wastes. Receipt of these wastes by LANL is expected to continue at the historical rate of 5 to 10 waste shipments per year. The expected quantities of offsite waste would be small compared to the onsite waste generated and would be easily accommodated by the existing LANL waste management infrastructure.

In the sections that follow, waste generation rates for each facility are evaluated for the three alternatives. Bounding waste generation rates were projected for the No Action Alternative, considering the actions covered by the *1999 SWEIS* and any subsequent actions that have received independent NEPA analysis. Under the Reduced Operations Alternative, waste projections were selectively reduced to correspond to a lower level of operations. For the Expanded Operations Alternative, planned additional activities were considered and waste projections were increased as necessary to adequately bound the impacts. **Table 5–37** summarizes the waste management impacts associated with each of the alternatives.

5.9.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

The types and quantities of wastes expected to be generated by LANL operations under the No Action Alternative are generally the same as those presented for the Expanded Operations Alternative in the *1999 SWEIS*, but modified for a lower level of pit production.

Table 5–37 Summary of Total (Operations, Decontamination, Decommissioning, and Demolition, and Remediation) Waste Generation Projections by Alternative (Cumulative 2007 through 2016)

Waste Type	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Low-Level Radioactive Waste [a, b]			
Bulk low-level radioactive waste (cubic yards)	39,000	39,000	196,000 to 884,000
Packaged low-level radioactive waste (cubic yards)	33,000 to 128,000	33,000 to 110,000	80,000 to 183,000
High activity low-level radioactive waste (cubic yards)	–	–	0 to 347,000
Remote-handled low-level radioactive waste (cubic yards)	–	–	480 to 1,700
Mixed low-level radioactive waste (cubic yards)	1,800 to 2,800	1,800 to 2,800	3,900 to 183,000
Transuranic Waste			
Contact-handled (cubic yards) [a]	3,500 to 5,900	3,500 to 5,900	5,300 to 33,000
Remote-handled (cubic yards)	–	–	11 to 61
Construction and demolition debris [c] **(cubic yards)**	198,000	197,000	642,000 to 722,000
Chemical waste [d] **(pounds)**	19,000,000 to 37,000,000	19,000,000 to 36,000,000	64,000,000 to 129,000,000
Liquid Radioactive Waste			
Liquid transuranic waste (gallons)	300,000	300,000	500,000
Liquid low-level radioactive waste (at TA-50) (gallons)	40,000,000	40,000,000	50,000,000
Liquid low-level radioactive waste (at TA-53) (gallons)	1,400,000	50,000 [e]	1,400,000

TA = technical area.

[a] Operations waste volumes are assumed to be contact-handled transuranic waste and packaged low-level radioactive waste, although small volumes of other types could be generated.

[b] The subcategories of low-level radioactive waste do not necessarily meet precise definitions, but are used to assist in the analysis of disposal and transportation options and impacts.
- Bulk low-level radioactive waste = wastes that can be transported in large volumes in soft-sided containers.
- Packaged low-level radioactive waste = typical low-level radioactive waste packaged in drums or boxes.
- High-activity low-level radioactive waste = waste exceeding 10 CFR 61.55 Class A concentrations (greater than 10 nanocuries per gram of transuranic nuclides) and therefore is not accepted at certain facilities.
- Remote-handled low-level radioactive waste = waste with a dose rate exceeding 200 millirem per hour at the surface of the container.

[c] Construction and demolition debris includes uncontaminated wastes such as steel, brick, concrete, pipe, and vegetative matter from land clearance.

[d] Chemical waste includes wastes regulated under the Resource Conservation and Recovery Act, Toxic Substance Control Act, or state hazardous waste regulations.

[e] Under the Reduced Operations Alternative, operations at LANSCE would cease. Approximately 5,000 gallons (20,000 liters) of radioactive liquid waste per year from TA-50 would continue to be treated at TA-53.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.78533; for pounds to kilograms, multiply by 0.45359. Values have been rounded to the nearest hundred, thousand, or million.

Wastewaters are collected and managed in systems designed for each specific category of wastewater – sanitary liquid waste, high explosives-contaminated liquid waste, and industrial effluent. Sanitary wastes from across the LANL facility are delivered by dedicated pipeline to the Sanitary Wastewater System Plant at TA-46. The Sanitary Wastewater System Plant design capacity of 600,000 gallons (2.3 million liters) per day (DOE 1999a) is expected to be adequate for demand under the No Action Alternative. The treated wastewater is pumped to TA-3 for recycling in the Steam Plant cooling towers or is discharged into Outfall 001. Reuse of treated sanitary wastewater is expected to continue. Sludge from the treatment of sanitary wastewater will continue to be disposed of offsite as a New Mexico special waste. Offsite disposal capacity is expected to be adequate. (See Chapter 4, Section 4.9.1, for more details on sanitary wastewater treatment.)

Wastewaters containing high explosives compounds are generated by high explosives testing and processing activities. The High Explosives Wastewater Treatment Facility, located in TA-16, treats process waters containing high explosives compounds. Under the No Action Alternative, the High Explosives Wastewater Treatment Facility is expected to continue to operate within the 170,000-gallon (640,000-liter) projection for annual discharges included in the *1999 SWEIS* (DOE 1999a). (See Chapter 4, Section 4.9.1.3, for additional discussion of high explosives treatment.)

Industrial effluent is discharged to a number of NPDES-permitted outfalls across LANL. Currently, LANL facilities discharge wastewater to a total of 21 outfalls, down from the 55 identified in the *1999 SWEIS* (LANL 2005h). LANL's projected industrial effluent discharges would be approximately 280 million gallons (1.1 billion liters) per year under the No Action Alternative (see Section 5.3.1). (See Chapter 4, Section 4.9.1.4, for more details on industrial effluents.)

Sanitary waste generated at LANL is generally managed at a transfer station, where solid waste is sorted and consolidated for transport to an offsite landfill (LANL 2005a, 2006a. LANL conducts an aggressive waste minimization and recycling program, which greatly reduces the amount of sanitary waste requiring disposal (LANL 2004l). Sanitary solid waste includes both routine and nonroutine wastes. Routine waste is waste produced from any type of periodic or recurring work, including waste produced from production operations; analytical, and/or research and development laboratory operations; and treatment, storage, and disposal facility operations. Under the No Action Alternative, routine sanitary waste quantities are expected to be bounded at 5,000 tons (4,500 metric tons) per year.

Nonroutine waste is defined as one-time operations waste, including waste produced from construction, environmental restoration, and DD&D activities (LANL 2003e). Nonroutine waste quantities are projected for construction, DD&D, and environmental restoration wastes in the sections that follow. (Solid wastes from environmental restoration may be sent directly to an offsite facility rather than being processed through the transfer station.) Under the No Action Alternative, three major construction projects would generate significant quantities of construction wastes: TA-16 Refurbishment, Chemistry and Metallurgy Research Replacement Facility at TA-55, and consolidation of certain activities at the Dynamic Experimentation Complex at TA-6, TA-22, and TA-40. Construction wastes associated with these projects are expected to total about 12,000 cubic yards (9,200 cubic meters) (DOE 2002l, 2003d, 2003e). Generally, construction wastes may be disposed of in a solid waste landfill or a construction and demolition debris landfill; offsite disposal capacity is expected to be adequate.

Under the No Action Alternative, DD&D wastes would be generated by six projects, as detailed in **Table 5–38**. Although large quantities of demolition debris and low-level radioactive waste could be generated under this alternative, most wastes could be disposed of offsite and offsite capacity is expected to be sufficient. Chemistry and Metallurgy Research Building DD&D would likely not occur until after 2015, after the new Chemistry and Metallurgy Research Replacement Facility is operational. Waste generated by the demolition process for that structure would likely involve both onsite and offsite disposal capacity.

Table 5–38 Wastes from Decontamination, Decommissioning, and Demolition Activities – No Action Alternative (cubic yards)

Decontamination, Decommissioning, and Demolition Project	*Bulk Low-Level Radioactive Waste*	*Packaged Low-Level Radioactive Waste*	*Mixed Low-Level Radioactive Waste*	*Demolition Debris*	*Chemical Waste [a] (pounds)*
TA-16	8	3	–	5,800	51,000
Los Alamos Site Office	–	–	–	10,000	486,000
General Excess Facilities	13,900	4,600	26	128,000	246,000
Dynamic Experimentation Buildings [b]	–	20	–	21,000	781,000
Chemistry and Metallurgy Research Building [c]	12,000	4,000	280	20,000	280,000
LANSCE Area A [d]	4,000	–	89	520	3,000
Total [e]	30,000	8,700	400	186,000	1,847,000

TA = technical area, RCRA = Resource Conservation and Recovery Act, TSCA = Toxic Substances Control Act, LANSCE = Los Alamos Neutron Science Center.

[a] Chemical waste includes RCRA hazardous waste and TSCA waste (asbestos).

[b] Values from *Dynamic Experimentation EA* (DOE 2003e).

[c] Values from the *Chemistry and Metallurgy Research Building Replacement EIS* (DOE 2003d) and *Preliminary Chemistry and Metallurgy Research Building Disposition Study* (LANL 2003a).

[d] Values from the *1999 SWEIS* (DOE 1999a) and *National Environmental Policy Act Review LAN-05-018* (LANL 2006a).

[e] Totals may not add due to rounding.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Wastes generated by LANL's environmental restoration activities are presented separately from operational wastes. These nonroutine waste quantities vary widely from year to year and could differ significantly from projections due to selection of remedies and actual site-specific conditions encountered during field activities. Low-level radioactive waste generated by LANL's environmental restoration activities could be disposed of onsite at TA-54 Area G or offsite at a commercial or DOE disposal facility. Chemical waste quantities generated by LANL's environmental restoration activities are expected to be substantial (LANL 2004g); however, offsite capacity for all waste types is expected to be sufficient.

The expected impacts of waste generation are discussed below for each category of chemical and radioactive waste. Projections of chemical and radioactive waste quantities are presented in **Table 5–39**. The information presented is based on the *1999 SWEIS* projections, which were updated with information from the *Waste Volume Forecast* prepared in June 2003 (LANL 2003e) and updated in September 2004 (LANL 2004g) and information from LANL staff (LANL 2006a). The *Forecast* integrates historical generation data with near- and long-term program plans (LANL 2003e). To aid the analysis, waste categories were further characterized as routine or nonroutine.

Table 5–39 Radioactive and Chemical Waste Projections from Routine Operations – No Action Alternative

Key and Non-Key Facilities	Waste Projections (cubic yards per year) [a]			
	Low-Level Radioactive Waste	Mixed Low-Level Radioactive Waste	Transuranic Waste	Chemical Waste (pounds per year)
Chemistry and Metallurgy Research Building [b]	2,400 [b]	25	55 [b]	24,000
Sigma Complex	1,300	5	0	22,000
Machine Shops	790	0	0	1,045,000
Materials Science Laboratory	0	0	0	1,300
Metropolis Center [c]	0	0	0	0
High Explosives Processing Facilities	20	<1	0	29,000
High Explosives Testing Facilities	1,200	10 [d]	<1	78,000
Tritium Facilities	630	4	0	3,800
Pajarito Site	190	2	0	8,800
Target Fabrication Facility	13	<1	0	8,400
Bioscience Facilities	45	4	0	29,000
Radiochemistry Facility	350	5	0	7,300
Radioactive Liquid Waste Treatment Facility [e]	330	3	13	880
Los Alamos Neutron Science Center	1,400	1	0	37,000
Solid Radioactive and Chemical Waste Facilities [f]	300 [g]	10 [g]	35	2,000
Plutonium Facility Complex	990	20	440	19,000
Non-Key Facilities	2,000 [h]	40	30 [h]	1,435,000
TOTAL [i]	12,000	130	570	2,749,000

[a] Projected values from *1999 SWEIS* ROD, as documented in the *2004 SWEIS Yearbook* (LANL 2005f), unless otherwise noted. Projections are based upon expected, routine facility operations and do not include wastes from nonroutine events such as chemical cleanouts and construction projects.
[b] Values reflect a pit production level of 20 pits per year.
[c] Value was not projected in the *1999 SWEIS* ROD. The Metropolis Center was not a designated Key Facility at that time. No wastes are projected for this facility.
[d] Value adjusted upward from *1999 SWEIS* projection based on projected waste volumes resulting from hydrotesting activities (LANL 2006a).
[e] Values adjusted from *1999 SWEIS* projections based on historical generation rates and new projections (LANL 2006a).
[f] This Key Facility includes the Legacy Transuranic Waste Retrieval Program and the Off-Site Source Recovery Project.
[g] Value adjusted upward from *1999 SWEIS* ROD projection based on projections in the 2004 revision to the *Waste Volume Forecast* (LANL 2004g).
[h] Value adjusted upward from *1999 SWEIS* projection based on historical generation rates and projections in the 2004 revision to the *Waste Volume Forecast* (LANL 2004g). Low-level radioactive waste increases are attributable to heightened activities and new construction. Transuranic waste increases are attributable to waste generated by the Off-Site Source Recovery Project; because this waste comes from shipping and receiving, it is attributed to non-Key Facilities (LANL 2006g).
[i] Totals may not add because all values have been rounded.

Note: To convert pounds to kilograms, multiply by 0.45359; for cubic yards to cubic meters, multiply by 0.76456. Values have been rounded to the nearest hundred, thousand, or million.

Low-Level Radioactive Wastes—Routine low-level radioactive waste generation has been declining (LANL 2003e) and is expected to continue in this direction under the No Action Alternative. Some fluctuations in facility-specific generation rates are expected. For example, the High Explosives Testing Key Facilities, due to increased numbers of hydrotests, are projected to double their average low-level radioactive waste generation (LANL 2004g). In addition, relocating the actinide processing and recovery capability to the Chemistry and Metallurgy Research Replacement Facility may increase low-level radioactive waste quantities by up to 24 cubic yards (18 cubic meters) per year (DOE 2003d). Table 5–39 presents the projected annual low-level radioactive waste quantities from routine operations at Key and non-Key Facilities. The TA-54 Area G expansion into Zone 4 is designed to provide 40 years of disposal capacity for operational low-level radioactive waste, assuming a disposal rate of about 3,900 cubic yards (3,000 cubic meters) per year. In addition, offsite disposal capacity is available and, together with onsite capacity, is expected to be adequate for wastes generated under the No Action Alternative.

Mixed Low-Level Radioactive Wastes—The pattern for mixed low-level radioactive waste generation is similar to that for low-level radioactive waste, with routine generation declining and LANL's environmental restoration-generated quantities varying widely (LANL 2004g). Table 5–39 presents the projected annual mixed low-level radioactive waste quantities from routine operations at Key and non-Key Facilities.

Transuranic and Mixed Transuranic Wastes—In the *Waste Volume Forecast*, transuranic and mixed transuranic categories have been combined for discussion; both waste categories are managed for disposal at WIPP. Higher generation rates, up to about 1600 cubic yards (1,200 cubic meters) per year LANL-wide, are projected for the short term (2005 through 2007), primarily due to activities under the Legacy Transuranic Waste Retrieval Program and several nuclear materials programs (LANL 2004g). The Nuclear Materials Technology vault cleanout would contribute nonroutine transuranic wastes for the short term. Pit production activities (up to 20 pits per year) are expected to yield quantities of transuranic and mixed transuranic wastes at the Plutonium Facility Complex. Relocating the actinide processing and recovery capability to the Chemistry and Metallurgy Research Replacement Facility may increase transuranic waste quantities by 8 cubic yards (6.1 cubic meters) per year (DOE 2003c). After 2007, most transuranic wastes would be generated through routine activities (LANL 2003e). The WIPP capacity attributed to newly-generated transuranic waste from LANL is about 14,000 cubic yards (10,800 cubic meters) (DOE 2002f), which is expected to be adequate for wastes generated under the No Action Alternative. Table 5–39 presents the projected annual transuranic quantities from routine operations at Key and non-Key Facilities.

Chemical Wastes—Routine chemical waste generation has been trending downward (LANL 2003e) and is expected to continue in this direction under the No Action Alternative. Bulk chemical wastes generated by LANL operations and environmental restoration activities make up approximately 90 percent of the chemical and hazardous waste generated across LANL (LANL 2003e). Although LANL's environmental restoration waste quantities are highly variable, operational bulk chemical waste is generated primarily at the Sanitary Wastewater Systems Plant in steady quantities. Nonbulk chemical and hazardous wastes are generated by a wide range of operations at LANL (LANL 2004g). Approximately half of the nonbulk chemical waste is not regulated as hazardous by the State of New Mexico, but this waste does not meet waste acceptance criteria for disposal at a solid waste landfill (LANL 2003e). Generation rates for nonbulk chemical and hazardous wastes from operations are expected to remain steady under the No Action Alternative (LANL 2003e). Scheduled cleanouts of outdated or unused chemicals periodically could increase annual quantities for specific facilities (LANL 2004g). Table 5–39 presents the projected annual chemical waste quantities from routine operations at Key and non-Key Facilities.

Radioactive Liquid Waste Treated at LANL—Radioactive liquid waste is treated at three locations, TA-21, TA-50 and TA-53. Treatment at TA-21 would continue only until all DD&D activities at this TA are complete. The Radioactive Liquid Waste Treatment Facility at TA-50 continues to treat the majority of radioactive liquid wastes generated at LANL. Treated radioactive liquid waste quantities at the Radioactive Liquid Waste Treatment Facility, including acid and caustic radioactive liquid waste treated in Room 60, are projected in **Table 5–40**. If hydrotesting activities at the High Explosives Testing Facilities continue to use foam as a containment matrix, up to 66,000 gallons (250,000 liters) of additional radioactive liquid waste annually may be treated at the Radioactive Liquid Waste Treatment Facility, but these quantities are well within projected treatment volumes. Quantities of radioactive liquid wastes at TA-53 are also included in Table 5–40.

Table 5–40 Radioactive Liquid Waste Treated at Los Alamos National Laboratory – No Action Alternative

Waste Treatment Activity	*Projection*
Pretreatment of radioactive liquid waste at TA-21	(a)
Pretreatment of transuranic liquid waste from TA-55 in Room 60	30,000 gallons (110,000 liters) per year
Solidification of transuranic sludge at TA-50	16 cubic yards (12 cubic meters) per year
Radioactive liquid waste treated at TA-50	4,000,000 gallons (15,000,000 liters) per year
Secondary treatment of radioactive liquid waste at TA-50	260,000 gallons (1,000,000 liters) per year
De-water low-level radioactive waste sludge at TA-50	70 cubic yards (50 cubic meters) per year
Radioactive liquid waste treated at TA-53	140,000 gallons (520,000 liters) per year [b]
Transport evaporator bottoms to Tennessee	66,000 gallons (250,000 liters) per year
Receive solidified evaporator bottoms from Tennessee [c]	25 cubic yards (20 cubic meters) per year

TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] No new radioactive liquid waste is being generated at TA-21, and all inventory that existed in tanks and equipment was processed or transported to TA-54 in 2006.

[b] Radioactive liquid waste treated at TA-53 includes waste volumes from LANSCE plus approximately 5,000 gallons (20,000 liters) per year from TA-50.

[c] This is solid low-level radioactive waste that is disposed of at TA-54.

Source: LANL 2006a.

Summary—Waste management impacts from LANL operations under the No Action Alternative are expected to remain within the capacity of the LANL waste management infrastructure. **Table 5–41** summarizes the waste quantities estimated for operations, DD&D, and environmental restoration activities under the No Action Alternative. Although the summary table provides waste projections only through 2016, impacts from operations are expected to continue at comparable rates for the longer term. For operational waste, waste projections are presented as a range, with the lower end of the range representing the quantity projected in the *Waste Volume Forecast* (LANL 2004g) and the upper end representing the *1999 SWEIS* projection, except as noted. For this summary table, the transuranic and low-level radioactive waste categories have been further subdivided (contact- and remote-handled transuranic) to facilitate identification of offsite disposal options and analysis of transportation impacts.

Table 5–41 Summary of Waste Types by Generator Category – No Action Alternative (Cumulative 2007 through 2016) (in cubic yards)

Waste Type	*Operational Waste* [a]	*DD&D Waste* [b]	*Remediation Waste* [c]	*Total*
Low-Level Radioactive Waste [d]				
Bulk low-level radioactive waste	–	30,000	8,800	39,000
Packaged low-level radioactive waste	25,000 to 120,000	8,700	–	33,000 to 128,000
High Activity low-level radioactive waste	–	–	–	–
Remote-handled low-level radioactive waste	–	–	–	–
Mixed Low-Level Radioactive Waste	270 to 1,300	400	1,100	1,800 to 2,800
Transuranic Waste				
Contact-handled	3,300 to 5,700	0	210	3,500 to 5,900
Remote-handled	–	–	–	–
Construction and Demolition Debris [e]	12,000 [f]	186,000	–	198,000
Chemical Waste [g] **(pounds)**	9,997,000 to 27,000,000	1,847,000	7,513,000	19,000,000 to 37,000,000

DD&D = decontamination, decommissioning, and demolition; TA = technical area; LANSCE = Los Alamos Neutron Science Center; MDA = material disposal area; CMRR = Chemistry and Metallurgy Research Replacement.

[a] Operations waste volumes are represented as a range, with the lower end represented by best-estimate values documented in the Waste Volume Forecasts (LANL 2003e, 2004g), and the upper end represented by the bounding *1999 SWEIS* projections (DOE 1999a), adjusted as detailed in Table 5–39. These wastes are assumed to be contact-handled transuranic waste and packaged low-level radioactive waste, although small volumes of other types could be generated.

[b] DD&D waste quantities were estimated for the following projects: TA-16 Refurbishment, Los Alamos Site Office Building Replacement, General Excess Facilities, CMRR Facility, LANSCE Area A Renovation, and consolidation of certain activities at the Dynamic Experimentation Complex at TA-6, TA-22, and TA-40.

[c] Details of LANL's environmental restoration activities and resulting wastes are provided in Appendix I.

[d] The subcategories of low-level radioactive waste do not necessarily meet precise definitions, but are used to assist in the analysis of disposal and transportation options and impacts.
- Bulk low-level radioactive waste = wastes that can be transported in large volumes in soft-sided containers.
- Packaged low-level radioactive waste = typical low-level radioactive waste packaged in drums or boxes.
- High-activity low-level radioactive waste = waste exceeding 10 CFR 61.55 Class A concentrations (greater than 10 nanocuries per gram of transuranic nuclides), which is not accepted at certain facilities.
- Remote-handled low-level radioactive waste = waste with a dose rate exceeding 200 millirem per hour at the surface of the container.

[e] Construction and demolition debris includes uncontaminated wastes such as steel, brick, concrete, pipe, and vegetative matter from land clearance.

[f] Construction debris quantities were estimated for the following projects: TA-16 Refurbishment, Chemistry and Metallurgy Research Replacement Facility, and consolidation of certain activities at the Dynamic Experimentation Complex at TA-6, TA-22, and TA-40.

[g] Chemical waste includes wastes regulated under Resource Conservation and Recovery Act, Toxic Substance Control Act, or state hazardous waste regulations.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; for pounds to kilograms, multiply by 0.45359. Totals may not add because values have been rounded to the nearest hundred, thousand, or million.

Most wastes, with the exception of some low-level radioactive waste, are disposed of offsite at permitted facilities designed for specific categories of wastes. The expansion of TA-54 Area G into Zone 4 is expected to provide onsite low-level radioactive waste disposal capacity for operations waste through the 2016 timeframe and beyond. Because of the difficulties in accurately predicting the volumes of wastes generated by LANL's environmental restoration activities, some variances from projections are possible in future years. The waste management infrastructure at LANL has adequate staffing and facilities to manage the quantities of waste expected to be generated under the No Action Alternative.

5.9.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Many of the waste management impacts under the Reduced Operations Alternative would be the same as those under the No Action Alternative. Wastewaters, including sanitary liquid waste, high explosives-contaminated liquid waste, and industrial effluent, would be collected and managed in systems designed for each category of waste. High explosive-contaminated waste quantities would be reduced by about 20 percent as operations are scaled back at the High Explosives Processing and Testing Facilities. Sanitary waste generated at LANL would generally be managed at a transfer station, where solid waste is sorted and consolidated for transport to an offsite landfill (LANL 2005a). (Solid waste from environmental restoration may be sent directly to an offsite facility rather than through the transfer station.) As discussed under the No Action Alternative, waste minimization and recycling activities would reduce the quantities of solid waste disposed of. Waste management impacts associated with construction and DD&D activities would be similar to those for the No Action Alternative. Construction waste from the Chemistry and Metallurgy Research Replacement Facility would be about 500 cubic yards (382 cubic meters) smaller than that for the No Action Alternative, and DD&D of the Chemistry and Metallurgy Research Building may be further delayed beyond 2015.

Under the Reduced Operations Alternative, smaller quantities of some radioactive and chemical wastes would be generated due to shutdown of the Pajarito Site and LANSCE, as well as reductions in high explosives processing and testing. Projections of chemical and radioactive waste quantities from routine operations at Key and non-Key Facilities are presented in **Table 5–42**.

Radioactive liquid waste treatment would be the same as under the No Action Alternative, with the exception of limited treatment at TA-53 as LANSCE operations are halted; some liquid wastes with high tritium content from TA-50 could continue to be processed at TA-53. Radioactive liquid waste treatment quantities are presented in **Table 5–43**.

Table 5–42 Radioactive and Chemical Waste Projections from Routine Operations – Reduced Operations Alternative

Key and Non-Key Facilities	Waste Projections (cubic yards per year) [a]			
	Low-Level Radioactive Waste	Mixed Low-Level Radioactive Waste	Transuranic Waste	Chemical Waste (pounds per year)
Chemistry and Metallurgy Research Building [b]	2,400	25	55	24,000
Sigma Complex	1,300	5	0	22,000
Machine Shops	790	0	0	1,045,000
Materials Science Laboratory	0	0	0	1,300
Metropolis Center [c]	0	0	0	0
High Explosives Processing Facilities	15 [d]	<1 [d]	0	23,000 [d]
High Explosives Testing Facilities	980 [d]	8	<1 [d]	62,000 [d]
Tritium Facilities	630	4	0	3,800
Pajarito Site [f]	0	0	0	0
Target Fabrication Facility	13	<1	0	8,400
Bioscience Facilities	45	4	0	29,000
Radiochemistry Facility	350	5	0	7,300
Radioactive Liquid Waste Treatment Facility [g]	330	3	13	880
Los Alamos Neutron Science Center [h]	5	1	0	0
Solid Radioactive and Chemical Waste Facilities [i]	300 [j]	10 [j]	35	2,000
Plutonium Facility Complex	990	20	440	19,000
Non-Key Facilities	2,000 [k]	40	30 [k]	1,435,000
Total [l]	10,000	130	570	2,682,000

[a] Projected values are from the *1999 SWEIS* ROD, as documented in the *2004 SWEIS Yearbook* (LANL 2005f), unless otherwise noted. Projections are based upon expected, routine facility operations and do not include wastes from nonroutine events such as chemical cleanouts and construction projects.
[b] Values reflect a pit production level of 20 pits per year.
[c] Value was not projected in *1999 SWEIS* ROD. The Metropolis Center was not a designated Key Facility at that time.
[d] A 20 percent reduction from No Action levels is projected, based on a 20 percent reduction in operations.
[e] Value adjusted upward from 1999 SWEIS projection based on projected waste volumes from hydrotesting activities (LANL 2006a).
[f] No wastes would be generated at TA-18 as activities are ceased.
[g] Values adjusted from *1999 SWEIS* projections based on historical generation rates and new projections (LANL 2006a).
[h] Only small quantities of waste would be generated as LANSCE operations are halted and the facility is maintained in standby mode.
[i] This Key Facility includes the Legacy Transuranic Waste Retrieval Program and the Off-Site Source Recovery Project.
[j] Value adjusted upward from *1999 SWEIS* ROD projection based on projections in the 2004 revisions to the *Waste Volume Forecast* (LANL 2004g).
[k] Value adjusted upward from *1999 SWEIS* projection based on historical generation rates and projections in the 2004 revisions to the *Waste Volume Forecast* (LANL 2004g). Low-level radioactive waste increases are attributable to heightened activities and new construction. Transuranic waste increases are attributable to waste generated by the Off-Site Source Recovery Project; because this waste comes from shipping and receiving, it is attributed to non-Key Facilities.
[l] Totals may not add due to rounding. Values have been rounded to the nearest hundred, thousand, or million.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; for pounds to kilograms, multiply by 0.45359.

Table 5–43 Radioactive Liquid Waste Treated at Los Alamos National Laboratory – Reduced Operations Alternative

Waste Treatment Activity	*Projection*
Pretreatment of radioactive liquid waste at TA-21	(a)
Pretreatment of transuranic liquid waste from TA-55 in Room 60	30,000 gallons (110,000 liters) per year
Solidification of transuranic sludge at TA-50	16 cubic yards (12 cubic meters) per year
Radioactive liquid waste treated at TA-50	4,000,000 gallons (15,000,000 liters) per year
Secondary treatment of radioactive liquid waste at TA-50	260,000 gallons (1,000,000 liters) per year
De-water low-level radioactive waste sludge at TA-50	70 cubic yards (50 cubic meters) per year
Radioactive liquid waste treated at TA-53	5,000 gallons (20,000 liters) per year [b]
Transport evaporator bottoms to Tennessee	66,000 gallons (250,000 liters) per year
Receive solidified evaporator bottoms from Tennessee [c]	25 cubic yards (20 cubic meters) per year

TA = technical area.
[a] No new radioactive liquid waste is being generated at TA-21, and all inventory that existed in tanks and equipment was processed or transferred to TA-54 in 2006.
[b] Under the Reduced Operations Alternative, operations at the LANSCE facility would cease. Approximately 5,000 gallons (20,000 liters) of radioactive liquid waste per year from TA-50 would continue to be treated at TA-53.
[c] This is solid low-level radioactive waste that is disposed of at TA-54.
Source: LANL 2006a.

Summary—Waste management impacts from LANL operations under the Reduced Operations Alternative are expected to be similar to those under the No Action Alternative, with some reductions in waste quantities due to the closure of LANSCE and the Pajarito Site and reduced operational levels at the High Explosives Facilities. **Table 5–44** summarizes the waste quantities estimated for operations, DD&D, and environmental restoration activities under the Reduced Operations Alternative. Although the summary table provides waste projections only through 2016, impacts from operations are expected to continue at comparable rates for the longer term. For operational waste, waste projections are presented as a range, with the lower end of the range representing the quantity projected in the *Waste Volume Forecast* (LANL 2004g) and the upper end representing the *1999 SWEIS* projection, except as noted. The waste management infrastructure at LANL has adequate staffing and facilities to manage the quantities of waste expected to be generated under the Reduced Operations Alternative.

5.9.3 Expanded Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Many of the waste management impacts under the Expanded Operations Alternative would be the same as under the No Action Alternative although certain waste volumes would periodically increase. Wastewaters, including sanitary liquid waste, high explosives-contaminated liquid waste, and industrial effluent, would be collected and managed in systems designed for each category of waste. Sanitary waste generated at LANL would generally be managed at a transfer station where solid waste is sorted and consolidated for transport to an offsite landfill (LANL 2005a). (Large quantities of solid wastes from construction, DD&D, and environmental restoration may be shipped directly to an offsite disposal facility rather than being processed through the transfer station.) Waste minimization and recycling activities would reduce the quantities of solid waste disposed of.

Table 5–44 Summary of Waste Types by Generator Category – Reduced Operations Alternative (Cumulative 2007 through 2016) (in cubic yards)

Waste Type	*Operational Waste* [a]	*DD&D Waste* [b]	*Remediation Waste* [c]	*Total*
Transuranic Waste				
Contact-handled	3,300 to 5,700	–	210	3,500 to 5,900
Remote-handled	–	–	–	–
Low-Level Radioactive Waste [d]				
Bulk low-level radioactive waste	–	30,000	8,800	39,000
Packaged low-level radioactive waste	25,000 to 101,000	8,700	–	33,000 to 110,000
High-activity low-level radioactive waste	–	–	–	–
Remote-handled low-level radioactive waste	–	–	–	–
Mixed Low-Level Radioactive Waste	270 to 1,300	400	1,100	1,800 to 2,800
Construction and Demolition Debris [e]	12,000 [f]	186,000	–	198,000
Chemical Waste [g] **(pounds)**	9,997,000 to 27,000,000	1,847,000	7,513,000	19,000,000 to 36,000,000

DD&D = decontamination, decommissioning, and demolition.

[a] Operations waste volumes are represented as a range, with the lower end represented by best-estimate values documented in the *Waste Volume Forecasts* (LANL 2003e, 2004g) and the upper end represented by the bounding *1999 SWEIS* projections (DOE 1999a), adjusted as detailed in Table 5–42. These wastes are assumed to be contact-handled transuranic waste and packaged low-level radioactive waste, although small volumes of other types could be generated.

[b] DD&D waste quantities are the same as those under the No Action Alternative.

[c] Environmental restoration-related waste quantities are the same as those under the No Action Alternative. These waste estimates do not include an additional 600 cubic yards of chemical waste, and 4,800 cubic yards of bulk low-level radioactive waste may be generated by a removal action.

[d] The subcategories of low-level radioactive waste do not necessarily meet precise definitions, but are used to assist in the analysis of disposal and transportation options and impacts.
- Bulk low-level radioactive waste = wastes that can be transported in large volumes in soft-sided containers.
- Packaged low-level radioactive waste = typical low-level radioactive waste packaged in drums or boxes.
- High-activity low-level radioactive waste = waste exceeding 10 CFR 61.55 Class A concentrations (greater than 10 nanocuries per gram of transuranic nuclides), which is not accepted at certain facilities.
- Remote-handled low-level radioactive waste = waste with a dose rate exceeding 200 millirem per hour at the surface of the container.

[e] Construction and demolition debris includes uncontaminated wastes such as steel, brick, concrete, pipe, and vegetative matter from land clearance.

[f] Construction debris quantities are about 500 cubic yards (382 cubic meters) smaller than those for the No Action Alternative.

[g] Chemical waste includes wastes regulated under RCRA, TSCA, or state hazardous waste regulations.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; for pounds to kilograms, multiply by 0.45359. Totals may not add because values have been rounded to the nearest hundred, thousand, or million.

Waste management impacts associated with DD&D activities would increase under the Expanded Operations Alternative, as detailed in **Table 5–45**. Large quantities of demolition debris and bulk low-level radioactive waste wastes are expected from DD&D actions, along with smaller quantities of transuranic and mixed low-level radioactive waste and sanitary, asbestos, and hazardous wastes. Most of the waste would be disposed of offsite. Demolition debris may be sent to any solid waste landfill permitted to accept it. Low-level radioactive waste may be disposed of at TA-54 Area G or sent offsite to DOE or commercial facilities. Additional construction waste would be generated as new facilities are constructed under this alternative. **Table 5–46** summarizes the quantities of construction wastes associated with major new construction under the Expanded Operations Alternative.

Table 5–45 Wastes from Decontamination, Decommissioning, and Demolition Activities – Expanded Operations Alternative (cubic yards)

DD&D Project	*Contact-Handled Transuranic Waste*	*Bulk Low-Level Radioactive Waste*	*Packaged Low-Level Radioactive Waste*	*Mixed Low-Level Radioactive Waste*	*Demolition Debris*	*Chemical Waste [a] (pounds)*
No Action Total [b]	–	30,000	8,700	400	186,000	1,847,000
Physical Science Research Complex	–	13,000	4,300	< 1	177,000	314,000
Replacement Office Buildings	–	23	8	–	6,900	–
Radiological Sciences Institute	1,100 [c]	72,000	23,000 [c]	1,000	77,000	988,000
Radioactive Liquid Waste Treatment Facility Upgrade [d]	230	7,700	2,600	150	1,800	212,000
Plutonium Refurbishment	340	970	320	220	2,100	2,000
TA-18 Closure	–	4,700	–	5	17,000	75,000
TA-21 Structure	1	26,000	8,600	65	47,000	422,000
Waste Management Facilities Transition	–	23,000	7,600	8	54,000	566,000
Total [e]	1,700	177,000	56,000	1,900	569,000	4,425,000

DD&D = decontamination, decommissioning, and demolition; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act.

[a] Chemical waste includes RCRA hazardous waste and TSCA waste (asbestos).

[b] Details of the DD&D waste volumes generated under the No Action Alternative are provided in Table 5–38.

[c] In addition to these volumes, DD&D associated with the Radiological Sciences Institute is expected to generate 479 cubic yards of remote-handled low-level radioactive waste and 11 cubic yards of remote-handled transuranic waste.

[d] Waste volumes reflect the option that generates the most waste.

[e] Totals may not add because all values have been rounded to the nearest hundred, thousand, or million.

Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Table 5–46 Construction Wastes [a] – Expanded Operations Alternative

Construction Project	*Waste Generated (cubic yards)*
No Action Total	12,000
Physical Science Research Complex	1,600
Replacement Office Buildings	1,700
Radiological Sciences Institute	2,800
Radioactive Liquid Waste Treatment Facility Upgrade	1,200
TA-55 Radiography Facility	24
Plutonium Facility Complex Refurbishment	690
Science Complex	3,300
Remote Warehouse and Truck Inspection Station	610
Waste Management Facilities Transition	500
Security-Driven Transportation Modifications	1,500
Total	26,000

TA = technical area.

[a] Construction debris includes uncontaminated wastes such as steel, brick, concrete, pipe and vegetative matter from land clearance.

Note: Totals may not add because values have been rounded to the nearest hundred, thousand, or million.

The type and extent of many environmental restoration activities that would be required by the New Mexico Environment Department are not yet known. To assess impacts under this uncertainty, LANL's MDA remediation activities were analyzed under two scenarios, the Capping Option and the Removal Option. The waste management impacts associated with both scenarios are presented here.

MDA remediation wastes would be generated under the Capping Option, with substantial quantities of demolition and low-level radioactive waste expected. Variations in actual versus projected waste quantities are expected for these wastes due to the difficulty in predicting selected environmental remedies and waste types and quantities. In addition, no credit was taken for waste volume reduction techniques, such as sorting.

Much greater quantities of MDA remediation wastes would be generated under the Removal Option than under the No Action Alternative because of the substantial quantities of demolition debris and low-level radioactive waste expected. The closure of some TA-54 Area G facilities and the subsequent remediation of the area would generate large quantities of demolition debris and low-level radioactive waste. Industrial, hazardous, and low-level radioactive liquid wastes also would be generated by remedial actions. These liquid wastes would be treated onsite at existing LANL facilities.

Under the Expanded Operations Alternative, larger quantities of some radioactive and chemical wastes would be generated due to increased levels of operations at various facilities. Expanded actinide activities at the Chemistry and Metallurgy Research Replacement Facility, increased pit production (up to 80 pits per year) at the Plutonium Facility Complex, and increased recovery of sealed sources under the Off-Site Source Recovery Project would result in larger quantities of transuranic and low-level radioactive wastes. Increased pit production is projected to annually result in about 240 cubic yards (180 cubic meters) of additional contact-handled transuranic waste. In addition, activities at TA-55 in support of mixed oxide fuel fabrication could generate additional quantities of transuranic waste (LANL 2004g). Projections of chemical and radioactive waste quantities from routine operations at Key and non-Key Facilities are presented in **Table 5–47**.

Radioactive liquid waste treatment volumes are expected to increase under the Expanded Operations Alternative due to increased pit production and activities in support of mixed oxide fuel fabrication. The TA-21 demolition work is expected to generate about 8,400 gallons (32,000 liters) of low-level radioactive liquid waste, which would be treated at the Radioactive Liquid Waste Treatment Facility in TA-50. Radioactive liquid waste treatment quantities are presented in **Table 5–48**.

Table 5–47 Radioactive and Chemical Waste Projections from Routine Operations – Expanded Operations Alternative

Key and Non-Key Facilities	*Waste Projections (cubic yards per year)* [a]			
	Low-Level Radioactive Waste	***Mixed Low-Level Radioactive Waste***	***Transuranic Waste***	***Chemical Waste (pounds per year)***
Chemistry and Metallurgy Research Building	2,600 [b]	30 [b]	90 [b]	25,000 [b]
Sigma Complex	1,300	5	0	22,000
Machine Shops	790	0	0	1,045,000
Materials Science Laboratory	0	0	0	1,300
Metropolis Center [c]	0	0	0	0
High Explosives Processing Facilities	20	<1	0	29,000
High Explosives Testing Facilities	1,200	10 [d]	<1	78,000
Tritium Facilities	630	4	0	3,800
Pajarito Site	190	2	0	8,800
Target Fabrication Facility	13	<1	0	8,400
Bioscience Facilities	45	4	0	29,000
Radiochemistry Facility	350	5	0	7,300
Radioactive Liquid Waste Treatment Facility [e]	390	3	18	1,100
Los Alamos Neutron Science Center	1,400	1	0	37,000
Solid Radioactive and Chemical Waste Facilities [f]	300 [g]	10 [g]	35	2,000
Plutonium Facility Complex	1,400 [h]	20	690 [i]	19,000
Non-Key Facilities	2,000 [j]	40	30 [j]	1,435,000
Total [k]	13,000	140	860	2,750,000

[a] Projected values are from the *1999 SWEIS* ROD, as documented in the *2004 SWEIS Yearbook* (LANL 2005f), unless otherwise noted. Projections are based upon expected, routine facility operations and do not include wastes from nonroutine events such as chemical cleanouts and construction projects.
[b] Value taken from *CMRR EIS* (DOE/EIS-0350).
[c] Values not projected in *1999 SWEIS* ROD. The Metropolis Center was not a designated Key Facility at that time.
[d] Value adjusted upward from *1999 SWEIS* projection based on projected waste volumes resulting from hydrotesting activities (LANL 2006a).
[e] Values adjusted from *1999 SWEIS* projections are based on historical generation rates and new projections (LANL 2006a).
[f] This Key Facility includes the Transuranic Waste Retrieval Project and the Off-Site Source Recovery Project.
[g] Value was adjusted upward from *1999 SWEIS* projection based on projections in *Waste Volume Forecast* (LANL 2004g).
[h] Projections for transuranic and low-level radioactive waste assume pit production of up to 80 pits per year, based on *1999 SWEIS* projections (DOE 1999a) and more recent waste estimates (LANL 2005d).
[i] Projections for transuranic and low-level radioactive waste assume pit production of up to 80 pits per year, based on *1999 SWEIS* projections (DOE 1999a) and more recent waste estimates (LANL 2005d). In addition, 46 cubic yards of transuranic waste per year are projected due to activities in support of mixed oxide fuel fabrication (LANL 2004g).
[j] Value was adjusted upward from the *1999 SWEIS* projection based on historical generation rates and projections in the *Waste Volume Forecast* (LANL 2004g). Low-level radioactive waste increases are attributable to heightened activities and new construction. Transuranic waste increases are attributable to waste generated by the Off-Site Source Recovery Project; because this waste comes from shipping and receiving, it is attributed to non-Key Facilities.
[k] Totals may not add because values have been rounded to the nearest hundred, thousand, or million.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; for pounds to kilograms, multiply by 0.45359.

Table 5–48 Radioactive Liquid Waste Treated at Los Alamos National Laboratory – Expanded Operations Alternative

Waste Treatment Activity	*Projection* [a]
Pretreatment of radioactive liquid waste at TA-21	(a)
Pretreatment of transuranic liquid waste from TA-55 in Room 60	50,000 gallons (190,000 liters) per year
Solidification of transuranic sludge at TA-50	22 cubic yards (17 cubic meters) per year
Radioactive liquid waste treated at TA-50	5,000,000 gallons (20,000,000 liters) per year
Secondary treatment of radioactive liquid waste at TA-50	320,000 gallons (1,200,000 liters) per year
De-water low-level radioactive waste sludge at TA-50	80 cubic yards (60 cubic meters) per year
Radioactive liquid waste treated at TA-53	140,000 gallons (520,000 liters) per year [b]
Transport evaporator bottoms to Tennessee	80,000 gallons (300,000 liters) per year
Receive solidified evaporator bottoms from Tennessee [c]	30 cubic yards (23 cubic meters) per year

TA = technical area, LANSCE = Los Alamos Neutron Science Center.
[a] No new radioactive liquid waste is being generated at TA-21, and all inventories that existed in tanks and equipment was processed or transferred to TA-54 in 2006.
[b] Radioactive liquid waste treated at TA-53 includes waste volumes from LANSCE plus approximately 5,000 gallons (20,000 liters) per year from TA-50.
[c] This is solid low-level radioactive waste that is disposed of at TA-54.
Source: LANL 2006a.

Summary—**Table 5–49** summarizes the waste quantities estimated for operations, DD&D, and LANL's environmental restoration activities under the Expanded Operations Alternative. Although the summary table provides waste projections only through 2016, impacts from operations are expected to continue at comparable rates for the longer term. For this summary table, the transuranic and low-level radioactive waste categories have been further subdivided (for example, contact- and remote-handled transuranic) to facilitate identification of offsite disposal options and analysis of transportation impacts. In addition, for the Operational Waste and Remediation Waste categories, the quantities are presented as ranges rather than discrete values. For Operational Waste, the lower end of the range represents the quantity projected in the *Waste Volume Forecast* (LANL 2004g) and the upper end represents the *1999 SWEIS* projection, except as noted.

Waste management impacts from LANL operations under the Expanded Operations Alternative are expected to increase compared to those under the No Action Alternative due to heightened operations at the Plutonium Facility Complex and increased characterization and management activities associated with legacy waste retrieval. Although operational transuranic waste quantities are higher under the Expanded Operations Alternative, waste disposal capacity at WIPP is expected to be adequate, assuming the best estimates are realized. Operational low-level radioactive waste quantities also are expected to increase under this alternative, and use of both onsite and offsite disposal options can be used to manage this waste. As detailed in Appendix H, Section H.3, improvements to the LANL waste management infrastructure would be implemented to ensure safe and efficient management of wastes.

Table 5–49 Summary of Waste Types by Generator Category – Expanded Operations Alternative (Cumulative 2007 through 2016) (in cubic yards)

Waste Type	*Operational Waste* [a]	*DD&D Waste* [b]	*Remediation Waste* [c]	*Total*
Transuranic Waste				
Contact-handled	3,300 to 8,600	1,700	280 to 22,000	5,300 to 33,000
Remote-handled	–	11	0 to 50	11 to 61
Low-Level Radioactive Waste [d]				
Bulk low-level radioactive waste	–	177,000	20,000 to 710,000	196,000 to 884,000
Packaged low-level radioactive waste	25,000 to 127,000	56,000	–	80,000 to 183,000
High-activity low-level radioactive waste	–	–	0 to 347,000	0 to 347,000
Remote-handled low-level radioactive waste	–	480	0 to 1,200	480 to 1,700
Mixed Low-Level Radioactive Waste	270 to 1,400	1,900	1,800 to 180,000	3,900 to 183,000
Construction and Demolition Debris [e]	26,000	569,000	47,000 to 126,000	642,000 to 722,000
Chemical Waste [g] **(pounds)**	9,997,000 to 27,500,000	4,425,000	50,000,000 to 97,000,000	64,000,000 to 129,000,000

DD&D = decontamination, decommissioning, and demolition; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act.

[a] Operations waste volumes are represented as a range, with the lower end represented by best-estimate values documented in the *Waste Volume Forecasts* (LANL 2003e, 2004g) and the upper end represented by the bounding *1999 SWEIS* projections (DOE 1999a), adjusted as detailed in Table 5–47. These wastes are assumed to be contact-handled transuranic waste and packaged low-level radioactive waste, although small volumes of other types could be generated.

[b] DD&D waste quantities include those under the No Action Alternative, as well as all DD&D wastes estimated to arise from new projects under the Expanded Operations Alternative, as detailed in Table 5–45.

[c] The low and high ends of the ranges correspond to the MDA Capping Option and Removal Option, respectively. See Appendix I for details.

[d] The subcategories of low-level radioactive waste do not necessarily meet precise definitions, but are used to assist in the analysis of disposal and transportation options and impacts.
– Bulk low-level radioactive waste = wastes that can be transported in large volumes in soft-sided containers.
– Packaged low-level radioactive waste = typical low-level radioactive waste packaged in drums or boxes.
– High-activity low-level radioactive waste = waste exceeding 10 CFR 61.55 Class A concentrations (greater than 10 nanocuries per gram of transuranic nuclides), which is not accepted at certain facilities.
– Remote-handled low-level radioactive waste = waste with a dose rate exceeding 200 millirem per hour at the surface of the container.

[e] Construction and demolition debris includes uncontaminated wastes such as steel, brick, concrete, pipe, and vegetative matter from land clearance.

[f] Construction debris quantities include those under the No Action Alternative, as well as all construction wastes estimated to arise from new projects under the Expanded Operations Alternative, as detailed in Table 5–46.

[g] Chemical waste includes waste regulated under RCRA, TSCA, or state hazardous waste regulations.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; for pounds to kilograms, multiply by 0.45359. Totals might not add because values have been rounded to the nearest hundred, thousand, or million.

DD&D activities also are expected to generate large quantities of waste, particularly low-level radioactive waste and uncontaminated debris. The quantities of low-level radioactive waste would exceed the Area G capacity and some portion would require offsite disposal. Uncontaminated debris would be sent offsite for disposal.

For remediation waste, the range is intended to reflect the uncertainty associated with site cleanups. Final decisions on cleanup of MDAs and other PRSs will be made after DOE and LANL investigate the sites and propose remedies to the New Mexico Environment Department, which will then solicit public comment on the proposed remedies and decide what remedies will be implemented. For many of LANL's MDAs and PRSs, investigation is still ongoing and the remedy selection process has not begun. Thus, the remediation process, including the amount of waste generated as a result of the process, is not clearly defined. To adequately address impacts, the remediation process was analyzed under a Capping Option, which would produce relatively small amounts of waste, and a Removal Option, which would involve significant excavations and would produce significantly more waste. These two options, Capping and Removal, represent the lower and upper values, respectively, in the remediation waste summary.

Under the MDA Capping Option, remedial actions would take place at PRSs such as high explosives testing sites and outfalls. Actions at most MDAs would be limited to installing an engineered cover, with the wastes remaining in place. Under this option, moderate quantities of bulk low-level radioactive waste, uncontaminated debris, and chemical wastes would be expected, as well as small quantities of transuranic waste. Offsite disposal of most waste could occur, although some portion of low-level radioactive waste could be disposed of onsite depending upon available capacity and disposal priorities.

Under the MDA Removal Option, the same remedial activities as those under the MDA Capping Option would take place, with one important addition: all MDAs would be exhumed, which would generate very large quantities of waste including transuranic, low-level radioactive, mixed low-level radioactive, uncontaminated debris, and chemical waste. For the uncontaminated debris (managed as solid waste) and chemical waste categories, offsite disposal capacity is expected to be adequate. Quantities of low-level radioactive waste would exceed the planned annual rate of disposal at Area G; decisions regarding onsite or offsite disposal would depend on available capacity, decisions about changes to disposal operations, if any, and disposal priorities.

The transuranic waste volumes projected for the MDA Removal Option involve waste, most of which DOE buried before 1970. These projected volumes are conservative, and may be smaller than that assumed depending on future regulatory decisions by the New Mexico Environment Department. Also, no credit was taken for use of waste volume reduction techniques such as sorting. It was assumed for this SWEIS that all transuranic waste would be disposed of at WIPP. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste and all transuranic waste buried before 1970 across the complex (63 FR 3624). Decisions about disposal of transuranic waste generated by remediation at LANL, will be based on the needs of the entire DOE complex. If necessary, any transuranic waste that is generated without a disposal pathway would be safely stored until disposal capacity becomes available.

The large quantities of waste resulting from the Removal Option may exceed LANL's waste handling and processing capacity. As needed, additional, augmented, or mobile waste management equipment or facilities could be developed similar to those described in Appendix H, Section H.3.2.2, and Appendix I, Section I.3.3.2.8, of this SWEIS. Modular mobile facilities could be sited at appropriate LANL locations, and moved between remediation sites as needed. These modular facilities could include capacity for safety inspections of removed waste, waste processing and temporary storage, radioactive and chemical analyses, or other support services.

5.10 Transportation

This section summarizes the potential impacts associated with shipping materials to and from LANL to various locations (such as waste disposal sites and other DOE or commercial sites) under both incident-free and accident conditions. For incident-free transportation, the potential human health impacts from the radiation field surrounding the radioactive packages were estimated for transportation workers and populations along the route (off-traffic, or off-link), people sharing the route (in-traffic or on-link), and people at rest areas and stops along the route. The RADTRAN 5 computer program (Neuhauser and Kanipe 2003) was used to estimate the impacts for transportation workers and populations, as well as the impact to an MEI (for example, a person stuck in traffic, a gas station attendee, or an inspector), who may be a worker or a member of the public.

Human heath impacts could result from transportation accidents. The impact of a specific radiological accident is expressed in terms of probabilistic risk, which is defined as the accident probability (accident frequency) multiplied by the accident consequences. The overall risk is obtained by summing individual risks from all reasonably conceivable accidents. The analysis of accident risks accounts for a spectrum of accidents ranging from high-probability accidents of low severity (a fender bender) to hypothetical high-severity accidents that have a corresponding low probability of occurrence. Only as a result of a severe fire or a powerful collision, which are of extremely low probability, could a transportation package of the type used to transport radioactive material be damaged to the extent that radioactivity could be released to the environment with significant consequences.

In addition to calculating the radiological risks that would result from all reasonably conceivable accidents during transportation of radioactive wastes, NNSA assessed the consequences of maximum reasonably foreseeable accidents with a probability greater than 1×10^{-7} (1 in 10 million) per year. These latter consequences were determined for the atmospheric conditions that would likely prevail during accidents. The analysis used the RISKIND computer program to estimate doses to individuals and populations (Yuan et al. 1995).

Incident-free radiological health impacts are expressed as additional LCFs. Radiological accident health impacts are also expressed as additional LCFs, and nonradiological accident risks are expressed in terms of additional immediate (traffic) fatalities. LCFs associated with radiological exposure were estimated by multiplying the occupational (worker) and public dose by 6.0×10^{-4} LCFs per person-rem of exposure. Transportation impacts of radioactive wastes were calculated assuming that all wastes are transported by truck.

In determining the transportation risks, per-shipment risk factors were calculated for the incident-free and accident conditions using the RADTRAN 5 computer program (Neuhauser and Kanipe 2003) in conjunction with the Transportation Rating Analysis Geographic Information System (TRAGIS) computer program (Johnson and Michelhaugh 2003) to choose transportation routes in accordance with U.S. Department of Transportation regulations. The TRAGIS program provides population estimates based on the 2000 census along the routes for determining the population radiological risk factors. For incident-free operations, the affected population includes individuals living within 0.5 miles (800 meters) of each side of the road. For accident conditions, the affected population includes individuals living within 50 miles (80 kilometers) of the accident, and the MEI is assumed to be an individual located 330 feet (100 meters) directly downwind from the accident.

For determining traffic accident fatalities from offsite commercial truck transportation, separate accident rates and accident fatality risks were used for rural, suburban, and urban population zones. These accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150 (Saricks and Tompkins 1999). The values selected were the "mean" accident and fatality rates given in ANL/ESD/TM-150 for "interstate," "primary," and "total." These values were assigned to rural, suburban, and urban population zones, respectively. Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with accident involvement count as the numerator of the fraction and vehicular activity (total travel distance in truck-kilometers) as its denominator. The accident rates for rural, suburban, and urban zones were 3.15, 3.52, and 3.66 per 10 million truck-kilometers, respectively; and the fatality rates were 0.88, 1.49, and 2.32 per 100 million truck kilometers, respectively.

For determining traffic accident fatalities from safe secure trailer (SST) transport, DOE operational experience between 1984 and 1999 was used. The mean probability of an accident requiring towing of a disabled trailer truck was about 6 per 100 million kilometers (DOE 2000g). The number of historical SST accidents is too small to support allocating this overall rate among the various types of routes (interstate, primary, others) used in the accident analysis. Therefore, data for the relative rate of accidents on these route types, or influence factor, as provided in *Determination of Influence Factor and Accident Rates for Armored Tractor/Safe Secure Trailer* (Phillips, Clauss, and Blower 1994), were used to estimate accident frequencies for rural, urban, and suburban transports. Traffic accident fatalities for the SST transports were estimated using the commercial truck transport fatality per accident ratios within each zone.

For determining traffic accident fatalities from local and regional transportation of industrial and hazardous waste, New Mexico State accident and fatality rates, which also are given in ANL/ESD/TM-150, were used. The rates used were 1.13 accidents per 10 million truck-kilometers and 1.18 fatalities per 100 million truck-kilometers. For assessment purposes, the total number of expected accidents or fatalities was calculated by multiplying the total shipment distance for a specific waste by the accident or fatality rate. Additional details on the analysis approach and on modeling and parameter selection are provided in Appendix K.

In summary, at LANL, radioactive materials (special nuclear material, low-level radioactive waste, transuranic waste, etc.) are transported both onsite (between the TAs) and offsite to multiple locations. Onsite transportation constitutes the majority of activities that are part of routine operations in support of various programs. The radioactive materials transported onsite between TAs are mainly limited quantities that are transported over short distances and mostly on closed roads. The impacts of these activities are part of the impacts of normal operations at these areas. For example, worker dose from handling and transporting radioactive materials is included as part of the worker dose from operational activities. Specific analyses performed in the *1999 SWEIS* (DOE 1999a) indicated that the projected collective radiation dose for LANL drivers from a projected 10,750 onsite shipments was 10.3 person-rem per year, or on average, less than 1 millirem per transport. A review of recent onsite radioactive materials transportation indicates a much smaller number of shipments than those projected in the *1999 SWEIS*. Therefore, the *1999 SWEIS* projection of impacts would envelop the impacts for routine onsite transportation. The impacts of nonroutine onsite transportation activities, such as waste transportation associated with facility DD&D or MDA remediation, were evaluated and are presented in this SWEIS where applicable.

Offsite transportation of radioactive materials would occur using both trucks and airfreight. Materials transported by airfreight would be similar in number, type, and forms to those considered in the *1999 SWEIS*, and hence would result in similar impacts. The aircrew dose from airfreight radioactive transportation was estimated at 2.4 person-rem per year (DOE 1999a).

Truck (both commercial and DOE SST) transportation is analyzed further in this SWEIS. The *1999 SWEIS* provides a comprehensive list of various radioactive material types, forms, origins and destinations, and quantities, as well as a projected number of shipments. The radioactive materials transported included tritium, plutonium, uranium (both depleted and enriched), offsite source recovery materials, medical isotopes, small quantities of activation products, low-level radioactive waste, and transuranic waste. The specific origins and destinations, except for Rocky Flats, are expected to be applicable to future transports. For analyses purposes in this SWEIS, the destinations were limited to those that could be significantly affected, namely offsite waste disposal sites (such as the Nevada Test Site, a commercial waste disposal site in Utah, and WIPP in New Mexico) and the DOE and NNSA sites supporting nuclear weapons production and mixed oxide fuel fabrication (such as the Pantex Plant in Texas, Oak Ridge National Laboratory and Y-12 Complex in Tennessee, Lawrence Livermore National Laboratory in California, and Savannah River Site in South Carolina). Impacts from the transportation of other radioactive materials would remain similar to those projected in the *1999 SWEIS*.

Table 5–50 provides the estimated number of material shipments under each alternative over a 10-year period. This table also provides the estimated number of shipments resulting from activities for proposed MDA remediation options such as removal or capping, and those from activities related to increasing pit production from 20 to up to 80 pits per year.

Table 5–50 10-Year Total Number of Offsite Shipments under Each Alternative and Selected Activities

Alternative (Activities)	*Number of Shipments*										
	Radioactive Materials									*Miscellaneous*	
	LSA	*DD&D Bulk*	*LLW* [a]	*High Activity* [b]	*LLW-RH* [c]	*Mixed LLW*	*TRU* [d]	*SNM*	*PuO_2*	*Hazardous*	*Others* [e]
No Action	624	812	9,217	312	0	196	1,460	958	20	946	10,778
Reduced Operations	624	812	7,883	312	0	196	1,460	958	20	932	10,778
Expanded Operations [f]	1,436-49,940	9,538	9,919	3,418-36,521	196-856	297-9,019	2,405-5,044	1,558	50	2,781-4,749	35,419-41,506
Expanded Operations (without MDA Remediation) [g]	681	9,538	9,919	3,418	196	240	2,397	1,558	50	1,000	31,856
(MDA Remediation) [h]	755-49,259	0	0	0-33,103	0-660	57-8,779	8-2,647	0	0	1,781-3,749	3,563-9,650
(Increase in Pit Production) [i]	0	0	701	0	0	6	246	600	0	0	0

LSA = low specific activity, DD&D = decontamination, decommissioning, and demolition, LLW = low-level radioactive waste, RH = remote handled, TRU = transuranic waste, SNM = special nuclear material, PuO_2 = plutonium dioxide.

[a] Low-level radioactive waste transported in drums or Type A, B-25 boxes. The values here also include shipments of evaporator bottoms from Radioactive Liquid Waste Treatment Facility to an offsite location and the returned dried wastes.

[b] High activity low-level radioactive waste containing more than 10 nanocuries per gram of transuranic waste transported in Type A, B-25 boxes. This waste is comparable to Class B or Class C of 10 CFR Part 61 waste classification. This waste is generated during MDA waste retrieval, and from decontamination and demolishing of some of the buildings. The shipments also include one shipment of strontium-90 radioisotope thermoelectric generators under all alternatives.

[c] Remote-handled low-level radioactive waste transported in 55-gallon (208-liter) drums.

[d] The sum of remote-handled and contact-handled transuranic waste shipments.

[e] Others include industrial, sanitary, and asbestos wastes.

[f] The range of values represent the estimated number of shipments for options of capping and remediation and removal and remediation of all MDAs.

[g] Expanded Operations with baseline MDA remediation (without capping or removal).

[h] The range values represent the estimated number of shipments for options of capping and removal of all MDAs.

[i] The waste shipment values presented are based on the differences between the No Action Alternative and the Expanded Operations Alternative projected waste volumes for routine operation.

Table 5–51 summarizes the total transportation impacts, as well as the transportation impacts on two nearby LANL transportation routes: LANL to Pojoaque, New Mexico, the route segment that trucks from LANL use, and Pojoaque to Santa Fe, New Mexico, the route segment that all trucks using Interstate-25 (such as trucks traveling to WIPP) use. For analysis purposes in this SWEIS, two sites, the DOE Nevada Test Site and a commercial facility in Utah, were selected as possible disposal sites for all low-level radioactive wastes should the decision be made to dispose low-level radioactive waste offsite rather than onsite. The differences in distance from LANL and the affected population along the different transportation routes between these two sites result in a range of impacts under each alternative. Transuranic waste was assumed to be disposed of at WIPP.

Table 5–51 Risks of Transporting Radioactive Materials under Each Alternative and Selected Activities

				Incident-Free				Accident	
				Crew		Population			
Transport Segments	Offsite Disposal Option [a]	Number of Shipments	Round Trip Kilometers Traveled (million)	Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radio-logical Risk [b]	Nonradio-logical Risk [b]
No Action									
LANL to Pojoaque	NTS	13,599	0.85	5.0	0.0030	1.8	0.0011	3.9×10^{-6}	0.0093
Pojoaque to Santa Fe		13,599	1.15	8.8	0.0053	3.3	0.0020	7.1×10^{-6}	0.016
Total		13,599	31.9	163.8	0.098	58.4	0.0350	0.00017	0.30
LANL to Pojoaque	Commercial	13,599	0.85	5.0	0.0030	1.8	0.0011	3.9×10^{-6}	0.009
Pojoaque to Santa Fe		2,893 [c]	0.30	3.9	0.0023	1.9	0.0011	1.1×10^{-6}	0.003
Total		13,599	28.2	147.3	0.088	53.0	0.032	0.00014	0.26
Reduced Operations									
LANL to Pojoaque	NTS	12,265	0.76	4.6	0.0028	1.7	0.0010	3.4×10^{-6}	0.009
Pojoaque to Santa Fe		12,265	1.1	8.1	0.0049	3.1	0.0019	6.2×10^{-6}	0.015
Total		12,265	28.6	147.2	0.088	53.1	0.032	0.00015	0.27
LANL to Pojoaque	Commercial	12,265	0.76	4.63	0.0029	1.7	0.0010	3.4×10^{-6}	0.009
Pojoaque to Santa Fe		2,893 [c]	0.30	3.9	0.0023	1.9	0.0011	1.1×10^{-6}	0.0032
Total		12,265	25.3	133.1	0.08	48.5	0.029	0.00013	0.24
Expanded Operations (with MDA Removal Option)									
LANL to Pojoaque	NTS	122,439	7.6	25.9	0.016	8.1	0.0049	0.000032	0.089
Pojoaque to Santa Fe		122,439	9.7	43.5	0.026	13.3	0.0080	0.000047	0.11
Total		122,439	299.9	910.1	0.55	286.8	0.17	0.0016	2.96
LANL to Pojoaque	Commercial	122,439	7.6	25.9	0.016	8.1	0.0049	0.000032	0.089
Pojoaque to Santa Fe		44,205 [c]	3.5	30.4	0.018	9.8	0.0059	0.000024	0.040
Total		122,439	272.8	866.2	0.52	273.6	0.16	0.0014	2.66
Expanded Operations (with MDA Capping Option)									
LANL to Pojoaque	NTS	28,817	1.8	8.0	0.0048	2.8	0.0017	5.7×10^{-6}	0.021
Pojoaque to Santa Fe		28,817	2.3	13.5	0.0081	4.6	0.0028	9.8×10^{-6}	0.034
Total		28,817	69.3	255.9	0.15	89.1	0.053	0.00025	0.66
LANL to Pojoaque	Commercial	28,817	1.8	8.0	0.0048	2.8	0.0017	5.7×10^{-6}	0.021
Pojoaque to Santa Fe		7,803 [c]	0.7	7.7	0.0046	3.0	0.0018	3.1×10^{-6}	0.0085
Total		28,817	62.0	236.3	0.142	82.9	0.050	0.00022	0.58
Expanded Operations (without MDA Removal or Capping Options)									
LANL to Pojoaque	NTS	27,997	1.7	8.0	0.0048	2.8	0.0017	5.5×10^{-6}	0.020
Pojoaque to Santa Fe		27,997	2.2	13.4	0.0080	4.6	0.0028	9.6×10^{-6}	0.033
Total		27,997	67.2	254.0	0.15	88.6	0.053	0.00024	0.64
LANL to Pojoaque	Commercial	27,997	1.7	8.0	0.0048	2.8	0.0017	5.5×10^{-6}	0.020
Pojoaque to Santa Fe		7,795 [c]	0.6	7.6	0.0046	3.0	0.0018	3.1×10^{-6}	0.0065
Total		27,997	60.2	234.6	0.14	82.4	0.049	0.00021	0.57
MDA Removal Option Activities									
LANL to Pojoaque	NTS	94,448	5.9	18.0	0.011	5.3	0.0032	0.000026	0.070
Pojoaque to Santa Fe		94,448	7.5	30.1	0.018	8.7	0.0052	0.000037	0.088
Total		94,448	232.7	656.4	0.400	198.2	0.12	0.0013	2.32
LANL to Pojoaque	Commercial	94,448	5.9	18.0	0.011	5.3	0.0032	0.000026	0.070
Pojoaque to Santa Fe		36,410 [c]	2.9	22.8	0.014	6.8	0.0041	0.000021	0.034
Total		94,448	212.5	631.6	0.38	191.2	0.120	0.0012	2.10

Transport Segments	Offsite Disposal Option [a]	Number of Shipments	Round Trip Kilometers Traveled (million)	Incident-Free				Accident	
				Crew		Population			
				Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Nonradiological Risk [b]
MDA Capping Option Activities									
LANL to Pojoaque	NTS	820	0.05	0.05	0.00003	0.01	0.00001	1.7×10^{-7}	0.0006
Pojoaque to Santa Fe		820	0.06	0.09	0.00005	0.02	0.00001	2.0×10^{-7}	0.0008
Total		820	2.04	1.9	0.0012	0.49	0.00029	0.00001	0.020
LANL to Pojoaque	Commercial	820	0.05	0.05	0.00003	0.01	0.00001	1.7×10^{-7}	0.00060
Pojoaque to Santa Fe		8	0.0006	0.02	0.00001	0.005	0.000003	3.9×10^{-11}	0.00001
Total		820	1.76	1.70	0.0010	0.042	0.00025	0.000008	0.017
Increase in Pit Production Activities									
LANL to Pojoaque	NTS	1,553	0.1	0.68	0.00041	0.36	0.00022	2.7×10^{-7}	0.00075
Pojoaque to Santa Fe		1,553	0.15	1.14	0.00068	0.59	0.00035	1.9×10^{-6}	0.0013
Total		1,553	3.63	18.0	0.011	8.95	0.0054	0.000011	0.024
LANL to Pojoaque	Commercial	1,553	0.1	0.68	0.00041	0.36	0.00022	2.7×10^{-7}	0.00075
Pojoaque to Santa Fe		879 [c]	0.08	0.79	0.00047	0.49	0.00029	1.4×10^{-6}	0.00043
Total		1,553	3.39	16.87	0.010	8.56	0.0051	9.6×10^{-6}	0.021

NTS = Nevada Test Site, MDA = material disposal area.

[a] Under this option, low-level radioactive waste would be shipped to either the Nevada Test Site or a commercial site in Utah. Transuranic wastes would be shipped to WIPP. Pantex, Y-12, Oak Ridge, Nevada Test site, Lawrence Livermore and the Savannah River Site would ship or receive special nuclear materials. Also note that the number of shipments along the Pojoaque to Santa Fe segment would be lower when the commercial site in Utah is used as an offsite disposal option for low-level radioactive waste.

[b] Risk is expressed in terms of latent cancer fatalities, except for the nonradiological risk, where it refers to the number of traffic accident fatalities.

[c] Shipments of low-level radioactive waste to a commercial disposal site in Utah would not pass along the Pojoaque to Santa Fe segment of highway.

Note: The values in this table are rounded in comparison to those provided in Appendix K.

The following conclusions can be drawn from the results presented in Table 5–51. The maximum total 10-year dose to the public would be 287 person-rem from all shipments under the Expanded Operations Alternative – MDA Removal Option with all low-level radioactive waste being sent to the Nevada Test Site for disposal. The expected excess LCFs among the exposed population would be less than 1 (0.17 LCF). The total dose to the public along the LANL to Pojoaque route under this option would be 8.1 person-rem, with less than 1 excess LCF (0.0049 LCF) among the exposed population. The total dose to the public along the Pojoaque to Santa Fe route would be up to 13.3 person-rem, with less than 1 excess LCF (0.008 LCF) among the exposed population. The maximum dose to the transportation crew (truck drivers) would be 910 person-rem over 10 years, with a potential of less than 1 (0.55) LCF among the exposed crew. It should be noted that DOE regulations limit the maximum annual dose to a transportation worker to 100 millirem per year unless the individual is a trained radiation worker, which would have an administrative control annual dose limit of 2 rem (DOE 1999e). The potential for a trained radiation worker to develop a fatal latent cancer from the maximum annual exposure is 0.0012. Therefore, an individual transportation worker would not be expected to develop a lifetime latent fatal cancer from exposures during these activities.

Table 5–51 also presents the risk of traffic accident fatalities for each of the alternatives. The risk of a traffic accident fatality is greater than the risk of an excess LCF for each of the alternatives. For instance, excess LCFs among the exposed population from all shipments under the Expanded Operations Alternative-MDA Removal Option with all waste being sent to the Nevada Test Site for disposal would be less than 1 (0.17 LCF), while the number of traffic accident fatalities from these shipments would be nearly 3 (2.66).

Onsite traffic patterns were reviewed with respect to traffic flowing through the main access points onto the site. Based on the average traffic flows recorded in 2004 and 2005, an estimate of the daily number of trips per employee was made, assuming that 90 percent of all trips were related to employee trips and the remaining 10 percent were related to truck trips in support of normal LANL activities, not including construction or DD&D-related activities, which were calculated separately. The alternatives were then analyzed and traffic flows were assumed to fluctuate consistent with the employment levels estimated in Section 5.8.1. For example, under the Reduced Operations Alternative, employment at LANL is projected to decline; therefore, the number of daily trips associated with LANL activities are also projected to decline. Similarly, under the Expanded Operations Alternative, LANL employment is projected to increase; consequently, traffic would likely increase as well.

As shown in **Table 5–52**, local traffic flows would likely remain at current levels under the No Action Alternative because employment levels would stay at current levels. Under the Reduced Operations Alternative, a small decline in traffic through LANL would be expected mainly because of the projected decrease in employment under this alternative. Under the Expanded Operations Alternative, traffic would likely increase substantially due to the projected increases in employment and construction and remediation activities. This would be particularly true for Pajarito Road as remediation activities start on MDA G. The Expanded Operations Alternative – MDA Removal Option would have a larger traffic increase relative to the MDA – Capping Option due to the more numerous truck trips associated with MDA remediation and the greater number of remediation workers needed to implement this option.

Table 5–52 Summary of Changes in Annual Traffic Flow at the Entrances to Los Alamos National Laboratory

Alternative	*Average Daily Vehicle Trips*				
	Diamond Drive Across Los Alamos Canyon	*Pajarito Road at NM 4*	*East Jemez Road at NM 4*	*West Jemez Road at NM 4*	*DP Road at Trinity Drive*
No Action	24,545	4,984	9,502	2,010	1,255
Reduced Operations - Estimated Daily Trips - Percent Change from No Action (%)	 23,600 -4	 4,800 -4	 9,100 -4	 1,900 -5	 1,200 -4
Expanded Operations – MDA Removal Option – Estimated Daily Trips - Percent Change from No Action (%)	26,000 +6	9,200 +85	10,700 +13	2,200 +9	1,700 +35

MDA = material disposal area.

5.10.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

Under this alternative, about 13,600 offsite shipments of radioactive materials would be made between 2007 and 2016 to the Nevada Test Site (or a commercial site in Utah), WIPP, and the

NNSA sites supporting nuclear weapons. Maximum transportation impacts would be realized if low-level radioactive waste were shipped to either the Nevada Test Site or a commercial site in Utah instead of being disposed of onsite. Transuranic waste would be shipped to WIPP, and special nuclear material would be shipped mainly between LANL and Pantex. The total projected (one-way) distance traveled on public roads transporting radioactive materials to various locations would range from about 8.5 million to 10 million miles (13.75 million to 16 million kilometers).

Impacts of Incident-free Transportation

The dose to the transportation crew from all offsite transportation activities under this alternative was estimated to range from about 147 person-rem for disposal at the commercial low-level radioactive waste disposal site in Utah to about 164 person-rem for disposal at the Nevada Test Site. The dose to the general population would range from 53 to 58 person-rem for the commercial site in Utah and the Nevada Test Site options, respectively. Accordingly, incident-free transportation would result in a maximum of 0.098 excess LCFs among the transportation workers and 0.035 excess LCFs in the affected population. The estimated dose associated with disposal of low-level radioactive waste at the Nevada Test Site is higher because of the longer distance traveled and larger affected population. The differences in estimated doses under either option are very small, however, as shown above.

It should be noted that DOE regulations limit the maximum annual dose to a transportation worker to 100 millirem per year unless the individual is a trained radiation worker. Trained radiation workers have an administrative control dose level of 2 rem per year (DOE 1999e). The potential for a trained radiation worker to develop a fatal latent cancer from an annual dose at the maximum annual exposure is 0.0012. Therefore, an individual transportation worker would not be expected to develop a lifetime fatal latent cancer from exposure during these activities.

The doses to the general populations along the routes from LANL to Pojoaque and from Pojoaque to Santa Fe were estimated to be a maximum of 1.8 and 3.3 person-rem, respectively. These doses would result in 0 (0.0011 and 0.0020) excess LCFs among the exposed populations.

Impacts of Accidents during Transportation

As stated earlier, two sets of analyses were performed for the evaluation of transportation accident impacts: impacts of maximum reasonably foreseeable accidents (accidents with probabilities greater than 1 in 10 million per year [1×10^{-7}]) and impacts of all conceivable accidents (total transportation accidents).

For radioactive materials transported under this alternative, the maximum reasonably foreseeable offsite truck transportation accident with the greatest consequence would involve a truck carrying contact-handled transuranic waste. The probability of such an accident occurring would be about 1 in 5.3 million (1.9×10^{-7}) per year in an urban area. If such an accident were to occur, the consequences in terms of general population dose would be 310 person-rem. Such an exposure could result in 0.19 excess LCFs among the exposed population. This accident, if it occurred, would result in a dose of 6.2 millirem to a hypothetical MEI located at a distance of 330 feet (100 meters) and exposed to the accident plume for 2 hours, with a corresponding risk of developing a latent fatal cancer of about 1 in 270,000 (3.7×10^{-6}).

Under the No Action Alternative, estimates of the total offsite transportation accident risks for all projected accidents involving radioactive shipments, regardless of type, are a maximum radiological dose-risk[5] to the general population of 0.28 person-rem, resulting in 0.00017 LCFs, and a maximum nonradiological accident risk of 0 (0.30) fatalities.

The maximum radiological transportation accident dose-risk to the general populations along the LANL to Pojoaque and the Pojoaque to Santa Fe routes would be 0.0065 and 0.012 person-rem, respectively. These doses would result in 0 (3.9×10^{-6} and 7.1×10^{-6}) excess LCFs among the exposed populations. The maximum expected traffic accident fatalities along these routes would be 0 (0.0093 and 0.016, respectively).

Impacts of Construction, Operations, and Hazardous Material Transportation

The impacts of transporting various nonradiological materials were evaluated. These impacts are presented in terms of distance traveled and numbers of expected traffic accidents and fatalities. The transportation impacts under this alternative would be, for 3.4 million miles (5.5 million kilometers) traveled, 1 (0.62) traffic accident and 0 (0.07) fatalities.

Local Traffic

Under the No Action Alternative, the impacts of LANL activities on local traffic flow and roadway infrastructure would be approximately the same as current conditions, as described in Chapter 4, Section 4.10.1. Efforts being undertaken to enhance site security, such as the Security Perimeter Project, would be implemented as planned. These modifications would alter traffic patterns in and around LANL, but would likely have only minor impacts on traffic flow during normal security conditions. In the case of heightened security, traffic entering the site would be delayed as vehicles were subjected to greater scrutiny.

Management of construction fill could result in up to 15,000 round trips on LANL roads from LANL construction sites to borrow areas for storage or to sites using construction fill. This traffic could be mitigated by scheduling trips during off-peak hours, as appropriate.

5.10.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Under this alternative, about 12,270 offsite shipments of radioactive materials would be made to the Nevada Test Site (or a commercial disposal site in Utah), WIPP, and the NNSA sites supporting nuclear weapons production between 2007 and 2016. Similar to the No Action Alternative, the maximum transportation impacts would result from shipments of low-level radioactive waste to either the Nevada Test Site or a commercial disposal site in Utah, transuranic waste to WIPP, and special nuclear material between LANL and Pantex. The total projected (one-way) distance traveled on public roads while transporting radioactive materials to

---

[5] Dose-risk includes the probability of an accident occurring. Here, these values are calculated by dividing the radiological risks in terms of LCFs given in Table 5–51 (column 9) by 0.0006, which is a risk of an LCF per person-rem of exposure.

various locations would range from 7.6 million to 8.9 million miles (12.3 million to 14.3 million kilometers).

Impacts of Incident-free Transportation

The dose to transportation workers from all offsite transportation activities under this alternative has been estimated to range from about 133 person-rem for the Utah commercial low-level radioactive waste disposal option to 147 person-rem for the Nevada Test Site disposal option. The dose to the general population would range from 49 to 53 person-rem for each option, respectively. Accordingly, incident-free transportation would result in a maximum of 0.088 excess LCFs among transportation workers and 0.032 excess LCFs in the affected population for the Nevada Test Site low-level radioactive waste disposal option because of the longer distance traveled and larger affected population.

The impact of this alternative on individual transportation workers would be the same as the impact discussed under the No Action Alternative. An individual transportation worker would not be expected to develop a lifetime latent fatal cancer from exposure during these activities.

The doses to the general populations along the routes from LANL to Pojoaque and from Pojoaque to Santa Fe under this alternative were estimated to be a maximum of 1.7 and 3.1 person-rem, respectively. These doses would respectively result in 0.0011 and 0.0019 excess LCFs among the exposed populations.

Impacts of Accidents during Transportation

Similar to the estimate forecast for No Action Alternative, for radioactive materials transported under this alternative, the maximum reasonably foreseeable offsite truck transportation accident with the highest consequence would involve a truck carrying contact-handled transuranic waste. The probability of such an accident occurring would be 1 in 5.3 million (1.9×10^{-7}) per year in an urban area. Should such an accident occur, the consequences would be similar to those projected for the No Action Alternative.

Under the Reduced Operations Alternative, the estimated maximum radiological dose-risk to the general population for all projected accidents involving radioactive shipments, regardless of type, would be about 0.25 person-rem, resulting in 0.00015 LCFs and a maximum nonradiological accident risk of 0 (0.27) fatalities.

The maximum radiological transportation accident dose-risk to the general populations along the LANL to Pojoaque and the Pojoaque to Santa Fe routes would be 0.0057 and 0.010 person-rem, respectively. These doses would result in 0 (3.4×10^{-6} and 6.2×10^{-6}) excess LCFs among the exposed populations. The maximum expected traffic accident fatalities along these routes would be 0 (0.009) and 0 (0.015), respectively.

Impacts of Construction, Operations, and Hazardous Material Transports

The impacts of transporting various nonradiological materials were evaluated. These impacts are presented in terms of distance traveled and numbers of expected traffic accidents and fatalities.

The transportation impacts under this alternative would be 1 (0.62) traffic accident and 0 (0.07) fatalities, for 3.4 million miles (5.5 million kilometers) traveled.

Local Traffic

Under the Reduced Operations Alternative, the impacts of LANL activities on local traffic flow and roadway infrastructure would be somewhat smaller than those expected under the No Action Alternative. The relatively small reduction in the number of employees associated with the reduction in high explosives processing and testing, cessation of TA-18 activities, and shutdown of LANSCE (see Section 5.8.1.2) would likely result in small decreases in local traffic flow and the impacts of site activities on local roadway infrastructure, as shown in **Table 5–53**.

Table 5–53 Estimated Changes in Traffic at the Entrances to Los Alamos National Laboratory under the Reduced Operations Alternative

Activity	*Average Daily Vehicle Trips*				
	Diamond Drive Across Los Alamos Canyon	*Pajarito Road at NM 4*	*East Jemez Road at NM 4*	*West Jemez Road at NM 4*	*DP Road at Trinity Drive*
No Action Alternative	24,545	4,984	9,502	2,010	1,255
Estimated Daily Vehicle Trips under Reduced Operations Alternative	23,600	4,800	9,100	1,900	1,200
Percent Change from Baseline	-4	-4	-4	-5	-4

5.10.3 Expanded Operations Alternative

The discussions in this section focus on the doses and risk impacts from activities under the Expanded Operations Alternative with the MDA Capping and Removal Options. For each receptor (transportation workers or population) a range of impacts is provided reflecting those activities associated with the MDA Capping and MDA Removal Options. Table 5–52 also provides similar information for the Expanded Operations Alternative without the MDA Capping or Removal Options; and those resulting from activities associated with the MDA Removal Option, the MDA Capping option, and increasing pit production from 20 to 80 pits per year.

Los Alamos National Laboratory Site-Wide Impacts

Under this alternative, under the MDA Capping and Removal Options respectively, approximately 28,820 to 122,440 offsite shipments of radioactive materials would be made between 2007 and 2016 to the Nevada Test Site (or a commercial disposal site in Utah), WIPP, and the NNSA sites supporting nuclear weapons production and mixed oxide fuel fabrication. Maximum transportation impacts would be realized if low-level radioactive waste were shipped to either the Nevada Test Site or a commercial site in Utah instead of being disposed of onsite. Transuranic waste would be shipped to WIPP, and special nuclear material would be shipped mainly between LANL and Pantex or Savannah River. The total projected (one-way) distance traveled on public roads while transporting radioactive materials to various locations would range from 18.9 million to 21.6 million miles (30.3 million to 34.7 million kilometers) under the MDA Capping Option, and 84.3 million to 93.2 million miles (135.6 million to 155 million kilometers) under the MDA Removal Option.

Impacts of Incident-free Transportation

The dose to transportation workers from all offsite transportation activities under this alternative would range from 223 to 770 person-rem for low-level radioactive waste disposal at a commercial facility in Utah, and from 256 to 910 person-rem for disposal at the Nevada Test Site for the MDA Capping and Removal Option. The corresponding dose to the general population would range from 82 to 274 person-rem for disposal at a commercial facility and from 89 to 287 person-rem for disposal at the Nevada Test Site. The doses for options involving disposal of low-level radioactive waste at the Nevada Test Site are larger because of the longer distances traveled and larger affected population. Accordingly, incident-free transportation would result in a maximum of 0.15 excess LCFs among transportation workers and 0.053 excess LCFs in the affected population for the MDA Capping Option, and a maximum of 0.55 LCFs among transportation workers and 0.17 excess LCFs in the affected population for the MDA Removal Option.

The impact of this alternative on individual transportation workers would be the same as the impact discussed under the No Action Alternative. An individual transportation worker would not be expected to develop a lifetime latent fatal cancer from exposure during these activities.

Under the MDA Capping Option, doses to the general populations along the LANL to Pojoaque and the Pojoaque to Santa Fe routes were estimated to be a maximum of 2.8 and 4.6 person-rem, respectively. These doses would result in 0 (0.0017 and 0.0028) excess LCFs among the exposed populations. Under the MDA Removal Option, doses to the general populations along the LANL to Pojoaque and the Pojoaque to Santa Fe routes were estimated to be a maximum of 8.1 and 13.3 person-rem, respectively. These doses would result in 0 (0.0049 and 0.0080) excess LCFs among the exposed populations.

Impacts of Accidents during Transportation

Similar to the projection under the No Action Alternative, for radioactive materials transported under this alternative, the maximum reasonably foreseeable offsite truck transportation accident with the highest consequence would involve a truck carrying contact-handled transuranic waste. The probability of such an accident occurring would be about 1 in 3.7 million (2.7×10^{-7}) per year in an urban area under the MDA Capping Option and 1 in 1.9 million (5.2×10^{-7}) per year in an urban area under the MDA Removal Option. If this accident occurred, the consequences would be similar to those projected for the No Action Alternative.

The estimated maximum radiological dose-risk to the general population for all projected accidents involving radioactive shipments, regardless of type, would be 0.42 person-rem, resulting in 0.00025 LCFs and a maximum nonradiological accident risk of 1 (0.66) fatality under the MDA Capping Option. Under the MDA Removal Option, the estimated maximum radiological dose-risk to the general population for all projected accidents involving radioactive shipments, regardless of type, would be 2.7 person-rem, resulting in 0.0016 LCFs, and a maximum nonradiological accident risk of 3 (2.96) fatalities.

The maximum radiological transportation accident dose-risk to the general populations along the LANL to Pojoaque and the Pojoaque to Santa Fe routes would be about 0.0095 and 0.016 person-rem under the MDA Capping Option, and about 0.053 and 0.078 person-rem under the MDA Removal Option. These doses would result in excess LCFs among the exposed populations of 0 under either MDA remediation option (5.7×10^{-6} and 9.8×10^{-6} for the MDA Capping Option and 3.2×10^{-5} and 4.7×10^{-5} for the MDA Removal Option). The maximum expected traffic fatalities along these routes would be 0 (0.021 and 0.026, respectively) under the MDA Capping Option. Under the MDA Removal Option, the maximum expected traffic accident fatalities along these routes also would be 0 (0.089 and 0.11, respectively).

Impacts of Construction, Operations, and Hazardous Material Transports

The impacts of transporting various nonradiological materials were also evaluated. These impacts are presented in terms of distance traveled and numbers of expected traffic accidents and fatalities. The transportation impacts under this alternative for the MDA Capping Option would be, for 15.2 million miles (24.5 million kilometers) traveled, 3 (2.8) traffic accidents and 0 (0.29) fatalities. For the MDA Removal Option, the nonradiological transportation impacts would be, for 17.4 million miles (28.1 million kilometers) traveled, 3 (3.2) traffic accidents and 0 (0.33) fatalities.

Local Traffic

Under the Expanded Operations Alternative, the impacts of LANL activities on local traffic flow and roadway infrastructure could be substantial without changes to current conditions. The potential addition of thousands of new employees combined with an increased number of trucks traveling to and from the site associated with increased construction, DD&D, and MDA remediation activities could impact local transportation. As shown in **Table 5–54**, a number of intersections could see large increases in daily traffic flow.

Table 5–54 Estimated Changes in Traffic at the Entrances to Los Alamos National Laboratory under the Expanded Operations Alternative

Activity	Average Daily Vehicle Trips				
	Diamond Drive Across Los Alamos Canyon	*Pajarito Road at NM 4*	*East Jemez Road at NM 4*	*West Jemez Road at NM 4*	*DP Road at Trinity Drive*
No Action Alternative	24,545	4,984	9,502	2,010	1,255
Estimated Daily Vehicle Trips under Expanded Operations Alternative	26,000	9,200	10,700	2,200	1,700
Percent Change from Baseline	+6	+85	+13	+9	+35

Areas of concern include increased truck traffic along East Jemez Road at NM 4 if it continues to be the route for trucks traveling to LANL or from the Los Alamos townsite. With the number of construction projects and MDA remediation efforts occurring along Pajarito Road that are expected to be underway in TA-18, TA-54, TA-55 and TA-3 under this alternative, it may be necessary to consider an alternate truck entry point for trucks working on these projects along Pajarito Road at NM 4 to alleviate some of the truck traffic on East Jemez.

Under the proposal to construct a new warehouse on East Jemez Road, a traffic study concluded that the level of service on East Jemez would lead to a breakdown in traffic flow during the afternoon rush hour without changes to the current road (LSC 2005). The study concluded that left turn lanes would be needed, as well as acceleration lanes for east- and west-bound traffic on

East Jemez Road (see Appendix G.9). These concerns would likely be further exacerbated by increased remediation activities under the Expanded Operations Alternative. For example, there would be a substantial increase in truck traffic into and out of the TA-61 borrow pit under the MDA Capping Option. Under this option, an average of about 60 truckloads of fill could be transported daily out of this borrow pit over a 10-year period. Trucks coming in and out of the pit would likely delay traffic flow on East Jemez Road and add to the noise level around this area.

The intersection of Trinity Drive and DP Road is already an area of concern. As discussed in Chapter 4, Section 4.10.2, the New Mexico Department of Transportation is planning improvements to this intersection that would improve the ability of trucks to leave DP Road and turn onto Trinity Drive. Expected increases in traffic during the period that TA-21 is undergoing DD&D and MDAs A, B, T, and U are being remediated would increase the need for these improvements. The concerns about additional trucks entering and leaving DP Road and the affect of increased truck traffic on the local road infrastructure may result in the need for another entry point to TA-21 during periods of heavy activity.

Large increases beyond those discussed under the No Action Alternative also are expected on Pajarito Road; however, usage of this road is much lower than that of other main access points into and out of LANL. Further traffic studies may be needed to determine whether any changes would be required if all of the planned projects progressed on the current schedules set under the Expanded Operations Alternative. Pajarito Road would experience the largest increase in traffic once remediation efforts start at MDA G. It may be necessary to regulate traffic flow at its intersection with NM 4 during peak travel hours under this alternative.

Furthermore, although some of the traffic on Pajarito Road is associated with staff that work in technical areas along Pajarito Road, other traffic is through traffic – for instance, people traveling from White Rock to TA-3 or the Los Alamos townsite. Implementation of the proposed Security-Driven Transportation Modifications to the Pajarito Corridor would occasionally restrict private vehicles from this section of Pajarito Road, and result in increased traffic on other local roads such as the Truck Route (NM 501) and NM 502. Additional traffic information would be needed to fully assess the impacts that the Security Driven Transportation Modification would have on local traffic.

5.11 Environmental Justice

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from normal operations resulting from implementing the alternatives considered in this SWEIS. In assessing the impacts, the following definitions of minority individuals and populations and low-income population were used:

- *Minority individuals:* Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African-American, Native Hawaiian or Other Pacific Islander, or two or more races (meaning individuals who identified themselves on the census form as being a member of two or more races, such as both Hispanic and Asian).

- *Minority populations*: Minority populations are identified where either: (1) the minority population of the affected area exceeds 50 percent, or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

- *Low-income population*: Low-income populations in an affected area are identified using the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

Consistent with the impact analysis for the public and occupational health and safety, the affected populations are defined as those minority and low-income populations that reside within a 50-mile (80-kilometer) radius centered on the LANL LANSCE Facilities at TA-53 and the High Explosives Testing Sites at TA-36 (see **Table 5–55**). A 50-mile (80-kilometer) radius was chosen because impacts are not typically significant beyond 50 miles (80 kilometers). If it is determined that impacts could be significant beyond a 50-mile (80-kilometer) radius, additional analysis would be performed. In the case of this LANL SWEIS, it was determined that impacts beyond a 50-mile (80-kilometer) radius were not expected to be significant. For example, projected radiation doses drop dramatically with increasing distance from the source. For LANL, the highest projected dose to the public would be to persons residing north-northeast of LANSCE as discussed in Section 5.6.1. Under this scenario, individuals residing 0.5 miles (0.8 kilometers) from LANSCE would receive a dose of approximately 7.5 millirem annually while those residing 50 miles (80 kilometers) away in the same direction would receive a dose of 0.035 millirem annually. For additional information on the analysis of impacts beyond a 50-mile (80-kilometer) radius see Appendix C, Section C.1.3.3.

Table 5–55 Potentially Affected Populations

Source Location	*Total Population*	*Total Minority Population*	*Hispanic Population*	*American Indian Population*	*Low-Income Population*
TA-53	283,766	155,261	127,641	17,811	35,826
TA-36	375,495	185,474	151,110	21,263	39,206

Based on the analysis of impacts for other resource areas, NNSA expects no high and adverse impacts from the continued operation of LANL under any of the alternatives. NNSA also analyzed the potential risk due to radiological exposure through the consumption patterns of special pathways receptors, including subsistence consumption of native vegetation (pinyon nuts and Indian Tea [Cota]), locally grown produce and farm products, groundwater, surface water, fish (game and nongame), game animals, other foodstuffs, and incidental consumption of soils and sediments (on produce, in surface water, and ingestion of inhaled dust); absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathways receptors analysis is important to the environmental justice analysis because this consumption pattern may reflect the traditional or cultural practices of members of minority populations in the area. See Section 5.6.1.1 and Appendix C, Section C.1.4 for more information on special pathways receptors.

Subsistence Consumption of Fish and Wildlife

Section 4–4 of Executive Order 12898 directs Federal agencies "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that Federal governments communicate to the public the risks of these consumption patterns." In the *1999 SWEIS*, DOE considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Consideration of special pathways took into account the levels of contaminants in native vegetation (pinyon nuts and Indian Tea [Cota]), locally grown produce and farm products, groundwater, surface water, fish (game and nongame), game animals (including organ meats), and soils and sediments on or near LANL (DOE 1999a).

Based on recent monitoring results, concentrations of contaminants in native vegetation, produce, surface water, fish, game animals, other foodstuffs, soils and sediments in areas surrounding LANL have been quite low (at or near the threshold of detection) and seldom above background levels (see Appendix C, Section C.1.4). For a person whose diet and lifestyle reflect all of the special pathways considered, his or her annual dose would be expected to increase by between 4.5 millirem (0.0045 rem) and 10.7 millirem (0.0107 rem) annually. Using a risk estimator value of 0.0006 lifetime probability of fatal cancer per person-rem, an increased dose of between 4.5 millirem (0.0045 rem) and 10.7 millirem (0.0107 rem) per year would equate to an increased annual risk of developing a fatal cancer of between 1 in 370,000 (2.7×10^{-6}) and 1 in 156,000 (6.4×10^{-6}). By comparison, the average resident of New Mexico receives a dose of approximately 400 millirem (0.4 rem) per year from background sources. Therefore, for those individuals participating in all of the special pathways, their average annual dose and risk of developing a fatal cancer would increase by approximately 1.1 to 2.7 percent due to these special pathways.

Ingestion pathway calculations focused on concentrations of radionuclides in environmental media from natural background sources, weapons testing fallout, and previous radiological releases from LANL, as reported in LANL environmental surveillance reports for 2001 through 2004. The actual contribution from recent operations at LANL is only a small fraction of this value. The overall risk to the special pathway receptor would not differ among the alternatives considered in this new SWEIS because most of the risk would be attributed to the existing low levels of radiological contamination in water and soils in the area around LANL. Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

5.11.1 No Action Alternative

Los Alamos National Laboratory Site-Wide Impacts

There would be no disproportionately high and adverse environmental impacts on minority and low-income populations due to construction activities at LANL under the No Action Alternative. This conclusion is a result of investigations in this SWEIS that determined there were no significant impacts on human health, ecological, cultural, paleontological, socioeconomic, and other resource areas described in other subsections of this chapter.

Under the No Action Alternative, all current nuclear production operations would be conducted in existing or replacement facilities at LANL and no new nuclear operations would be conducted. As discussed in Sections 5.6.1 and 5.6.2, radiological and hazardous chemical risks to the public resulting from normal operations would be small and are not considered significant. In summary, implementation of the No Action Alternative would pose no disproportionately high and adverse health and safety risks to low-income or minority populations living in the potentially affected area surrounding LANL.

As shown in Table 5–18, the total population within 50 miles (80 kilometers) of LANL for the No Action Alternative is projected to receive an annual dose of about 30 person-rem. Because the majority of this dose results from operations at LANSCE, the environmental justice analysis for this alternative uses the 50-mile (80-kilometer) population centered on LANSCE in TA-53. As shown in **Table 5–56**, the dose from LANSCE along with the dose associated with High-Explosive Testing firing site operations ascribed to TA-36 would result in an annual dose of approximately 29.2 person-rem to the affected population and an average annual individual dose of 0.10 millirem. These two locations account for approximately 97 percent of the total estimated dose from all sites at LANL under the No Action Alternative.

Table 5–56 Comparison of Total Minority, Hispanic, American Indian and Low-Income Population and Average Individual Doses Under the No Action Alternative [a]

	Annual Dose in Person-rem	*Annual Dose in Millirem*
Total Population [b]	29.2	
Average Individual		0.10
White (non-Hispanic) Population	15.0	
Non-Minority Average Individual		0.11
Total Minority Population	14.1	
Minority Average Individual		0.088
Hispanic Population [c]	11.3	
Hispanic Average Individual		0.086
American Indian Population [d]	1.8	
American Indian Average Individual		0.092
Non-Low-Income Population	25.9	
Non-Low-Income Average Individual		0.10
Low-Income Population	3.0	
Low-Income Average Individual		0.082

[a] The total population dose displayed in this table, accounts for the estimated dose from LANSCE at TA-53 and the High-Explosive Testing firing site operations at TA-36 for the No Action Alternative.

[b] The total population dose for this environmental justice analysis differs by 3 percent from that in Table 5–18. This difference is due to different models used to estimate the populations; both estimates are based on data drawn from the 2000 decennial census. The SECPOP computer program used for the analysis for Table 5–18 does not allow for the identification of minority and low-income populations. Therefore an alternate method that uses a more refined distribution of the population is used for this analysis. The minor differences do not affect the conclusions supported by the analyses.

[c] The Hispanic population includes all Hispanic persons regardless of race.

[d] The American Indian population may include persons who also indicated that they were of Hispanic ethnicity in the 2000 census.

Similar population doses are estimated for the following populations: white (non-Hispanic), all (total) minorities, American Indians, and Hispanic of any race. The white (non-Hispanic) population would be expected to receive the largest annual collective dose (15 person-rem) and annual average individual dose (0.11 millirem). This compares to a total minority annual collective dose of 14.1 person-rem and an average annual dose of 0.088 millirem to a member of the minority population. American Indians living within 50 miles (80 kilometers) of LANL would receive a collective dose of 1.8 person-rem annually and an average annual individual dose of 0.092 millirem. The Hispanic population would receive a collective dose of 11.3 person-rem annually; the annual average dose to a member of the Hispanic population would be 0.086 millirem.

Population doses to persons living below the poverty level are also analyzed in Table 5–56. Low-income populations surrounding LANL would receive an annual dose of 3.0 person-rem and an annual average individual dose of 0.082 millirem. Persons living above the poverty level would receive an annual collective dose of 25.9 person-rem and an annual average individual dose of 0.10 millirem. These data show that the total minority, American Indian, Hispanic, and low-income populations would not be subjected to disproportionately high and adverse dose impacts from normal operations at LANL under the No Action Alternative.

As shown in Table 5–17, the MEI for the No Action Alternative is projected to receive a dose of 7.8 millirem (0.0078 rem). As explained in Chapter 4, Section 4.6.1.2, the offsite MEI is a hypothetical member of the public who would receive the largest dose from LANL operations. For this SWEIS, that person would be located at LANL's East Gate along NM 502. Since no one actually resides at this location, the MEI dose is considered a conservative estimate with all members of the public expected to receive a dose that would be smaller than the estimated MEI dose. Therefore, doses to members of minority or low-income populations would not be considered significant because the dose to the MEI under this Alternative is not considered significant. As discussed earlier in Section 5.11, the average resident of New Mexico receives a dose of approximately 400 millirem (0.4 rem) per year from background sources. Therefore, for any individual under the No Action Alternative, his or her average annual dose and risk of developing a fatal cancer from the dose received would be expected to increase by a maximum of approximately 2.0 percent as a result of LANL operations.

As discussed in Section 5.6.2.1, the maximum public risk of developing a cancer as a result of chemical releases under the No Action Alternative would be below the guideline value of 1 in a million (1.0×10^{-6}) for the major carcinogenic pollutants that could be released from LANL under normal operations. In other words, one person in a population of a million would develop cancer if this population were exposed to this concentration over a lifetime, a level of concern established in the Clean Air Act. Therefore, the impact of potential chemical releases on minority or low-income individuals under this alternative would not be considered significant.

For nonradiological air quality impacts, as shown in Table 5–8, the concentrations of criteria pollutants as a result of LANL operations under the No Action Alternative would remain well below the ambient standards established to protect human health. Therefore, the impact of potential nonradiological air pollutant releases on minority or low-income individuals under this alternative would not be considered significant.

As shown in Table 5–62, the accident with the highest risk to the offsite MEI is a lightning strike at the Radioassay and Nondestructive Testing Facility in TA-54 that leads to a catastrophic fire. This accident represents the highest risk to an offsite MEI for all alternatives under consideration including the No Action Alternative. Under this accident scenario, the risk to the MEI of developing a fatal cancer as a result of radiation exposure from this accident is conservatively estimated to be 1 chance in 17 per year (0.06). For this accident, the MEI would be at the site boundary on the San Ildefonso Pueblo; however, the likelihood of an individual being at this location at the time of the accident would be highly unlikely since no one resides in the area adjacent to LANL. The accident with the highest risk to the offsite public for all alternatives under consideration, shown in Table 5–78, is a wildfire that would consume the waste storage domes in TA-54. Under this accident, the risk to the public is estimated to be 3 (2.7) latent cancer fatalities in the general public. Given the proximity of the more heavily populated areas of Los Alamos and White Rock to TA-54, these areas would be the most heavily impacted in the event of such an accident. Since neither of these is a minority or low-income community, this accident would not have a disproportionate high and adverse impact on low income or minority populations. For more information on the demographics of Los Alamos County, see Chapter 4, Section 4.8.1.2.

Key Facilities Impacts

Routine normal operations at Key Facilities would not be expected to cause fatalities or illness among the general population, including minority and low-income populations living within the potentially affected area.

The annual radiological risks to the offsite population that could result from the maximum potential accident at a Key Facility is estimated to be smaller than 0.76 LCFs (see Table 5–62). Thus, the risk of an excess LCF in the entire offsite population would be less than 1 under the No Action Alternative.

5.11.2 Reduced Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Implementation of the Reduced Operations Alternative would pose no disproportionately high and adverse health and safety risks to low-income or minority populations living in the potentially affected area surrounding LANL. Under the Reduced Operations Alternative, the risks of disproportionately high and adverse environmental impacts on minority and low-income populations in the vicinity of LANL would be no higher than those described under the No Action Alternative; in some cases, they would be lower.

As shown in Table 5–18, the total population within 50 miles (80 kilometers) of LANL for the Reduced Operations Alternative is projected to receive an annual dose of about 6.4 person-rem. Because the majority of this dose results from operations at the High Explosive Testing firing sites in TA-36, the environmental justice analysis for this alternative uses the 50-mile (80-kilometer) population centered on TA-36. As shown in **Table 5–57**, the dose from High Explosive Testing would result in an annual dose of approximately 4.9 person-rem to the affected population and an average annual individual dose of 0.013 millirem. The High Explosive

Testing firing site operations account for approximately 77 percent of the total estimated dose from all sites at LANL under the Reduced Operations Alternative.

Table 5–57 Comparison of Total Minority, Hispanic, American Indian and Low-Income Population and Average Individual Doses Under the Reduced Operations Alternative [a]

	Annual Dose in Person-rem	*Annual Dose in Millirem*
Total Population [b]	4.9	
Average Individual		0.013
White (non-Hispanic) Population	2.7	
Non-Minority Average Individual		0.014
Total Minority Population	2.2	
Minority Average Individual		0.012
Hispanic Population [c]	1.9	
Hispanic Average Individual		0.012
American Indian Population [d]	0.20	
American Indian Average Individual		0.0094
Non-Low-Income Population	4.4	
Non-Low-Income Average Individual		0.013
Low-Income Population	0.44	
Low-Income Average Individual		0.011

[a] The collective population dose displayed in this table, accounts for the estimated dose from the High Explosive Testing firing site operations at TA-36 for the Reduced Operations Alternative.
[b] The collective population doses for this environmental justice analysis differs by 6 percent from that in Table 5–18. This difference is due to different models used to estimate the populations; both estimates are based on data drawn from the 2000 decennial census. The SECPOP computer program used for the analysis for Table 5–18 does not allow for the identification of minority and low-income populations. Therefore an alternate method that uses a more refined distribution of the population is used for this analysis. The minor differences do not affect the conclusions supported by the analyses.
[c] The total Hispanic population includes all Hispanic persons regardless of race.
[d] The American Indian population may include persons who also indicated that they were of Hispanic ethnicity in the 2000 census.

The white (non-Hispanic) population would be expected to receive the largest annual collective dose (2.7 person-rem) and annual average individual dose (0.014 millirem). This compares to a total minority annual collective dose of 2.2 person-rem and an average annual dose of 0.012 millirem to a member of the minority population. American Indians living within 50 miles (80 kilometers) of LANL would receive a collective dose of 0.20 person-rem annually and an annual average individual dose of 0.0094 millirem. The Hispanic population would receive a collective dose of 1.9 person-rem annually; the annual average dose to a member of the Hispanic population would be 0.012 millirem.

Population doses to persons living below the poverty level are also presented in Table 5–57. Low-income populations surrounding LANL would receive an annual dose of 0.44 person-rem and an average annual individual dose of 0.011 millirem. Persons living above the poverty level would receive an annual collective dose of 4.4 person-rem and an average annual individual dose of 0.013 millirem. These data show that the total minority, American Indian, Hispanic, and low-income populations would not be subjected to disproportionately high and adverse dose impacts from normal operations at LANL under the Reduced Operations Alternative.

As shown in Table 5–17, the MEI for the Reduced Operations Alternative is projected to receive a dose of 0.79 millirem (0.00079 rem), about 10 times smaller than the dose projected for the

MEI under the No Action Alternative. As discussed in Section 5.11.1, doses to members of minority or low-income populations would not be considered significant because the dose to the MEI under the No Action Alternative is not considered significant and this remains true for the Reduced Operations Alternative. As discussed earlier in Section 5.11, the average resident of New Mexico receives a dose of approximately 400 millirem (0.4 rem) per year from background sources. Therefore, for the MEI under the Reduced Operations Alternative, his or her average annual dose and risk of developing a fatal cancer from the dose received would be expected to increase by a maximum of approximately 0.2 percent as a result of LANL operations.

As discussed in Section 5.6.2.2, the maximum public risk of developing a cancer as a result of chemical releases under the Reduced Operations Alternative would be approximately the same as those cited for the No Action Alternative and below the guideline value of 1 in a million (6.4×10^{-6}) for the major carcinogenic pollutants that could be released from LANL under normal operations. In other words, one person in a population of a million would develop cancer if this population were exposed to this concentration over a lifetime, a level of concern established in the Clean Air Act. Therefore, the impact of potential chemical releases on minority or low-income individuals under this alternative would not be considered significant.

For nonradiological air quality impacts, as discussed in Section 5.4.1.2, the concentrations of criteria pollutants as a result of LANL operations under the Reduced Operations Alternative would likely be smaller than those expected under the No Action Alternative and would remain well below the ambient standards established to protect human health. Therefore, the impact of potential nonradiological air pollutant releases on minority or low-income individuals under this alternative would not be considered significant.

The impact of potential accidents on the minority or low-income populations under the Reduced Operations Alternative would be the same as those discussed above for the No Action Alternative in Section 5.11.1.

5.11.3 Expanded Operations Alternative

Los Alamos National Laboratory Site-Wide Impacts

Based on the analysis of impacts for other resource areas in this chapter, there would be no high and adverse impacts from continued operation of LANL under the Expanded Operations Alternative. No disproportionately high and adverse environmental impacts on minority or low-income populations would occur due to construction activities at LANL or to the project-specific activities discussed in Appendices G, H, I, and J under this alternative. As stated in other subsections of this chapter, environmental impacts from construction under this alternative would be small and would not be expected to be significant and adverse beyond the LANL site boundary.

No disproportionately high and adverse environmental impacts on minority or low-income populations would occur under this alternative. This conclusion results from analyses presented in this SWEIS that determined there would be no significant impacts on human health, ecological, cultural, paleontological, socioeconomic, and other resource areas described in other subsections of this chapter.

As shown in Table 5–18, the total population within 50 miles (80 kilometers) of LANL for the Expanded Operations Alternative is projected to receive an annual dose of about 36 person-rem. Because the majority of this dose results from operations at LANSCE, the environmental justice analysis for this alternative uses the 50-mile (80-kilometer) population centered on LANSCE in TA-53. As shown in **Table 5–58**, the dose from LANSCE along with the dose associated with High Explosive Testing firing site operations ascribed to TA-36 would result in an annual dose of 29.2 person-rem to the affected population and an average annual individual dose of 0.10 millirem. These two locations account for approximately 81 percent of the total estimated dose from all sites at LANL under the Expanded Operations Alternative.

Table 5–58 Comparison of Total Minority, Hispanic, American Indian and Low-Income Population and Average Individual Doses Under the Expanded Operations Alternative [a]

	Annual Dose in Person-rem	*Annual Dose in Millirem*
Total Population [b]	29.2	
Average Individual		0.10
White (non-Hispanic) Population	15.0	
Non-Minority Average Individual		0.11
Total Minority Population	14.1	
Minority Average Individual		0.088
Hispanic Population [c]	11.3	
Hispanic Average Individual		0.086
American Indian Population [d]	1.8	
American Indian Average Individual		0.092
Non-Low-Income Population	25.9	
Non-Low-Income Average Individual		0.10
Low-Income Population	3.0	
Low-Income Average Individual		0.082

[a] The total population dose displayed in this table, accounts for the estimated dose from LANSCE at TA-53 and the High-Explosive Testing firing site operations at TA-36 for the Expanded Operations Alternative.
[b] The total population dose for this environmental justice analysis differs by 3 percent from that in Table 5–18. This difference is due to different models used to estimate the populations; both estimates are based on data drawn from the 2000 decennial census. The SECPOP computer program used for the analysis for Table 5–18 does not allow for the identification of minority and low-income populations. Therefore an alternate method that uses a more refined distribution of the population is used for this analysis. The minor differences do not affect the conclusions supported by the analyses.
[c] The total Hispanic population includes all Hispanic persons regardless of race.
[d] The American Indian population may include persons who also indicated that they were of Hispanic ethnicity in the 2000 census.

The white (non-Hispanic) population would be expected to receive the largest annual collective dose (15 person-rem) and annual average individual dose (0.11 millirem). This compares to a total minority annual collective dose of 14.1 person-rem and an average annual dose of 0.088 millirem to a member of the minority population. American Indians living within 50 miles (80 kilometers) of LANL would receive a collective dose of 1.8 person-rem annually and an annual average individual dose of 0.092 millirem. The Hispanic population would receive a collective dose of 11.3 person-rem annually; the annual average dose to a member of the Hispanic population would be 0.086 millirem.

Population doses to persons living below the poverty level are also analyzed in Table 5–58. Annually, low-income populations surrounding LANL would receive a collective dose of

3.0 person-rem and an average individual dose of 0.082 millirem. Persons living above the poverty level would receive an annual collective dose of 25.9 person-rem and an annual average individual dose of 0.10 millirem. These data show that the total minority, American Indian, Hispanic, and low-income populations would not be subjected to disproportionately high and adverse dose impacts from normal operations at LANL under the Expanded Operations Alternative.

As discussed in Sections 5.6.1 and 5.6.2, radiological and hazardous chemical risks to the public resulting from normal operations would be small and not considered significant. As shown in Table 5–17, the MEI for the Expanded Operations Alternative is projected to receive a dose of approximately 8.2 millirem (0.00082 rem), about a 5 percent increase in the dose projected for the MEI under the No Action Alternative. This increase in the MEI dose would not be considered significant and therefore doses to members of minority or low-income populations that would be lower than the increase in dose to the MEI would not be considered significant. As discussed earlier in Section 5.11, the average resident of New Mexico receives a dose of approximately 400 millirem (0.4 rem) per year from background sources. Therefore, for the MEI under the Expanded Operations Alternative, his or her average annual dose and risk of developing a fatal cancer from the dose received would be expected to increase by a maximum of approximately 2.1 percent as a result of LANL operations.

As discussed in Section 5.6.2.3, the maximum public risk of developing a cancer as a result of chemical releases under the Expanded Operations Alternative would be approximately the same as those cited for the No Action Alternative with the exception of a small increase in high explosives processing that would not be expected to substantially change the risks. Therefore, the impact of potential chemical releases on minority or low-income individuals under this alternative would not be considered significant.

For nonradiological air quality impacts, as discussed in Section 5.4.1.3, the concentrations of criteria pollutants as a result of LANL operations under the Expanded Operations Alternative would likely be larger than those expected under the No Action Alternative but would remain below the ambient standards established to protect human health. Therefore, the impact of potential nonradiological air pollutant releases on minority or low-income individuals under this alternative would not be considered significant.

The impact of potential accidents on the minority and low-income populations under the Expanded Operations Alternative would be the same as those discussed above for the No Action Alternative in Section 5.11.1.

Key Facilities Impacts

Routine normal operations at Key Facilities would not be expected to cause fatalities or illness among the general population, including minority and low-income populations living within the potentially affected area.

Annual radiological risk to the offsite population that could result from the maximum potential accident at a Key Facility is estimated to be less than 0.76 LCFs (see Table 5–65). Thus, the risk of an excess LCF in the entire offsite population under the Expanded Operations Alternative would be less than 1.

5.12 Facility Accidents

The estimated impacts of potential accidents are described in this section for the No Action, Reduced Operations, and Expanded Operations Alternatives. A summary of the risks from radiological and chemical operations, potential seismic events, and a potential wildfire is provided in **Table 5–59**. Radiological impacts from facility accidents are addressed in Section 5.12.1. Chemical impacts from facility accidents are addressed in Section 5.12.2. Impacts from postulated earthquake events that could simultaneously affect multiple facilities are addressed in Section 5.12.3. Wildfire, another natural event that can also impact multiple facilities, is addressed in Section 5.12.4. Additional accident analysis details are provided in Appendix D. For all accident scenarios, the noninvolved worker is a hypothetical individual located 110 yards (100 meters) from the site of the accident, the MEI is a hypothetical individual located at the nearest site boundary, and the population includes residents within 50 miles (80 kilometers) of the site of the accident.

Table 5–59 Summary of Worker and Public Radiological Risks and Chemical Consequences from Potential Accidents

Maximum Potential Accident	*No Action Alternative*	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Facility Radiological Release		Same as No Action Alternative	Same as No Action Alternative
• Offsite Population (LCF per year)	0.8		
• MEI (LCF per year)	0.06		
• Noninvolved Worker (LCF per year)	0.1		
Facility Chemical Release [a]		Same as No Action Alternative	Same as No Action Alternative
• Concentrations above which life-threatening health effects could result (ERPG-3 [t] limit)	5 parts per million		
• ERPG-3 distance	962 yards		
• Distance to the site boundary	537 yards		
Site-Wide Seismic Event Radiological		Same as No Action Alternative	Same as No Action Alternative
• Offsite Population (LCF per year)	0.009		
• MEI (LCF per year)	0.0003		
• Noninvolved Worker (LCF per year)	0.001		
Site-Wide Seismic Event Chemical [a]		Same as No Action Alternative	Same as No Action Alternative
• Concentrations above which life-threatening health effects could result (ERPG-3 [t] limit)	25 parts per million		
• ERPG-3 distance	122 yards		
• Distance to the site boundary	13 yards		
Wildfire Radiological		Same as No Action Alternative	Same as No Action Alternative
• Offsite Population (LCF per year)	2.7		
• MEI (LCF per year)	0.05		
• Noninvolved Worker (LCF per year)	0.05		
Wildfire Chemical [a]		Same as No Action Alternative	Same as No Action Alternative
• Concentrations above which life-threatening health effects could result (ERPG-3 [t] limit)	25 parts per million		
• ERPG-3 distance	97 yards		
• Distance to the site boundary	13 yards		

LCF = latent cancer fatality, MEI = maximally exposed individual, ERPG = Emergency Response Planning Guideline.

[a] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005e).

Note: To convert yards to meters, multiply by 0.9144.

5.12.1 Facility Radiological Impacts

Estimated radiological accident consequences and risks associated with the No Action, Reduced, and Expanded Alternatives are shown in Tables 5–60 through 5–65.

5.12.1.1 No Action Alternative

The accident with the highest estimated consequences to the offsite population, as shown in **Table 5–60**, is a lightning strike fire at the Radioassay and Nondestructive Testing Facility.[6] If this accident were to occur, there could be 6 additional LCFs in the offsite population. The accident with the highest estimated consequences to the MEI and a noninvolved worker is a waste storage dome fire at TA-54 as shown in Tables 5–60 and **5–61**. If this accident were to occur as modeled, the noninvolved worker and the MEI would receive large radiation doses. Depending on the specific radionuclides released and the route of human exposure, radiation doses of this magnitude would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual, mitigating health impacts, or both. In addition to the conservative assumptions used to develop the source term (amount of radioactive material released) for this accident, the calculated doses are based on the assumptions that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs. The MEI for all of the scenarios is located at the nearest site boundary.

The potential exists for exposures in excess of the above in the vicinity of the Chemistry and Metallurgy Research Building because of public access to Diamond Drive, which is approximately 50 meters from the building. The Chemistry and Metallurgy Building is expected to be operational until transition to the Chemistry and Metallurgy Research Replacement Facility is completed. The consequences to an individual at this Diamond Drive location during the HEPA Filter Fire would be 8.1 rem, resulting in an increased individual LCF risk of 0.0049 (approximately 1 in 210). Appendix D, Section D.3.2.1, contains further discussion of the Chemistry and Metallurgy Research Building exposures.

After accounting for the frequency of the postulated accidents (see Appendix D), the estimated highest risk accident would be a Radioassay and Nondestructive Testing Facility lightning strike fire (TA-54-38). **Table 5–62** shows the annual risk of an increased likelihood of an LCF for this accident to be 0.059 (about 1 in 17 years) for the MEI. The offsite population annual risk of additional LCFs is estimated to be 0.76 for an LCF in any one member of the total offsite population. Table 5–62 shows the annual risk of an increased likelihood of an LCF for this accident to be 0.12 (about 1 in 8 years) for a noninvolved worker.

---

[6] *The lightning fire accident scenario conservatively assumes that any lightning striking the Radioassay and Nondestructive Testing Facility would result in a fire that affects and releases radioactive material located inside the facility regardless of the lightning energy or the specific location at the facility subject to the lightning strike.*

Table 5–60 Radiological Accident Offsite Population Consequences for the No Action and Reduced Operations Alternatives

Accident Scenario	Maximally Exposed Individual		Population to 50 Miles (80 kilometers)	
	Dose [a] (rem)	Latent Cancer Fatality [b]	Dose (person-rem)	Latent Cancer Fatalities [c, d]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	410	0.49	11,000	6 (6.3)
Weapons Engineering Tritium Facility Fire (TA-16-205)	5.9	0.0036	190	0 (0.11)
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	46	0.055	4,800	3 (2.9)
Waste Storage Dome Fire (TA-54)	420	0.50	4,200	3 (2.5)
Onsite Transuranic Waste Fire (TA-54)	190	0.22	5,700	3 (3.4)
Plutonium Facility Material Staging Area Fire (TA-55-4)	73	0.087	9,000	5 (5.4)
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	20	0.012	190	0 (0.11)
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	320	0.39	6,100	4 (3.7)
SHEBA Hydrogen Detonation (TA-18-168) [e]	0.88	0.00053	69	0 (0.041)
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.77	0.00046	200	0 (0.12)

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air (filter).

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations Alternative.

Table 5–61 Radiological Accident Onsite Worker Consequences for the No Action and Reduced Operations Alternatives

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose [a] (rem)	Latent Cancer Fatality [b]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	1,900	1.0 [c]
Weapons Engineering Tritium Facility Fire (TA-16-205)	8.92	0.00535
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	1,100	1.0 [c]
Waste Storage Dome Fire (TA-54)	2,000	1.0 [c]
Onsite Transuranic Waste Fire (TA-54)	760	0.91
Plutonium Facility Material Staging Area Fire (TA-55-4)	1,600	1.0 [c]
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	51	0.062
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	890	1.0 [c]

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose [a] (rem)	Latent Cancer Fatality [b]
SHEBA Hydrogen Detonation (TA-18-168) [d]	15	0.0092
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	5.4	0.0032

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air (filter).
[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.
[b] Increased risk of an LCF to an individual, assuming the accident occurs.
[c] The indicated dose yields a risk value greater than 1.0. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For this reason, a value of 1.0 is shown.
[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations Alternative.

Table 5–62 Radiological Accident Offsite Population and Worker Risks for the No Action and Reduced Operations Alternatives

Accident Scenario	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	Maximally Exposed Individual [a]	Population to 50 Miles (80 kilometers) [b, c]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	0.12 [d]	0.12	0.059	0.76
Weapons Engineering Tritium Facility Fire (TA-16-205)	1.1×10^{-5}	5.9×10^{-8}	4.0×10^{-8}	1.3×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	0.14 [d]	0.14	0.0077	0.4
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.0005	0.0025
Onsite Transuranic Waste Fire (TA-54)	0.001	0.00091	0.00022	0.0034
Plutonium Facility Material Staging Area Fire (TA-55-4)	0.01	0.01	0.00087	0.054
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	0.02	0.0012	0.00024	0.0022
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	0.001	0.001	0.00039	0.0037
SHEBA Hydrogen Detonation (TA-18-168) [e]	0.0054	0.00005	2.8×10^{-6}	0.00022
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.01	0.000032	4.6×10^{-6}	0.0012

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air (filter).
[a] Increased risk of an LCF to an individual per year.
[b] Increased number of LCFs for the offsite population per year.
[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, DVRS, Domes), 301,900 (TA-55-4).
[d] The lightning strike fire accident scenarios conservatively assumes that any lightning strike on the facility would result in a source term equivalent to a structure fire.
[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations Alternative.

5.12.1.2 Reduced Operations Alternative

The accident impacts from the Reduced Operations Alternative are the same as those from the No Action Alternative and are presented in Tables 5-60 through 5-62. Activities at TA-18, including operation of SHEBA, would cease under this alternative. Inspection of the tables shows that SHEBA operations are a small component of the facility impacts at LANL; its elimination would not significantly alter the overall risk profile of individual facility operations. All other impacts in the tables are equally applicable for this alternative.

5.12.1.3 Expanded Operations Alternative

Accident impacts under the Expanded Operations Alternative are shown in **Tables 5–63** through **5–65**. SHEBA operations would cease under the Expanded Operations Alternative, so its impacts, although relatively small, have been eliminated from the tables below. Additional or replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste storage would be consolidated in a new facility, the TRU Waste Facility located in TA-50 or a generic site along the Pajarito Road corridor. The impacts from this new facility would be smaller than those of the existing facilities because of its new location and because less material would be stored and the rest would be moved offsite. The entries in Tables 5–63 through 5–65 reflect present Decontamination and Volume Reduction System and waste storage domes operations because they would bound the impacts of the new facility. Accident impacts for the new facility are described in Appendix H.

MDA cleanup is a component of the Expanded Operations Alternative. A number of scenarios were considered for this activity and an explosion or fire during removal operations that breaches the MDA enclosure and bypasses the HEPA filtration was chosen. MDA G, because of its relatively large inventory, bounds the accident impacts from MDA removal. The consequences and risks from this scenario are included in Tables 5–63 through 5–65. As with the No Action Alternative, TA-54 operations generally dominate the accident risks from Expanded Operations. Possible removal of MDA G in TA-54 adds a component to this risk. Appendix I includes more details about MDA cleanup accident impacts.

The accident with the largest consequences to the offsite population is a fire at Chemistry and Metallurgy Research Building involving sealed sources, as shown in Table 5–63. If this accident were to occur, there could be 7 additional LCFs in the offsite population. The accident with the highest consequences to the MEI and the noninvolved worker is a waste storage dome fire at TA-54.

The potential exists for exposures in excess of those above at the Chemistry and Metallurgy Research Building because of public access to Diamond Drive, approximately 50 meters from the facility. The Chemistry and Metallurgy Research Building is expected to be operational until the transition to the Chemistry and Metallurgy Research Replacement Facility is completed. The consequences to an individual at this Diamond Drive location during a fire impacting sealed sources (applicable to only the Expanded Operations Alternative) or a HEPA filter fire would be 4.3 rem and 8.1 rem, respectively. These doses would result in an increased risk of a latent fatal cancer during the lifetime of the individual of 0.0026 (approximately 1 in 390) and 0.0049 (approximately 1 chance in 210), respectively. Appendix D, Section D.3.2.1, contains further discussion of the Chemistry and Metallurgy Research Building exposures.

Table 5–63 Radiological Accident Offsite Population Consequences for the Expanded Operations Alternative

Accident Scenario	Maximally Exposed Individual		Population to 50 Miles (80 kilometers)	
	Dose [a] (rem)	LCF [b]	Dose (person-rem)	LCF [c, d]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	410	0.49	11,000	6 (6.3)
Weapons Engineering Tritium Facility Fire (TA-16-205)	5.9	0.0036	190	0 (0.11)
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	46	0.055	4,800	3 (2.9)
Waste Storage Dome Fire (TA-54)	420	0.50	4,200	3 (2.5)
Onsite Transuranic Waste Fire (TA-54)	190	0.22	5,700	3 (3.4)
Plutonium Facility Material Staging Area Fire (TA-55-4)	73	0.087	9,000	5 (5.4)
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	20	0.012	190	0 (0.11)
Explosion at Material Disposal Area G (TA-54)	55	0.066	770	0 (0.46)
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	320	0.39	6,100	4 (3.7)
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	0.099	0.000059	12,000	7 (7.0)
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.77	0.00046	200	0 (0.12)

LCF = latent cancer fatality, TA = technical area, HEPA = high-efficiency particulate air (filter).

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, DVRS, Domes), 301,900 (TA-55-4).

After accounting for the frequency of the postulated accidents, the estimated highest risk accident would be a Radioassay and Nondestructive Testing Facility lightning strike fire (TA-54-38). Table 5–65 shows the annual risk of an increased likelihood of an LCF for this accident to be 0.059 (about 1 in 17 years) for the MEI. The offsite population annual risk of additional LCFs is shown to be 0.76 for any one member of the offsite population. Table 5–65 shows the annual risk of an increased likelihood of an LCF for this accident to be 0.12 (about 1 chance in 8 years) for a noninvolved worker.

Table 5–64 Radiological Accident Onsite Worker Consequences for the Expanded Operations Alternative

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	LCF [b]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	1,900	1.0 [c]
Weapons Engineering Tritium Facility Fire (TA-16-205)	8.9	0.0054
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	1,100	1.0 [c]
Waste Storage Dome Fire (TA-54)	2,000	1.0 [c]
Onsite Transuranic Waste Fire (TA-54)	760	0.91
Plutonium Facility Material Staging Area Fire (TA-55-4)	1,600	1.0 [c]
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	51	0.062
Explosion at Material Disposal Area G (TA-54)	410	0.49
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	890	1.0 [c]
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	1.2	0.00073
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	5.4	0.0032

LCF = latent cancer fatality, TA = technical area, HEPA = high-efficiency particulate air (filter).

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] The indicated dose yields a risk value greater than 1.0. This means that it is likely that an individual exposed to the indicated dose would develop a fatal latent cancer. For this reason, a value of 1.0 is shown.

Table 5–65 Radiological Accident Offsite Population and Worker Risks for the Expanded Operations Alternative

Accident Scenario	Frequency (per year)	Risk to Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	Maximally Exposed Individual [a]	Population to 50 Miles (80 kilometers) [b, c]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	0.12 [d]	0.12	0.059	0.76
Weapons Engineering Tritium Facility Fire (TA-16-205)	1.1×10^{-5}	6.0×10^{-8}	4.0×10^{-8}	1.3×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	0.14 [d]	0.14	0.0077	0.4
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.0005	0.0025
Onsite Transuranic Waste Fire (TA-54)	0.001	0.00091	0.00022	0.0034
Plutonium Facility Material Staging Area Fire (TA-55-4)	0.01	0.01	0.00087	0.054
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	0.02	0.0012	0.00024	0.0022
Explosion at Material Disposal Area G (TA-54)	0.01	0.0049	0.00066	0.0046
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	0.001	0.001	0.00039	0.0037
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	0.00024	1.7×10^{-7}	1.4×10^{-8}	0.0017

Accident Scenario	Frequency (per year)	Risk to Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	Maximally Exposed Individual [a]	Population to 50 Miles (80 kilometers) [b, c]
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.01	0.000032	4.6×10^{-6}	0.0012

TA = technical area, HEPA = high-efficiency particulate air (filter).

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, DVRS, Domes), 301,900 (TA-55-4).

[d] The lightning strike fire accident scenarios conservatively assumes that any lightning strike on the facility would result in a source term equivalent to a structure fire.

5.12.2 Facility Hazardous Chemical Impacts

5.12.2.1 No Action Alternative

The chemicals of concern at LANL facilities under the No Action Alternative are shown in **Table 5–66**. They were selected from a database of chemicals used onsite based on their quantities, chemical properties, and human health effects. The table shows the Emergency Response Planning Guideline (ERPG) values. ERPG-2 and ERPG-3 values are the concentrations that, if an accident were to occur, could result in serious health effects or life-threatening implications for exposed individuals.

Table 5–66 also shows the risk of worker and public exposure in the event of a chemical release from site-wide events only (seismic- and wildfire-related releases are discussed in their respective sections). The cause of a chemical release could be mechanical failure, corrosion, mechanical impact, or natural phenomena. The estimated frequency of each accident is shown in the table. The direction traveled by the chemical plume, which would depend on meteorological conditions at the time of the accident, would determine what segment of the worker and offsite populations would be at risk of exposure.

For selenium hexafluoride located at TA-54-216, there is an annual risk of 0.0041 (1 in 240 years) that workers and the public within a distance of 962 yards (880 meters) of the release would be exposed to concentrations in excess of ERPG-3 values. The workers and the public within a distance of 3,062 yards (2,800 meters) of the release face the same risk of being exposed to concentrations in excess of ERPG-2 values.

For sulfur dioxide located at TA-54-216, there is an annual risk of 0.00051 (1 in 1,950 years) that workers and the public within a distance of 755 yards (690 meters) of the release would be exposed to concentrations in excess of ERPG-3 values. The workers and the public within a distance of 1,804 yards (1,650 meters) of the release face the same risk of being exposed to concentrations in excess of ERPG-2 values.

Table 5–66 Chemical Accident Risks under the No Action and Reduced Operations Alternatives

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]	
			Value (ppm)	Annual Risk	Value (ppm)	Annual Risk
Selenium hexafluoride from waste cylinder storage at TA-54-216	0.0041	19.8 gallons (75 liters)	0.6 [c]	1 chance in 240 years of workers or public within 3,062 yards (2,800 meters) of facility receiving exposures in excess of limit. Nearest public access is at 537 yards (491 meters).	5 [c]	1 chance in 240 years of workers or public within 962 yards (880 meters) of facility receiving exposures in excess of limit. Nearest public access is at 537 yards (491 meters).
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (136 kilograms)	3	1 chance in 1,950 years of workers or public within 1,804 yards (1,650 meters) of facility receiving exposures in excess of limit. Nearest public access is at 537 yards (491 meters).	15	1 chance in 1,950 years of workers or public within 755 yards (690 meters) of facility receiving exposures in excess of limit. Nearest public access is at 537 yards (491 meters).
Chlorine gas released outside of Plutonium Facility Complex (TA-55-4)	0.063	150 pounds (68 kilograms)	3	1 chance in 15 years of workers within 1,181 yards (1,080 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).	20	1 chance in 15 years of workers within 416 yards (380 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).
Helium at TA-55-41	0.063	9,230,000 cubic feet (at STP) (261,366 cubic meters)	280,000 ppm [c]	1 chance in 15 years of workers within 203 yards (186 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,146 yards (1,048 meters).	500,000 ppm [c]	1 chance in 15 years of workers within 152 yards (139 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,146 yards (1,048 meters).

ERPG = Emergency Response Planning Guideline, ppm = parts per million, TA = technical area, STP = standard temperature and pressure.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2005e).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005e).

[c] The Temporary Emergency Exposure Limit value is used. ERPGs have not been issued for this substance.

For chlorine gas located outside of TA-55-4, there is an annual risk of 0.063 (1 in 15 years) that workers within a distance of 416 yards (380 meters) of the release would be exposed to concentrations in excess of ERPG-3 values. Workers and the public within a distance of 1,181 yards (1,080 meters) of the release face the same risk of being exposed to concentrations in excess of ERPG-2 values.

For helium gas located at TA-55-41, there is an annual risk of 0.063 (1 in 15 years) that workers within 152 yards (139 meters) of the release would be exposed to concentrations in excess of ERPG-3 values. Workers within a distance of 203 yards (186 meters) of the release face the same risk of being exposed to concentrations in excess of ERPG-2 values.

5.12.2.2 Reduced Operations Alternative

The chemicals of concern that could be released in a facility accident are the same for the Reduced Operations Alternative as for the No Action Alternative. None of the chemicals identified for the latter is eliminated in this alternative. The information in Table 5–66, therefore, also applies to the Reduced Operations Alternative.

5.12.2.3 Expanded Operations Alternative

The chemicals of concern that could be released in a facility accident for the No Action Alternative apply equally to the Expanded Operations Alternative. In addition, MDA cleanup, a component of the Expanded Operations Alternative, also includes a potential for accidental releases of toxic chemicals. A fire during removal operations that breaches any MDA enclosure and bypasses the HEPA filtration was chosen for analysis. There is a great deal of uncertainty regarding how much and which chemicals were disposed of in the MDAs. For the most conservative analysis, MDA B, the MDA closest to the public (and thus with the potential for the greatest impact on the public), was chosen to represent the chemical accident impacts of MDA cleanup. Two chemicals, sulfur dioxide (a gas) and beryllium (assumed to be in powder form), were chosen based on their restrictive ERPG values to bound the impacts of an extensive list of possible chemicals disposed of in the MDAs. **Table 5–67** shows, if present in MDA B in the quantities assumed, both of these chemicals would dissipate to below the ERPG-3 value very close to the release, but would continue to be a risk to the public due to the short distance to the nearest public access point for this MDA. Appendix I includes more details about MDA cleanup chemical accident impacts.

5.12.3 Site-Wide Seismic Impacts

As addressed in more detail in Appendix D, Section D.4, two site-wide seismic events, referred to as Seismic 1 and Seismic 2, were postulated to estimate the potential effects of radiological and chemical releases during an earthquake. In the event of a site-wide seismic event, radiological and chemical hazardous materials could be simultaneously released. Seismic events are categorized by their performance category (PC), which is numbered from PC-0 through PC-4. A higher performance category has a smaller annual frequency of occurrence, but a larger associated ground acceleration. A higher performance category has more severe consequences and structures would require a more resilient engineering design to survive.

The seismic accident scenarios (Seismic 1 and 2) analyzed in the SWEIS were based on the February 24, 1995, *Seismic Hazards Evaluation of the Los Alamos National Laboratory*. Seismic 1 – the seismic event characterized by a peak horizontal ground acceleration of 0.22g (0.22 times the acceleration due to gravity) – had an estimated annual probability of exceedance of 0.001 (1 in 1,000). Seismic 2 – a more severe seismic event characterized by a peak ground acceleration of 0.31g – had an estimated annual probability of exceedance of 0.0005 (1 in 2,000).

Table 5–67 Chemical Accident Risks under the Expanded Operations Alternative

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]	
			Value	Annual Risk	Value	Annual Risk
Selenium hexafluoride from waste cylinder storage at TA-54-216	0.0041	19.8 gallons (75 liters)	0.6 ppm [c]	1 chance in 240 years of workers or public within 3,062 yards (2,800 meters) of facility receiving exposures in excess of limit. Public access is at 537 yards (491 meters).	5 ppm [c]	1 chance in 240 years of workers or public within 962 yards (880 meters) of facility receiving exposures in excess of limit. Nearest public access is at 537 yards (491 meters).
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (136 kilograms)	3 ppm	1 chance in 1,950 years of workers or public within 1,804 yards (1,650 meters) of facility receiving exposures in excess of limit. Public access is at 537 yards (491 meters).	15 ppm	1 chance in 1,950 years of workers or public within 755 yards (690 meters) of facility receiving exposures in excess of limit. Nearest public access is at 537 yards (491 meters).
Chlorine gas released outside of Plutonium Facility Complex (TA-55-4)	0.063	150 pounds (68 kilograms)	3 ppm	1 chance in 15 years of workers within 1,181 yards (1,080 meters) of facility receiving exposures in excess of limit. Public access is at 1,111 yards (1,016 meters).	20 ppm	1 chance in 15 years of workers within 416 yards (380 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).
Helium at TA-55-41	0.063	9,230,000 cubic feet (261,366 cubic meters) (at STP)	280,000 ppm [c]	1 chance in 15 years of workers within 203 yards (186 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,146 yards (1,048 meters).	500,000 ppm [c]	1 chance in 15 years of workers within 152 yards (139 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,146 yards (1,048 meters).
Sulfur Dioxide (MDA B)	No frequency established; performed as an enveloping analysis	1 pound (0.45 kilogram)	3 ppm	Risk of workers or public within 90 yards (83 meters) of facility receiving exposures in excess of limit. Nearest public access is at 49 yards (45 meters).	15 ppm	Risk of workers or public within 37 yards (34 meters) of facility receiving exposures in excess of limit. Nearest public access is at 49 yards (45 meters).
Beryllium Powder (MDA B)	No frequency established; performed as an enveloping analysis	22 pounds [d] (10 kilograms)	0.025 milligram per cubic meter	Risk of workers within 25 yards (23 meters) of facility receiving exposures in excess of limit. Public access is at 49 yards (45 meters).	0.1 milligram per cubic meter	Risk of workers within 10 yards (9 meters) of facility receiving exposures in excess of limit. Nearest public access is at 49 yards (45 meters) and beyond this limit.

ERPG = Emergency Response Planning Guideline, TA = technical area, ppm = parts per million, MDA = material disposal area.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2005e).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005e).

[c] The Temporary Emergency Exposure Limit value is used. ERPGs have not been issued for this substance.

[d] This quantity represents the total material at risk. A fraction of this solid (0.00006) would be released as respirable particles under the hypothesized scenario.

An updated probabilistic seismic hazard analysis providing an improved understanding of the seismic characteristics of LANL was completed in 2007 (LANL 2007a). The new study indicates that the seismic hazard is higher than previously understood; the annual probability of exceedance for the previously analyzed peak ground accelerations is now estimated to be about 1 in 700 (rather than 1 in 1,000) for the Seismic 1 event, and 1 in 1,250 (rather than 1 in 2,000) for the Seismic 2 event. The revised annual probabilities of exceedance are thus 0.0015 and 0.0008, respectively. Using these larger probabilities, however, the seismic accident risks for the MEI, the noninvolved worker, and the population are less than 1 percent of accident risks for other types of accidents in the SWEIS such as fires at the Radioassay and Nondestructive Testing Facility, the Waste Characterization, Reduction, and Repackaging Facility, and the TA-54 waste storage domes.

For many facilities involved in the SWEIS Seismic 1 and 2 accident scenarios, a conservative assumption was made that there was complete failure of structures, systems, and components (given the Seismic 1 and 2 ground shaking), thereby resulting in the maximum possible radioisotope or chemical release. Higher seismic accelerations at the same annual frequency of exceedance would result in identical consequences for these facilities. Therefore, the larger seismic peak ground accelerations associated with the updated probabilistic seismic hazard analysis would not increase the consequence of these accident scenarios.[7] Furthermore, structures are typically designed with considerable factors of safety that provide large margins before failure would occur. For those facilities that were not assumed to completely fail, it is not possible to state the impacts of different peak horizontal ground accelerations without detailed structural analyses of LANL facilities using the updated probabilistic seismic hazard analysis results. Therefore, a bounding analysis was used to estimate the maximum expected effect of the updated seismic hazard analysis on the SWEIS seismic accident risks.

Using the accident source terms that were developed for the SWEIS Seismic 1 and 2 accident scenarios, the effect of the revised estimates of annual probability of exceedance would be an increase in the radiological risk of 50 percent for Seismic 1 scenarios and 60 percent for Seismic 2 scenarios. For this assessment, no credit was taken for facilities for which complete failure was already assumed and therefore no larger accident source term would be expected at larger seismic ground accelerations. Furthermore, the number of LCFs calculated for these two postulated seismic events should be considered within the context of the nonradiological human health impacts expected from these seismic events, which would cause widespread failures of non-nuclear LANL structures and structures outside of LANL. A much larger number of fatalities and injuries from structure collapse would be expected for these seismic events in the area surrounding LANL.

Just as the updated probabilistic seismic hazards analysis used new data and advanced methods to calculate LANL seismic hazards, revised structural analysis methods tied to damage states

---

[7] *The facilities for which the consequences would be the same include: the Chemistry and Metallurgy Research Building, the Weapons Engineering Test Facility, the Tritium Science and Fabrication Facility, the Tritium System Test Assembly, and Radioactive Liquid Waste Treatment Facility, the Waste Characterization, Reduction, and Repackaging Facility, and the Radioassay and Nondestructive Testing Facility. Facilities for which the consequences of higher ground acceleration may be greater include: the Plutonium Facility, the TA-55 Storage Facility, the Decontamination and Volume Reduction System, Waste Storage Domes, and the Safe Secure Transport Facility.*

credited in safety assessment documents will be used to update the seismic structural integrity evaluation of LANL facilities. The effect of the higher values of peak horizontal ground acceleration on accident consequences and risks will be analyzed in future facility safety analyses and incorporated as appropriate into future NEPA documents. NNSA and the LANL management and operating contractor will undertake an evaluation of LANL facility performance in terms of the updated seismic hazard information. Until that revised analysis is completed, operations would be authorized based on NNSA approval of a contractor-prepared justification for continued operation.

The LANL management and operating contractor has developed and NNSA has accepted a site-wide justification for continued operation as a result of the estimates of increased seismic event frequency and acceleration associated with the updated probabilistic seismic hazards analysis. The justification for continued operation presents a qualitative evaluation of the effect of this increased seismic hazard on site-wide transportation and on the following LANL facilities: Chemistry and Metallurgy Research Building, Beryllium Technology Facility, Dual-Axis Radiographic Hydrodynamic Test Facility, Weapons Engineering Test Facility, Radioactive Liquid Waste Treatment Facility, Waste Characterization, Reduction, and Repackaging Facility, TA-53 underground spent resin tank, LANSCE, Area G waste operations, Radioassay and Nondestructive Testing Facility, Plutonium Facility, Safe and Secure Transport Facility, and the nuclear environmental sites (MDA A, MDA B, MDA C, MDA H, MDA T, MDA W, TA-35 Wastewater Treatment Plant, TA-35 Pratt Canyon, and MDA AB). The justification for continued operation determined that existing bounding seismic accident analyses; new facility safety analyses; compensatory measures of limiting radioactive material inventory, new programs, and procedures; and the low probability of a seismic event during the anticipated time period for detailed quantitative analysis of each facility's safety documentation provide the basis for an acceptable risk for continued operation of LANL (LANL 2007a, NNSA 2007c).

The Los Alamos Site Office directed the LANL management and operating contractor to develop a draft project execution plan to perform specific detailed facility seismic analyses; incorporate necessary changes to facility safety bases; and develop a list of potential facility modifications to address deficiencies identified in the seismic analyses (NNSA 2007c). If necessary, facility-specific justifications for continued operation will be developed as part of this process. This project will provide for the evaluation of each LANL facility using the updated probabilistic seismic hazard analysis seismic accelerations and frequencies and in accordance with appropriate LANL structural engineering standards for seismic events using all applicable industry, federal government, and international standards, codes, and criteria.

5.12.3.1 No Action Alternative

Site-Wide Seismic 1 – Radiological

Site-wide Seismic 1 is represented by a PC-2 seismic event. Referring to **Tables 5–68** through **5–70** and noting that all of the listed facilities could contribute to offsite population impacts, the facility with generally the highest contribution to worker and public risk is the Chemistry and Metallurgy Research Building. In the event of this seismic event, it is estimated that there would be four LCFs in the offsite population from a Chemistry and Metallurgy Research Building release. As a result of such a release, the noninvolved worker would receive a large radiation dose. There is also a potential for an individual at publicly accessible Diamond Drive, approximately 55 yards (50 meters) from the Chemistry and Metallurgy Research Building, to receive an exposure in excess of the offsite MEI exposure. The calculated dose to such an individual is 6,400 rem, or about 100 times the MEI dose. Depending on the specific radionuclides released and the route of human exposure, radiation doses calculated for the individual on Diamond Drive and the noninvolved worker would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual, mitigating health impacts, or both. In addition to the conservative assumptions used to develop the source term (the amount of radioactive material released) for this accident, the calculated dose is based on the assumptions that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs. Since the annual probability of this seismic event is 0.001, the increased risk of an additional LCF occurring in the population is estimated to be 0.0037 per year; the increased risk of a health effect for an individual on Diamond Drive or the noninvolved worker is estimated to be 0.001 or 1 chance in 1,000.

Table 5–68 Site-Wide Seismic 1 Radiological Accident Offsite Population Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

	Maximally Exposed Individual		*Population to 50 Miles (80 kilometers)*	
Facility Impacted by Seismic 1 Event	***Dose (rem)***	***Latent Cancer Fatality*** [a]	***Dose (person-rem)***	***Latent Cancer Fatalities*** [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	62	0.075	6,100	4 (3.7)
SHEBA (TA-18-168) [d]	0.03	0.000018	0.77	0 (0.00046)
Tritium System Test Assembly (TA-21-155)	0.0015	8.8×10^{-7}	0.049	0 (0.00003)
Tritium Science and Fabrication Facility (TA-21-209)	0.013	7.5×10^{-6}	0.43	0 (0.00026)
Radioactive Liquid Waste Treatment Facility (TA-50-1)	3	0.0018	520	0 (0.31)
Radioassay and Nondestructive Testing Facility (TA-54-38)	64	0.077	1,100	1 (0.67)
Storage Facility (TA-55-185)	6	0.0036	590	0 (0.35)
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	2.8	0.0017	49	0 (0.03)
	Max 64	Max 0.077	Total or sum 8,400	Total 5 (5.01)

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Increased number of LCFs for the offsite population, assuming the accident occurs.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1), 343,100 (TA-54-38, DVRS).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations and Expanded Operations Alternatives.

Table 5–69 Site-Wide Seismic 1 Radiological Accident Onsite Worker Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	*Noninvolved Worker at 110 Yards (100 meters)*	
	Dose (rem) [a]	*Latent Cancer Fatality* [b]
Chemistry and Metallurgy Research Building (TA-3-29)	2,000	1.0 [c]
SHEBA (TA-18-168) [d]	1.1	0.00064
Tritium System Test Assembly (TA-21-155)	0.011	6.7×10^{-6}
Tritium Science and Fabrication Facility (TA-21-209)	0.097	0.000058
Radioactive Liquid Waste Treatment Facility (TA-50-1)	120	0.15
Radioassay and Nondestructive Testing Facility (TA-54-38)	580	0.69
Storage Facility (TA-55-185)	240	0.29
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	10	0.0061

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] The indicated dose yields a risk value greater than 1.0. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For this reason, a value of 1.0 is shown.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations and Expanded Operations Alternatives.

Table 5–70 Site-Wide Seismic 1 Radiological Accident Offsite Population and Worker Risks for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	*Frequency (per year)*	*Onsite Worker*	*Offsite Population*	
		Noninvolved Worker at 110 Yards (100 meters) [a]	*Maximally Exposed Individual* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	0.001	0.001	0.000075	0.0037
SHEBA (TA-18-168) [d]	0.001	6.4×10^{-7}	1.8×10^{-8}	4.6×10^{-7}
Tritium System Test Assembly (TA-21-155)	0.001	6.7×10^{-9}	8.8×10^{-10}	3×10^{-8}
Tritium Science and Fabrication Facility (TA-21-209)	0.001	5.8×10^{-8}	7.5×10^{-9}	2.6×10^{-7}
Radioactive Liquid Waste Treatment Facility (TA-50-1)	0.001	0.00015	1.8×10^{-6}	0.00031
Radioassay and Nondestructive Testing Facility (TA-54-38)	0.001	0.00069	0.000077	0.00067
Storage Facility (TA-55-185)	0.001	0.00029	3.6×10^{-6}	0.00035
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	0.001	6.1×10^{-6}	1.7×10^{-6}	0.00003
		Maximum 0.001	Maximum 0.000077	Total 0.0051

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual per year; new seismic data increases the risk by about 50 percent.

[b] Increased number of LCFs for the offsite population per year; new seismic data increases the risk by about 50 percent.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1), 343,100 (TA-54-38, DVRS).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations and Expanded Operations Alternatives.

All site facilities containing hazardous radiological materials that are susceptible to structural failure during this event could potentially contribute to the exposure of LANL workers and the public in the event of a site-wide seismic event. As a result, the population risks given in Table 5–70 can be summed as shown to provide a meaningful estimate of worker and public impacts. The individual risks to the MEI and noninvolved worker cannot be summed, however, because the risk at a specific location depends on the meteorology during the event. The direction that the wind carries the release from each facility would not impact one location in the same manner for multiple accidents at the same time. As a result, Table 5–70 shows the maximum risk of the individual receptors. The total impact to these individuals could be somewhat greater than indicated if more than one release affects these locations. Table 5–70 only provides estimated impacts for facilities with the highest potential impacts. If all facilities were taken into account, the sum of offsite population impacts from all LANL facilities with radiological materials would be somewhat larger.

As discussed in Section 5.12.3, an updated seismic hazard analysis has been developed for the LANL site (LANL 2007a). Because it is not possible to state the impacts of the different peak horizontal ground accelerations indicated in the updated seismic hazard analysis without detailed structural analyses of LANL facilities, a bounding approach was used to estimate the expected effect of the updated seismic hazard analysis on the SWEIS seismic accident risks. The effect of the revised estimate on the annual probability of exceedance of the Seismic 1 accident would be an increase in radiological risk of 50 percent. This results in a maximum risk of an LCF of 0.00012 for the MEI, 0.0015 for the noninvolved worker, and 0.0077 for the population. These estimated higher seismic accident risks do not take credit for facilities in which complete failure has already been assumed (including the Chemistry and Metallurgy Research Building and Radioassay and Nondestructive Testing Facility in Tables 5–68 through 5–70) and therefore no larger accident source term would be expected at higher seismic ground accelerations. Although these seismic risks have increased due to the results of the updated seismic analysis, they remain less than 1 percent of the highest MEI, noninvolved worker, and population risks for other types of accidents analyzed in the SWEIS.

Site-Wide Seismic 2 – Radiological

Site-Wide Seismic 2 is represented by a PC-3 seismic event. Referring to **Tables 5–71** through **5–73** and noting that all of the listed facilities could contribute to offsite population impacts, the facility with the highest contribution to public consequence is the Plutonium Facility at TA-55. In the event of this seismic event, it is estimated that there would be 9 LCFs in the offsite population from this TA-55 release. The waste storage domes at TA-54 holding transuranic waste would result in the highest contribution to the MEI's radiological consequences. A TA-55 release would result in the highest contribution to the noninvolved worker's radiological consequences. As discussed above for the Seismic 1 scenario, depending on the specific radionuclides released and the route of human exposure, radiation doses calculated for the MEI and the noninvolved worker would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual, mitigating health impacts, or both. In addition to the conservative assumptions used to develop the source term (the amount of radioactive material released) for this accident, the calculated dose is based on the assumptions that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs. The risk of additional LCFs from the TA-55 release would be estimated at 0.0035 per year in the offsite population. The next highest risk of an LCF to the general population would be from the waste storage domes. The increased risk of an LCF for the MEI and noninvolved worker are estimated at 1 in 3,600 (0.00028) and 1 in 2,000 (0.0005) per year, respectively.

Table 5–71 Site-Wide Seismic 2 Radiological Accident Offsite Population Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	Maximally Exposed Individual		Population to 50 Miles (80 kilometers)	
	Dose (rem) [a]	Latent Cancer Fatality [b]	Dose (person-rem)	Latent Cancer Fatality [c, d]
Chemistry and Metallurgy Research Building (TA-3-29)	62	0.075	6,100	4 (3.7)
Weapons Engineering Tritium Facility (TA-16-205)	17	0.01	110	0 (0.063)
SHEBA (TA-18-168) [e]	0.03	0.000018	0.77	0 (0.00046)
Tritium System Test Assembly (TA-21-155)	0.0015	8.8×10^{-7}	0.049	0 (0.00003)
Tritium Science and Fabrication Facility (TA-21-209)	0.013	7.5×10^{-6}	0.43	0 (0.00026)
Radioactive Liquid Waste Treatment Facility (TA-50-1)	3	0.0018	520	0 (0.31)
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	43	0.052	5,400	3 (3.1)
Radioassay and Nondestructive Testing Facility (TA-54-38)	64	0.077	1,100	1 (0.67)
Plutonium Facility (TA-55-4)	150	0.17	14,000	9 (8.6)
Storage Facility (TA-55-185)	6	0.0036	590	0 (0.35)
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	34	0.04	600	0 (0.36)
Waste Storage Domes (TA-54)	460	0.55	7,400	5 (4.5)
Safe, Secure Transport Facility (TA-55-355)	3.9	0.0024	290	0 (0.18)
	Max 460	Max 0.55	Total 36,000	Total 22

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1, -69), 343,100 (TA-54-38, 4-12, Domes), 301,900 (TA-55-4, -185, -355).

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations and Expanded Operations Alternatives.

Table 5–72 Site-Wide Seismic 2 Radiological Accident Onsite Worker Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	Latent Cancer Fatality [b]
Chemistry and Metallurgy Research Building (TA-3-29)	2,000	1.0 [c]
Weapons Engineering Tritium Facility (TA-16-205)	156	0.17
SHEBA (TA-18-168) [d]	1.1	0.00064
Tritium System Test Assembly (TA-21-155)	0.011	6.7×10^{-6}
Tritium Science and Fabrication Facility (TA-21-209)	0.097	0.000058
Radioactive Liquid Waste Treatment Facility (TA-50-1)	120	0.15
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	1,100	1.0 [b]
Radioassay and Nondestructive Testing Facility (TA-54-38)	580	0.69
Plutonium Facility (TA-55-4)	2,700	1.0 [c]

Facility Impacted by Seismic 2 Event	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	Latent Cancer Fatality [b]
Storage Facility (TA-55-185)	240	0.29
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	120	0.15
Waste Storage Domes (TA-54)	2,200	1.0 [c]
Safe, Secure Transport Facility (TA-55-355)	130	0.16

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.
[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.
[b] Increased risk of an LCF to an individual, assuming the accident occurs.
[c] The indicated dose yields a risk value greater than 1.0. This means that it is likely that an individual exposed to the indicated dose would develop a fatal latent cancer. For this reason a value of 1.0 is shown.
[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations and Expanded Operations Alternatives.

Table 5–73 Site-Wide Seismic 2 Radiological Accident Offsite Population and Worker Risks for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	Frequency (per year)	Onsite Worker	Offsite Population	
		Risk to Noninvolved Worker at 110 Yards (100 meters) [a]	Maximally Exposed Individual [a]	Population to 50 Miles (80 kilometers) [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	0.0005	0.0005	0.000037	0.0018
Weapons Engineering Tritium Facility (TA-16-205)	0.0005	8.7×10^{-5}	5×10^{-6}	0.000032
SHEBA (TA-18-168) [d]	0.0005	3.2×10^{-7}	9×10^{-9}	2.3×10^{-7}
Tritium System Test Assembly (TA-21-155)	0.0005	3.3×10^{-9}	4.4×10^{-10}	1.5×10^{-8}
Tritium Science and Fabrication Facility (TA-21-209)	0.0005	2.9×10^{-8}	3.8×10^{-9}	1.3×10^{-7}
Radioactive Liquid Waste Treatment Facility (TA-50-1)	0.0005	0.000073	9.1×10^{-7}	0.00016
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	0.0001 [e]	0.0001	5.2×10^{-6}	0.00031
Radioassay and Nondestructive Testing Facility (TA-54-38)	0.0005	0.00035	0.000039	0.00034
Plutonium Facility (TA-55-4)	0.0004 [e]	0.0004	7×10^{-5}	0.0035
Storage Facility (TA-55-185)	0.0005	0.00014	1.8×10^{-6}	0.00018
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	0.0005	0.000074	0.00002	0.00018
Waste Storage Domes (TA-54)	0.0005	0.0005	0.00028	0.0022
Safe, Secure Transport Facility (TA-55-355)	0.0005	0.000077	1.2×10^{-6}	0.000088
		Maximum 0.0005	Maximum 0.00028	Total 0.009

TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.
[a] Increased risk of an LCF to an individual per year; new seismic data increases the risk by about 60 percent.
[b] Increased number of LCFs for the offsite population per year; new seismic data increases the risk by about 60 percent.
[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18, -168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1, -69), 343,100 (TA-54-38, DVRS, Domes), 301,900 (TA-55-4, -185, -355).
[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduced Operations and Expanded Operations Alternatives.
[e] Different frequency than other seismic events due to assumption of other addition failures.

All site facilities containing hazardous radiological materials that are susceptible to structural failure during this event could potentially contribute to the exposure of LANL workers and the public in the event of a site-wide seismic event. As a result, the offsite population risks given in Table 5–73 can be summed as shown to provide a meaningful estimate of worker and public impacts. The individual risks to the MEI and noninvolved worker cannot be summed because the risk at a specific location depends on the meteorology during the event. The direction that the wind carries the release from each facility would not impact one location in the same manner as for multiple accidents at the same time. As a result, Table 5–73 shows the maximum risk of the individual receptors. The total impact to these individuals could be somewhat greater than indicated if more than one release were to affect these locations. Table 5–73 only provides estimated impacts for facilities with the highest potential impacts. If all facilities were taken into account, the sum of worker and offsite population risks from all LANL facilities with radiological materials could be somewhat higher.

As discussed in Section 5.12.3, an updated seismic hazard analysis has been developed for the LANL site (LANL 2007a). Because it is not possible to state the impacts of the different peak horizontal ground accelerations indicated in the updated seismic hazard analysis without detailed structural analyses of LANL facilities, a bounding approach was used to estimate the expected effect of the updated seismic hazard analysis on the SWEIS seismic accident risks. The effect of the revised estimate of the probability of exceedance of the Seismic 2 accident would be an increase in radiological risk of 60 percent. This results in a maximum risk of an LCF of 0.00045 for the MEI, 0.0008 for the noninvolved worker, and 0.014 for the population. These estimated higher seismic accident risks do not take credit for facilities in which complete failure has already been assumed (including the Chemistry and Metallurgy Research Building and Radioassay and Nondestructive Testing Facility in Tables 5–71 through 5–73) and therefore no larger accident source term would be expected at higher seismic ground accelerations. Although these seismic risks have increased due to the results of the updated seismic analysis, they remain less than 1 percent of the highest MEI, noninvolved worker, and population risks for other types of accidents analyzed in the SWEIS.

Site-Wide Seismic 1 – Chemical

The facilities and chemicals of concern under site-wide Seismic 1 conditions are shown in **Table 5–74**. There are numerous chemicals in small quantities onsite that may be released under these conditions. The listed chemicals were selected from a complete set of chemicals used onsite, based on their larger quantities, chemical properties, and human health effects. Exposure to concentrations in excess of the ERPG values could result in serious health effects or life-threatening implications to the exposed individuals.

Table 5–74 also shows the estimated annual risks for workers and the public in the event of an accidental release of each chemical. The annual frequency of this accident is 0.001 based on the *Seismic Hazards Evaluation of the Los Alamos National Laboratory (February 24, 1995)*. Based on the 2007 update of the seismic hazard analysis (LANL 2007a), the annual frequency is estimated to be 0.0015. Because this accident is a site-wide seismic event, all of the chemicals shown in the table would be released almost simultaneously. The annual risk of exposure to workers and the public to chemical concentrations in excess of ERPG-2 and ERPG-3 values is 1 in 1,000 based on the previous seismic hazard analysis and 1 in 700 based on the 2007 update of the seismic hazard analysis. The nearest public access relative to each facility is shown for each chemical. For some chemicals, the nearest public access point is beyond the distance at which concentrations would be at ERPG values. In these instances, there would likely be no serious health affects to the public in the event of an accident. For formaldehyde, as shown in Table 5–74, the nearest public access point is closer than the distance at which concentrations would be at the ERPG values. If this accident were to occur, members of the public could be exposed to harmful and possibly fatal concentrations of formaldehyde.

Table 5–74 Chemical Accident Risks under Seismic 1 Conditions for the No Action, Reduced Operations, and the Expanded Operations Alternatives

Chemical	Frequency [a] (per year)	Quantity Released	ERPG-2 [a, b]		ERPG-3 [a, c]	
			Value (ppm)	Annual Risk	Value (ppm)	Annual Risk
Hydrogen cyanide at TA-3-66 (Sigma Complex)	0.001	13.5 pounds (6.1 kilograms)	10	1 chance in 1,000 years of workers within 150 yards (137 meters) of facility receiving exposures in excess of limit. Nearest public access is at 260 yards (238 meters).	25	1 chance in 1,000 years of workers within 94 yards (86 meters) of facility receiving exposures in excess of limit. Nearest public access is at 260 yards (238 meters).
Phosgene at TA-9-21	0.001	1 pound (0.45 kilograms)	0.2	1 chance in 1,000 years of workers within 302 yards (276 meters) of facility receiving exposures in excess of limit. Nearest public access is at 900 yards (823 meters).	1	1 chance in 1,000 years of workers within 129 yards (118 meters) of facility receiving exposures in excess of limit. Nearest public access is at 900 yards (823 meters).
Formaldehyde at TA-43-1 (Bioscience Facilities)	0.001	3.7 gallons (14.1 liters)	10	1 chance in 1,000 years of workers or public within 195 yards (178 meters) of facility receiving exposures in excess of limit. Nearest public access is at 13 yards (12 meters).	25	1 chance in 1,000 years of workers or public within 122 yards (112 meters) of facility receiving exposures in excess of limit. Nearest public access is at 13 yards (12 meters).

ERPG = Emergency Response Planning Guideline, ppm = parts per million, TA = technical area.
[a] A conservative estimate of the frequency based on the 2007 probabilistic seismic hazard analysis (LANL 2007a) is 0.0015. The corresponding annual risk would be 1 chance in 700 years.
[b] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2005e).
[c] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005e).

Site-Wide Seismic 2 - Chemical

The facilities and chemicals of concern under Site-Wide Seismic 2 conditions are shown in **Table 5–75**. There are numerous chemicals in small quantities onsite that could be released under these conditions. The listed chemicals were selected from a complete set of chemicals used onsite based on their larger quantities, chemical properties, and human health effects.

Table 5–75 Chemical Accident Risks under Seismic 2 Conditions for the No Action, Reduced Operations, and Expanded Operations Alternatives

Chemical	Frequency [a] (per year)	Quantity Released	ERPG-2 [a, b] Value (ppm)	ERPG-2 [a, b] Annual Risk	ERPG-3 [a, c] Value (ppm)	ERPG-3 [a, c] Annual Risk
Hydrogen cyanide at TA-3-66 (Sigma)	0.0005	13.5 pounds (6.1 kilograms)	10	1 chance in 2,000 years of workers within 150 yards (137 meters) of facility receiving exposures in excess of limit. Nearest public access is at 260 yards (238 meters).	25	1 chance in 2,000 years of workers within 94 yards (86 meters) of facility receiving exposures in excess of limit. Nearest public access is at 260 yards (238 meters).
Phosgene at TA-9-21	0.0005	1 pound (0.45 kilograms)	0.2	1 chance in 2,000 years of workers within 302 yards (276 meters) of facility receiving exposures in excess of limit. Nearest public access is at 900 yards (823 meters).	1	1 chance in 2,000 years of workers within 129 yards (118 meters) of facility receiving exposures in excess of limit. Nearest public access is at 900 yards (823 meters).
Formaldehyde at TA-43-1 (Bioscience Facilities)	0.0005	3.7 gallons (14.1 liters)	10	1 chance in 2,000 years of workers or public within 195 yards (178 meters) of facility receiving exposures in excess of limit. Nearest public access is at 13 yards (12 meters).	25	1 chance in 2,000 years of workers or public within 122 yards (112 meters) of facility receiving exposures in excess of limit. Nearest public access is at 13 yards (12 meters).
Chlorine gas released outside of Plutonium Facility Complex (TA-55-4)	0.0005	150 pounds (68 kilograms)	3	1 chance in 2,000 years of workers within 1,181 yards (1,080 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).	20	1 chance in 2,000 years of workers within 416 yards (380 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).
Nitric acid spill at Plutonium Facility Complex (TA-55-4)	0.0005	6,100 gallons (23,090 liters)	6	1 chance in 2,000 years of workers within 53.6 yards (49 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).	78	1 chance in 2,000 years of workers within 7.2 yards (6.6 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,111 yards (1,016 meters).
Hydrochloric acid spill at TA-55-249	0.0005	5,200 gallons (19,684 liters)	20	1 chance in 2,000 years of workers or public within 220 yards (185 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,221 yards (1,117 meters).	150	1 chance in 2,000 years of workers or public within 70 yards (64 meters) of facility receiving exposures in excess of limit. Nearest public access is at 1,221 yards (1,117 meters).
Beryllium at TA-3-141 (Beryllium Technology Facility)	0.0005	110 pounds (49 kilograms) (powder) [d]	0.025 [d]	1 chance in 2,000 years of workers or public within 309 yards (282 meters) of facility receiving exposures in excess of limit. Nearest public access is at 963 yards (880 meters).	0.1 [d]	1 chance in 2,000 years of workers or public within 127 yards (116 meters) of facility receiving exposures in excess of limit. Nearest public access is at 963 yards (880 meters).

ERPG = Emergency Response Planning Guideline, ppm = parts per million, TA = technical area.

[a] A conservative estimate of the frequency based on the 2007 probabilistic seismic hazard analysis (LANL 2007a) is 0.0008. The corresponding annual risk would be 1 chance in 1,250 years.

[b] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2005e).

[c] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005e).

[d] Units for beryllium are in milligrams per cubic meter.

Table 5–75 also shows the estimated annual risks for workers and the public in the event of an accidental release of each chemical. The annual frequency of this accident is 0.0005 based on the *Seismic Hazards Evaluation of the Los Alamos National Laboratory (February 24, 1995)*. Based on the 2007 update of the seismic hazard analysis (LANL 2007a), the annual frequency is estimated to be 0.0008. As this accident is a site-wide seismic event, all of the chemicals shown in the table would be released almost simultaneously. The annual risk of exposure to workers and the public to chemical concentrations in excess of ERPG-2 and ERPG-3 values is 1 in 2,000 per year based on the previous seismic hazard analysis and 1 in 1,250 based on the 2007 update of the seismic hazard analysis. The nearest public access point relative to each facility is shown for each chemical. For some chemicals, the nearest public access point is beyond the distance at which concentrations would be at ERPG values. In these instances, there would likely be no serious health affects to the public in the event of an accident. As shown in Table 5–75, for formaldehyde at the Bioscience Facilities and chlorine gas at the Plutonium Facility Complex, the nearest public access points are closer than the distance at which concentrations would be at the ERPG values. If these accidents were to occur, members of the public could be exposed to harmful and possibly fatal concentrations of these chemicals.

5.12.3.2 Reduced Operations Alternative

Site-Wide Seismic 1 and 2 – Radiological

The site-wide Seismic 1 and 2 radiological accident impacts under the Reduced Operations Alternative are similar to those under the No Action Alternative, as shown in Tables 5–68 through 5–73. Activities at TA-18, including operation of SHEBA, would cease under this alternative. SHEBA operations are a small component of the site-wide seismic accident impacts at LANL; its elimination would not significantly alter the overall site risk profile from such an event. All other impacts in the tables are equally applicable for this alternative.

Site-Wide Seismic 1 and 2 – Chemical

The chemicals of concern that could be released in a site-wide Seismic 1 or 2 event are the same under the Reduced Operations Alternative as those under the No Action Alternative. None of the chemicals identified for the latter is eliminated in this alternative. The information in Tables 5–74 and 5–75, then, is applicable to the Reduced Operations Alternative.

5.12.3.3 Expanded Operations Alternative

Site-Wide Seismic 1 and 2 – Radiological

The Seismic 1 and 2 accident impacts under the Expanded Operations Alternative are similar to those under the No Action Alternative, as shown in Tables 5–68 through 5–73. SHEBA operations would cease under the Expanded Operations Alternative. Because the potential impacts are relatively small, deleting this accident does not change the overall risk profile of this alternative. Additional accident risks would result from expanded waste management activities. Transuranic waste storage would be consolidated in a new facility, the TRU Waste Facility, which would be located in TA-50 or a generic site along the Pajarito Road corridor. The TRU Waste Facility would carry fewer potential accident impacts than the existing facility because of its new location and because less material would be stored onsite. The entries in Tables 5–68 through 5–73 reflect present Decontamination and Volume Reduction System Facility operations because the system would be active for most of the period of interest. Present accident impacts bound the impacts of the replacement facility. The potential accident impacts for the new facility are described in Appendix H.

Site-Wide Seismic 1 and 2 – Chemical

The chemicals of concern that could be released in a site-wide Seismic 1 or 2 event are the same under the Expanded Operations Alternative as those under the No Action Alternative. No additional chemicals were identified under this alternative that would have impacts exceeding those under the No Action Alternative. The information in Tables 5–74 and 5–75, therefore, also applies to the Expanded Operations Alternative.

5.12.4 Wildfire Accident Impacts

Wildfire accident scenarios were postulated as a method of evaluating potential impacts to onsite workers and the offsite population. Details of these scenarios are provided in Appendix D, including a discussion of the LANL buildings that could be affected by wildfire, an inventory of hazardous radiological materials, and the source term factors and estimated source terms.

5.12.4.1 Wildfire – Radiological

The estimated radiological consequences of a wildfire to workers and the public are shown in **Tables 5–76** and **5–77** for each listed facility. The values shown assume that a wildfire has occurred and therefore do not reflect any credit for the probability of a wildfire occurrence. The estimated annual risks for each wildfire scenario are shown in **Table 5–78**. These values take credit for the probability of a wildfire's occurrence. The wildfire accident scenario consequences and risks in Table 5–76 through 5–78 apply to the No Action, Reduced Operations and Expanded Operations Alternatives.

As shown in Table 5–76, the results indicate that radiological releases from the TA-54 waste storage domes dominate the impacts to workers and the public. In the event of this accident, the consequence to the MEI is a likelihood of developing an LCF during his or her lifetime and an additional 55 LCFs for the population. As shown in Table 5–77, an onsite worker located 110 yards (100 meters) from the facility would be likely to develop an LCF as a result of this accident occurring at TA-54.

The risks for this accident, which takes credit for its low frequency of occurrence, are estimated to be about 1 chance in 20 (0.05) of an increased likelihood of an LCF per year for the MEI and an additional 2.7 LCFs per year of operations in the offsite population. An onsite worker located 110 yards (100 meters) from the facility would experience an increased likelihood of an LCF of about 1 chance in 20 (0.05) per year of operations. These risks assume that the receptors do not take evasive action in the event of a wildfire. Because releases from the TA-54 domes dominate the consequences and risks from a wildfire, they represent the total impacts on the offsite and worker populations.

Table 5–76 Radiological Accident Offsite Population Consequences for a Wildfire Accident for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Wildfire	Maximally Exposed Individual		Population to 50 Miles (80 kilometers)	
	Dose (rem)	Latent Cancer Fatality Risk [a]	Dose (person-rem)	Latent Cancer Fatalities [b, c]
Sigma Complex (TA-3-66/451)	0.0039	2.3×10^{-6}	4.8	0 (0.0029)
Weapons Engineering Tritium Facility (TA-16-205)	0.061	0.000036	110	0 (0.067)
Radiochemistry Facility (TA-48-1)	0.0011	6.4×10^{-7}	0.44	0 (0.00026)
Waste Storage Domes (TA-54)	1,900	1.0 [d]	91,000	55 (54.8)
Device Assembly (TA-16-411)	1.6×10^{-6}	8.9×10^{-10}	0.00017	0 (1×10^{-7})
Decontamination and Volume Reduction System (TA-54-412)	4.9	0.003	1,200	0 (0.7)
Radiography (TA-8-23)	0.00033	2×10^{-7}	0.56	0 (0.00034)
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	27	0.032	6,900	4 (4.2)

TA = technical area.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.
[b] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.
[c] Offsite population size is approximately 297,030 for TA-3-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-01; 343,069 for Domes, and TA-54-412; and 349,780 for TA-8-23.
[d] The indicated dose yields a risk greater than 1.0. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For this reason, a value of 1.0 is shown.

Table 5–77 Radiological Accident Onsite Worker Consequences for a Wildfire Accident for the No Action, Reduced Operations, and Expanded Operations Alternatives

Accident	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem)	Latent Cancer Fatality [a]
Sigma Complex (TA-3-66/451)	0.076	0.000046
Weapons Engineering Tritium Facility (TA-16-205)	0.33	0.0002
Radiochemistry Facility (TA-48-1)	0.016	9.3×10^{-6}
Waste Storage Domes (TA-54)	8,700	1.00 [b]
Device Assembly (TA-16-411)	0.000017	1×10^{-8}
Decontamination and Volume Reduction System (TA-54-412)	16	0.0098
Radiography (TA-8-23)	0.0019	1.2×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	440	0.53 [b]

TA = technical area.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.
[b] The indicated dose yields a risk greater than 1.0. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For this reason, a value of 1.0 is shown.

Table 5–78 Radiological Accident Offsite Population and Worker Risks for a Wildfire Accident for the No Action, Reduced Operations, and Expanded Operations Alternatives

Accident	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	Maximally Exposed Individual [a]	Population to 50 Miles (80 kilometers) [b, c]
Sigma Complex (TA-3-66/451)	0.05	2.3×10^{-6}	1.2×10^{-7}	0.00014
Weapons Engineering Tritium Facility (TA-16-205)	0.05	1×10^{-5}	1.8×10^{-6}	0.0034
Radiochemistry Facility (TA-48-1)	0.05	4.7×10^{-7}	3.2×10^{-8}	1.3×10^{-5}
Waste Storage Domes (TA-54)	0.05	0.05	0.05	2.7
Device Assembly (TA-16-411)	0.05	5.2×10^{-10}	4.4×10^{-11}	5.2×10^{-9}
Decontamination and Volume Reduction System (TA-54-412)	0.05	0.00049	0.00015	0.035
Radiography (TA-8-23)	0.05	5.7×10^{-8}	1×10^{-8}	1.7×10^{-5}
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	0.01 [d]	0.0053	0.00032	0.042

TA = technical area.
[a] Increased risk of an LCF to an individual per year.
[b] Increased number of LCFs for the offsite population per year; value in parentheses is the calculated result.
[c] Offsite population size is approximately 297,030 for TA-3-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-01; 343,069 for Domes and TA-54-412; and 349,780 for TA-8-23.
[d] Assumes additional failures.

5.12.4.2 Wildfire – Chemical

The chemicals of concern at LANL facilities under wildfire conditions are shown in **Table 5–79**. They were selected from a database of chemicals used onsite based on their quantities, chemical properties, and human health effects. The table shows the ERPG-2 and ERPG-3 values for which, were an accident to occur, concentrations in excess of these values could result in serious health effects or life-threatening implications for exposed individuals.

Table 5–79 also shows the risks of worker and public exposure in the event of a chemical release, as well as the estimated frequency of each release. The direction traveled by the chemical plume would depend on the meteorological conditions at the time of the accident and would determine which segment of the worker and offsite populations would be at risk of exposure. The wildfire chemical accident impacts in Table 5–79 apply to the No Action, Reduced Operations, and Expanded Operations Alternatives.

For formaldehyde at TA-43-1, there is an annual risk of 0.05 (once in 20 years) that workers and the public within a distance of 97 yards (89 meters) of the release would be exposed to concentrations in excess of ERPG-3 values. The workers and public within a distance of 154 yards (141 meters) of the release would face the same risk of being exposed to concentrations in excess of ERPG-2 values.

Table 5–79 Chemical Accident Risks under Wildfire Conditions for the No Action, Reduced Operations, and Expanded Operations Alternatives

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a] Value (ppm)	ERPG-2 [a] Annual Risk	ERPG-3 [b] Value (ppm)	ERPG-3 [b] Annual Risk
Formaldehyde at TA-43-1	0.05	3.7 gallons (14.1 liters)	10	1 chance in 20 years of workers or public within 154 yards (141 meters) of facility receiving exposures in excess of limit. Nearest public access is at 13 yards (12 meters).	25	1 chance in 20 years of workers or public within 97 yards (89 meters) of facility receiving exposures in excess of limit. Nearest public access is at 13 yards (12 meters).
Hydrogen cyanide from TA-3-66	0.05	13.5 pounds (6.1 kilograms)	10	1 chance in 20 years of workers within 118 yards (108 meters) of facility receiving exposures in excess of limit. Nearest public access is at 260 yards (238 meters).	25	1 chance in 20 years of workers within 77 yards (70 meters) of facility receiving exposures in excess of limit. Nearest public access is at 260 yards (238 meters).

ERPG = Emergency Response Planning Guideline, ppm= parts per million, TA = technical area.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2005e).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2005e).

For hydrogen cyanide released from TA-3-66, there is an annual risk of 0.05 (once in 20 years) that workers within a distance of 77 yards (70 meters) of the release would be exposed to concentrations in excess of ERPG-3 values. The workers within a distance of 118 yards (108 meters) of the release would face the same risk of being exposed to concentrations in excess of ERPG-2 values. There would be no risk that the public would receive an exposure in excess of ERPG-2 or ERPG-3 values because the nearest public access is 260 yards (238 meters) from the location of this chemical release.

5.12.5 Construction Accidents

The construction of new facilities includes the risk of accidents that could impact workers. Because construction activities do not involve radioactive materials, there would be no radiological impacts. The presence of hazardous flammable, explosive, and other chemical substances, however, could initiate accident conditions that could impact the health and safety of workers. In addition, in the course of their work, construction and site personnel could receive serious or fatal injuries as a result of incidents that fall in the category of industrial accidents. DOE’s construction contractors are required to adhere to strict safety standards and procedures to promote a working environment that minimizes the possibility of such accidents.

5.12.6 Terrorist Incidents

The analysis of the impacts of terrorist incidents is described in a classified appendix to this SWEIS. The impacts of some terrorist incidents would be similar to the accident impacts described earlier in this section, while some terrorist incidents may have more severe impacts.

This section describes how NNSA assesses the vulnerability of its sites to terrorist threats and then designs its response systems.

5.12.6.1 Assessment of Vulnerability to Terrorist Threats

In accordance with DOE Order 470.3A, "Design Basis Threat Policy," and DOE Order 470.4, "Safeguards and Security Program," NNSA conducts vulnerability assessments and risk analyses of the facilities and sites under its management to evaluate the possible threats and the protection elements, technologies, and administrative controls used to protect against these threats. DOE Order 470.4 establishes the roles and responsibilities for the conduct of DOE's Safeguards and Security Program. DOE Order 470.3A establishes requirements designed to prevent unauthorized access, theft, diversion, or sabotage (including unauthorized detonation or destruction) of all nuclear weapons, nuclear weapons components, and special nuclear material under DOE's control. Among other provisions, the Order (a) specifies those national security assets that require protection; (b) outlines threat considerations for safeguards and security programs to provide a basis for planning, design, and construction of new facilities or modifications to existing facilities; and (c) provides an adversary threat basis for evaluating the performance of safeguards and security systems. NNSA also protects against espionage, sabotage, and theft of radiological, chemical, or biological materials; classified matter; non-nuclear weapon components; and critical technologies.

NNSA's safeguards and security programs and systems employ state-of-the-art technologies to:

- Deny access to nuclear weapons, nuclear test devices, and completed nuclear assemblies;
- Prevent theft, sabotage, or an unauthorized nuclear yield (criticality) of special nuclear materials and credible rollup quantities of special nuclear materials.
- Protect the public and employees from unacceptable impacts resulting from an adversary's use of radiological, chemical, or biological materials; and
- Protect classified matter and designated critical facilities and activities from sabotage, espionage, and theft.

NNSA's vulnerability assessments employ a rigorous methodology based on guidance from the *DOE Vulnerability Assessment Process Guide* (September 2004), and the Vulnerability Assessment Certification course. Typically, a vulnerability assessment involves analyses of modeling, simulation, and performance testing results by subject matter experts to determine the effectiveness of a safeguard and security system against an adversary's objectives. Vulnerability assessments generally include the following activities.

Characterizing the threat. Threat characterization provides a detailed description of a physical threat by a malevolent adversary to a site's physical protection systems. Usually the description includes information about potential adversary types, motivations, objectives, actions, physical capabilities, and site-specific tactical considerations. Much of the information required to develop a threat characterization is described in DOE Order 470.3A and the Adversary Capabilities List. DOE also issues additional site-specific threat clarification and guidance.

Determining the target. Target determination involves identifying, describing, and prioritizing potential targets among NNSA's security interests that meet the criteria outlined in DOE Order 470.3A. Target determination results are used to help characterize potential threats and target facilities, as well as protective force and neutralization requirements.

Defining the scope. The scope of a vulnerability assessment is determined by agreement among DOE Headquarters and Field staff and contractor personnel. In addition to defining the threat and applicable targets to be assessed, the scope establishes the key assumptions and interpretations that will guide the analyses, as well as the objectives, methods, schedule, personnel responsibilities, and format for documenting the results of the assessment.

Characterizing the facility or site. This activity requires defining and documenting aspects of the facility or site, particularly existing security programs (personnel security, information security, physical security, material control and accountability, etc.), to assist in identifying strengths and weaknesses. Results are used as inputs to the pathway analyses used to develop representative case scenarios for evaluating the security system. Facility and site characterization modeling tools include Analytical System and Software for Evaluating Safeguards and Security (ASSESS), Adversary Time-Line Analysis System (ATLAS), VISA, tabletop analysis, and others.

Characterizing the protective force. To assess a facility or site's vulnerability, analysts must accurately characterize the associated protective force's capabilities against a defined threat and objective, particularly the force's ability to detect, assess, respond to, interrupt, and neutralize an adversary. Specific data used for this activity include special nuclear materials categorization; configuration, flow, and movement of special nuclear materials within or from a facility or site; defined threats; detection and assessment times; and adversary delay and task time. The protective force's equipment, weapons, number, and locations also are considered in the characterization. The characterization information is validated and verified via observation, alarm response assessments, limited scope performance tests, force-on-force exercises, joint conflict and tactical simulations (JCATS), and tabletop analyses. The JCATS software tool is used for training, analysis, planning, and mission rehearsal, as well as characterization of the protective force. It employs detailed graphics and models of buildings, natural terrain features, and roads to simulate realistic operations in urban and rural environments.

Analyzing adversary pathways. This activity identifies and analyzes base case adversary pathways based on the results of threat, target, facility, and protective force characterization, as well as ancillary analyses such as explosives analysis. ASSESS and ATLAS are two primary tools that are used in this analysis. Analysts also conduct insider analysis as part of this activity.

Developing base case scenarios. Base case scenarios are developed for use in performance testing and to determine the effectiveness of the security system in place against a potential adversary's capabilities and objectives. As part of this activity, data from the base case adversary pathways analyses are used to identify applicable threats, threat strategies, and objectives, and combined with protective force strategies and capabilities to develop scenarios that include specific adversary resources, capabilities, and projected task times to successfully complete their objectives. Specialists also work with the vulnerability assessment team to develop realistic scenarios that provide a structured, intellectually honest analysis of the strengths and weaknesses of the terrorist adversary.

Determining the probability of neutralization. The probability of neutralization is a numeric value representing the probability that the protective force can prevent an adversary from achieving their objectives. The calculated number is derived from more than one source, one of which must be based on Joint Tactical Simulation, JCATS analysis, or force-on-force exercises.

Determining system effectiveness. System effectiveness is determined by applying an equation that reflects the capabilities of a multi-layered protection system. Analysis data derived from the various vulnerability assessment activities are used to calculate this equation, which reflects the security system's effectiveness against each of the scenarios developed for the vulnerability assessment. If system effectiveness is unacceptable for a scenario, the root cause of the weakness must be analyzed and security upgrades must be identified. The scenarios are reanalyzed with the upgrades, and the successful upgrades are documented in the vulnerability analysis report.

Implementation. The culmination of the vulnerability assessment is development of a report documenting the analyses and results and a plan for implementing any necessary upgrades to achieve the required security system effectiveness. NNSA verifies the results of the vulnerability assessment report and the conclusions of the implementation plan. NNSA also provides management oversight of the actual implementation of security system upgrades.

5.12.6.2 Terrorist Impacts Analysis

Substantive details of terrorist attack scenarios and security countermeasures are not released to the public because disclosure of this information could be exploited by terrorists to plan attacks. Depending on the malevolent, terrorist, or intentionally destructive acts, impacts may be similar to or could exceed bounding accident impact analyses prepared for the SWEIS. A separate classified appendix to this Final SWEIS has been prepared that considers the underlying facility threat assumptions with regard to malevolent, terrorist, or intentionally destructive acts. Based on these threat assumptions, the classified appendix evaluates the potential human health impacts using appropriate analytical models, similar to the methodology used in this SWEIS to analyze accident impacts. These data provide NNSA with information upon which to base, in part, decisions regarding activities at LANL.

5.13 Cumulative Impacts

In accordance with the Council on Environmental Quality regulations, a cumulative impact analysis includes, "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time," (40 CFR 1508.7).

The cumulative impact analysis for this SWEIS includes (1) an examination of cumulative impacts presented in the *1999 SWEIS*; (2) impacts since the *1999 SWEIS* was issued, which are presented in this chapter; and (3) a review of the environmental impacts of past, present, and reasonably foreseeable actions for other Federal and non-Federal agencies in the region.

Reasonably foreseeable future actions that are likely to occur at LANL are described in Chapter 3, Section 3.3 under the Expanded Operations Alternative. Additional DOE or NNSA actions that could impact LANL include consolidation of nuclear operations related to production of radioisotope power systems; proposed operation of a Biosafety Level 3 Facility; a potential advanced fuel cycle facility; implementation of NNSA's complex transformation planning; and a disposal facility for Greater-Than-Class C waste.

Consolidation of DOE plutonium-238 activities at the Idaho National Laboratory as proposed in the *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems* (DOE/EIS-0373D) (*Consolidation EIS*) (DOE 2005c) would reduce plutonium-238 operations at LANL. Regardless of the decision on the *Consolidation EIS*, some plutonium-238 operations would continue at LANL. Therefore, very small changes in the impacts from plutonium-238 activities at LANL would be realized.

If current plutonium-238 operations were continued at the LANL Plutonium Facility Complex, as described under the *Consolidation EIS* No Action Alternative, manufacturing of up to 80 pits per year could still be accomplished within the LANL Plutonium Facility Complex. This production rate would be accomplished by consolidating a number of plutonium processing and support activities (such as analytical chemistry and materials characterization at the Chemistry and Metallurgy Research Replacement Facility). The impacts of the 80-pit-per-year production rate and plutonium-238 processing (at levels far above the level identified in the *Consolidation EIS*) were evaluated in both the LANL *1999 SWEIS* and this new SWEIS. These evaluations indicate there would be no additional cumulative effects from these activities.

NNSA is preparing an *Environmental Impact Statement for the Operation of a Biosafety Level-3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0388D). Operation of the Biosafety Level 3 Facility would be consistent with the land use designation of Research & Development for Experimental Science. The facility is visually compatible with surrounding structures, therefore there are no impacts to visual resources. There would be no impacts to geology and soils and water resources from operations. Air emissions from the Biosafety Level 3 Facility laboratories would be HEPA-filtered, resulting in very minor air quality effects. Noise impacts would be limited to sounds from heating, ventilation, and air conditioning operations, consistent with other buildings in the area. Facility operations would have no effect upon ecological resources or prehistoric, historic, traditional or paleontological resources in the area. Facility personnel would come primarily from the existing LANL workforce, resulting in no socioeconomic impacts. Operations would be well within LANL infrastructure capability to provide utilities requirements such as electricity, water, and natural gas. There would be no discernable effects on local traffic conditions. There have been no reported cases of illnesses in the United States due to the release of diagnostic specimens during transport (Cummings 2007).

There would be a low potential risk of illness to site workers or visitors from routine operations involving biohazardous material and no public human health effect. Accident conditions would result in minimal or no impact to the public primarily because there would be severely limited opportunity for transport of an infectious dose of a biohazardous material to the public. Biohazardous material would be handled in open cultures only in a biosafety cabinet, where a spill would be contained. In addition, biohazardous material would be handled in a liquid or solid culture container that would release very few organisms to the air if dropped or spilled. This means that one of the most critical risk factors, public exposure to an infectious dose from a biohazardous material, is greatly minimized, and therefore, the potential risk of disease would be very low. The EIS will evaluate slope stability at the Biosafety Level 3 Facility based on the recent update to the LANL probabilistic seismic hazard analysis (Cummings 2007, LANL 2007a).

DOE issued a Notice of Intent (NOI) to prepare the *Global Nuclear Energy Partnership Programmatic Environmental Impact Statement (GNEP PEIS)* (DOE/EIS-0396) on January 4, 2007 (72 FR 331). The Global Nuclear Energy Partnership (GNEP) would encourage expansion of domestic and international nuclear energy production while reducing nuclear proliferation risks, and reduce the volume, thermal output, and radiotoxicity of spent nuclear fuel before disposal in a geologic repository. The *GNEP PEIS* includes evaluation of a proposed advanced fuel cycle facility that would support research and development associated with the GNEP program. LANL is one of the DOE sites being considered for the research facility. The advanced fuel cycle facility would be a large shielded facility (approximately 1 million square feet [92,900 square meters]) (DOE 2008). Construction would begin in about 2014 with full operations planned for 2020. Potential cumulative impacts at LANL associated with the proposed advanced fuel cycle facility were addressed in the *Complex Transformation SPEIS* cumulative impacts analysis based on preliminary data (DOE 2007b). Where available, the cumulative impacts analyses in this SWEIS are based on more recent, but still preliminary data (DOE 2008). Impacts analyses for the *GNEP PEIS* are still underway so data for some resource areas are not available at this time and data that are included in this SWEIS could change prior to public release of the draft *GNEP PEIS*.

In 2006, NNSA outlined a comprehensive proposal, called Complex Transformation, for a smaller, more efficient nuclear weapons complex that would be better able and more suited to respond to future national security challenges (NNSA 2006b). On October 19, 2006, NNSA issued an NOI (71 FR 61731) to prepare a *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement - Complex 2030* (now called the *Complex Transformation Supplemental Programmatic Environmental Impact Statement* [*Complex Transformation SPEIS*]). This NOI also announced the cancellation of NNSA's previous proposal to build a modern pit facility for which NNSA issued a draft Supplemental EIS in June 2003 (68 FR 33487). LANL had been one of the sites under consideration for a modern pit facility. The NOI outlined some alternatives for transforming the nuclear weapons complex to better meet future national security requirements, including a proposal to construct and operate a consolidated plutonium center within the complex. Another proposal, to construct and operate a consolidated nuclear production center, was added during the scoping period, which ended in January 2007. Both of these proposals are analyzed in the Draft *Complex Transformation SPEIS* (DOE 2007b).

Implementation of the alternatives analyzed through the *Complex Transformation SPEIS* could result in changes to facilities and operations at LANL; for instance, NNSA is reconsidering construction of the nuclear facility portion of the Chemistry and Metallurgy Research Replacement project, and the impacts of not constructing that facility have been addressed in the Reduced Operations Alternative in this SWEIS. LANL is one of the sites under consideration for a consolidated plutonium center or a consolidated nuclear production center. The Preferred Alternative in the Draft *Complex Transformation SPEIS* is to site a consolidated plutonium center at LANL with a capacity of up to 80 pits per year, based on the use of the existing and planned infrastructure already described in the SWEIS Expanded Operations Alternative. This SWEIS cumulative impacts analysis addresses the impacts of construction and operation of a consolidated nuclear production center at LANL; the center would include primarily new plutonium, highly enriched uranium, and weapons assembly/disassembly facilities.

On July 23, 2007, DOE issued an NOI to prepare an *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC EIS)* (72 FR 40135). The *GTCC EIS* will address the disposal of low-level radioactive waste that contains radionuclides in concentrations exceeding 10 CFR Part 61 Class C limits, generated by activities licensed by the U.S. Nuclear Regulatory Commission or an Agreement State, as well as DOE waste having similar characteristics. Certain sealed sources that would be managed at LANL under the Off-Site Source Recovery Project would be addressed in the *GTCC EIS*. LANL is being considered as one of eight candidate DOE disposal sites for Greater-Than-Class C waste, along with generic commercial disposal facility options in arid and humid environments. In addition, DOE is evaluating several disposal technologies in the *GTCC EIS* including geologic repositories, intermediate depth boreholes, and enhanced near-surface disposal facilities. The alternatives in the *GTCC EIS* could result in changes to facilities or operations at LANL, but because the changes have yet to be developed and evaluated, they are not included in the cumulative impacts analysis.

Primary sources of information on LANL contributions to cumulative impacts, other than the current and the *1999 SWEIS*, are listed below:

- *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250 (DOE 2002b).

- *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2 (DOE 1997a).

- *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV (LANL 2006h).

- *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems*, DOE/EIS-0373D (DOE 2005c).

- *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at the Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico,* DOE/EIS-0293 (DOE 1999d).

- NOI to Prepare an Environmental Impact Statement for the Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico, 70 FR 228, November 29, 2005.

- *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1D (*Draft Yucca Mountain SEIS*) (DOE 2007a)

- *Draft Complex Transformation Supplemental Programmatic Environmental Impact Statement*, DOE/EIS-0236-S4 (DOE 2007b).

It is also necessary to consider activities implemented by other Federal, state, and local agencies and individuals outside LANL, but within the its region of influence, including state or local development initiatives; new residential development; new industrial or commercial ventures; clearing land for agriculture; new utility or infrastructure construction and operation; and new waste treatment and disposal activities.

Sandia National Laboratories' main facility in Albuquerque is located approximately 60 miles from LANL. Due to this distance, cumulative impacts other than air emissions are not expected to be influenced by Sandia National Laboratories. For air emissions, the 2005 Sandia National Laboratories dose to the offsite MEI is estimated to be 0.0001 millirem and the 2005 population dose is estimated to be 0.00017 person-rem (SNL 2006). The Sandia National Laboratories MEI dose is 0.0012 percent of the LANL MEI dose, and the Sandia National Laboratories population dose is 0.00047 percent of the LANL population dose. Because the combined impacts would be very small, there would be no significant impact from Sandia National Laboratories and it is not considered in this cumulative impacts section.

The city of Santa Fe; Los Alamos, Mora, Rio Arriba, Sandoval, San Miguel, Santa Fe, and Taos Counties; the Santa Clara and San Ildefonso Pueblos; the New Mexico Department of Transportation; the Bureau of Land Management; and the U.S. Forest Service were contacted for information regarding expected future activities that could contribute to cumulative impacts. The city of Santa Fe and Mora, Sandoval, and San Miguel Counties did not identify any major future actions (Gallegos 2006, Pino 2006, Scales 2006, Tafoya 2006). Rio Arriba County and the Santa Clara and San Ildefonso Pueblos did not provide information for the cumulative impacts analysis. The following activities in the region surrounding LANL were identified.

- Los Alamos County identified residential, commercial, and industrial development on areas transferred from DOE to the county. Residential development will include about 120 homes on 70 acres (28 hectares) in White Rock, with a goal to build approximately 1,000 new homes in Los Alamos County within the next 5 years (Jeppson 2006).

- Taos County identified about 20 subdivisions scheduled for review this year, including 150 to 750 new homes on 300 to 1,500 acres (121 to 607 hectares) (Trujillo 2006). Many of these homes would be located more than 50 miles (80 kilometers) from LANL.

In addition, Los Alamos County is closing the Los Alamos County Landfill and considering use of the San Juan-Chama water allotment. The existing Los Alamos County Landfill will close in 2008. Solid wastes will be shipped out of the county via a new transfer station (LAC 2007). The Bayo Wastewater Treatment Facility in Santa Fe County was replaced in 2007 with an advanced wastewater treatment facility in Pueblo Canyon (Glasco 2008). The San Juan-Chama Project includes examining the feasibility of pumping 1,200 acre-feet of Rio Grande water up the mesa to Los Alamos County (LAC 2004b).

A number of projects were identified that would affect the Santa Fe National Forest, including invasive plant control, road closure, thinning and prescribed fire, fire salvage, mineral extraction; and grazing allotment (USFS 2005b).

The Bureau of Land Management identified smaller projects that would affect the Bureau of Land Management lands such as continued road maintenance, timber harvesting, and grazing permit renewals, as well as larger projects such as the Power Project; New Mexico Products Pipeline; Mid-America Pipeline Western Expansion Project; Santa Domingo Pueblo-Bureau of Land Management land exchange; San Pedro Rock Quarry; treatment of saltcedar and other noxious weeds; and the Buckman Water Diversion Project (BLM 2006a). These larger projects are described below.

- The Power Project involves upgrading and enhancing the electrical power transmission line system in the Santa Fe and Las Vegas, New Mexico, area and widening the existing right-of-way (BLM 2004b).

- The New Mexico Products Pipeline involves adding two additional segments to an existing petroleum products pipeline. Neither of the new segments would be within 50 miles (80 kilometers) of LANL (BLM 2006b).

- The Mid-America Pipeline Western Expansion Project would add 12 separate loop sections to the existing liquefied natural gas pipeline to increase system capacity. A 23-mile (37-kilometer) segment would be placed in Sandoval County, 30 miles (48 kilometers) from the LANL boundary (BLM 2006c). This segment would be constructed parallel to and 25 feet (7.6 meters) away from the existing pipeline right-of-way.

- The Santa Domingo Pueblo-Bureau of Land Management land exchange involves an equal-value exchange of approximately 7,376 acres (2,985 hectares) of the Bureau of Land Management lands for 645 acres (261 hectares) of Santa Domingo Pueblo land in Santa Fe and Taos Counties (BLM 2002). A record of decision has not been issued for this land exchange.

- The San Pedro Mountains Rock Quarry Project has been delayed and will be incorporated into the revised Taos Field Office Resource Management Plan (BLM 2006a).

- The treatment of saltcedar and other noxious weeds is an ongoing adaptive management program for control of exotic weeds. An EA was prepared for this project that resulted in a Finding of No Significant Impact (FONSI) (BLM undated). The project area is approximately 40 miles (64 kilometers) from the LANL boundary.

- The Buckman Water Diversion Project would divert water from the Rio Grande for use by the city of Santa Fe and Santa Fe County (BLM 2006a). The diversion project would withdraw water from the Rio Grande approximately 3 miles downstream from where Route 4 crosses the river. The pipelines for this project would largely follow existing roads and utility corridors. Decreased water withdrawals from the Buckman Well Field would benefit groundwater levels. Potential impacts on fish and aquatic habitats below the proposed project due to effects on water flow would be minimal (BLM and USFS 2007).

Another project would upgrade the existing 46-kilovolt transmission loop system that serves central Santa Fe County with a 115-kilovolt system (PNM 2005). No major new transmission lines are planned for the region around LANL (WAPA 2006).

No new Federal highways are planned within 50 miles (80 kilometers) of LANL (CFLHD 2005). A number of state transportation projects are ongoing or planned. Many of these are relatively minor maintenance, upgrading, widening, and resurfacing projects. Some of the more substantial transportation projects in the region include (NMDOT 2007):

- U.S. Route 84 reconstruction - Pojoaque to Española
- NM 502 reconstruction
- NM 344 four-lane road construction near Interstate 40
- NM 585 Reconstruction Project.

Although maintenance of the transportation infrastructure in the region would continue and a number of upgrade, expansion, and widening projects are scheduled over the next 5 years or so, no new major highway projects are scheduled that could substantially contribute to cumulative impacts at LANL.

The list of EPA National Priorities List sites (also known as Superfund sites) was reviewed to determine whether these sites could contribute to cumulative impacts at LANL. Only one site is within 50 miles (80 kilometers) of LANL. The North Railroad Avenue groundwater contamination plume is located over 12 miles (19 kilometers) from the LANL boundary in Rio Arriba County (EPA 2005b).

Most of these actions at other sites are not expected to affect the cumulative impacts of LANL activities because of their distance from LANL, their routine nature, their relatively small size, and the zoning, permitting, environmental review, and construction requirements they must meet. Available documentation reviewed to assess cumulative impacts include the following sources:

Bureau of Land Management

- *Final Environmental Impact Statement for the Buckman Water Diversion Project* (BLM and USFS 2007).
- Factsheet: "San Juan Public Lands (San Juan Field Center & San Juan National Forest) Draft Environmental Impact Statement (EIS) Northern San Juan Basin Coalbed Methane Project," (BLM 2004a).

- *Farmington Proposed Resource Management Plan and Final Environmental Impact Statement*, BLM-NM-PL-03-014-1610 (BLM 2003b).

- *Farmington Resource Management Plan with Record of Decision* (BLM 2003c).

- Final Air Dispersion Analysis Technical Report, "Revision to the BLM Farmington Resource Management Plan and Amendment of the Rio Puerco Resource Management Plan," (BLM 2003a).

U.S. Forest Service

- "Schedule of Proposed Action 01/01/2006 to 03/31/2006, Santa Fe National Forest," (USFS 2006).

- *Record of Decision for Invasive Plant Control Project Carson and Santa Fe National Forests in Colfax, Los Alamos, Mora, Rio Arriba, San Miguel, Santa Fe, Sandoval, and Taos Counties, New Mexico* (USFS 2005a).

U.S. Bureau of Reclamation

- *Upper Rio Grande Basin Water Operations Review Draft Environmental Impact Statement* (ACE, Reclamation, and ISC 2006).

- *Final Environmental Impact Statement City of Albuquerque Drinking Water Project* (Reclamation 2004).

National Park Service

- "Fire Management Plan for Bandelier National Monument," (NPS 2005b).

State of New Mexico

- *2004-2006 State of New Mexico Integrated Clean Water Act §303(d) §305(b) Report* (NMED 2004a).

- *State of New Mexico Standards for Interstate and Intrastate Surface Waters* (NMAC 20.6.4).

Each resource area in this SWEIS was reviewed to identify potential cumulative impacts and the analyses are summarized in the following paragraphs. The level of detail provided for each resource area depends on the extent of the potential cumulative impacts.

Land Resources

Land resources include impacts to land use and the visual environment. LANL actions proposed under this SWEIS would not likely result in any incompatible land uses. Under the *Land Conveyance and Transfer Environmental Impact Statement (Land Conveyance and Transfer EIS)* (DOE/EIS-0293), land conveyed and transferred by LANL to Los Alamos County and conveyed to the U.S. Department of the Interior in trust for the San Ildefonso Pueblo, could be developed.

Up to 826 acres (334 hectares) of this land could be developed after the transfer and conveyance, representing a potential introduction of incompatible land uses (land in adjacent areas that have land use designations that interfere with or restrict one another) and a loss of recreational opportunities such as hiking or fishing. Under the Expanded Operations Alternative, cumulative impacts would include fewer restrictions on future use of lands remaining part of LANL under the MDA Removal Option than the MDA Capping Option. For the Removal Option, the wastes currently buried in the MDAs would be removed completely and shipped offsite or consolidated in onsite disposal areas, which would allow use of some of these MDAs for other purposes. The Expanded Operations Alternative also would include the Security-Driven Transportation Modification Project, which would not conflict with current land use designations except for an option to construct a bridge over Sandia Canyon. Construction of the Sandia Canyon Bridge would depart from current site development plans. Overall cumulative impacts to land use in the region, however, would be small.

Transfer and conveyance of LANL land could result in visual impacts such as diminished viewsheds and increased ambient light from residential, industrial, and commercial development on previously undeveloped land. For example, Los Alamos County has indicated there are proposals to develop approximately 1,000 new residences on land adjacent to LANL and to develop land for light industry along the Los Alamos Canyon rim across from the airport.

LANL is one of the sites under consideration for a consolidated nuclear production center in the *Complex Transformation SPEIS*. Construction of the consolidated nuclear production center facilities could require up to 545 acres (221 hectares) of land in TA-16 or in TA-16 and TA-55. This proposal is consistent with current land use plans for these TAs. The total land area required for the GNEP advanced fuel cycle facility would be approximately 373 acres (151 hectares) with 144 acres (58 hectares) inside a property protection fence, including approximately 62 acres (25 hectares) within a perimeter intrusion, detection, and assessment system (DOE 2008).

Geology and Soils

Projects proposed under the Expanded Operations Alternative in this SWEIS combined with the *Complex Transformation SPEIS* consolidated nuclear production center facilities and GNEP advanced fuel cycle facility would impact mineral resources at LANL and the surrounding region. Primary impacts would be due to the proposed closures of the MDAs under the Consent Order through either waste containment in place (the MDA Capping Option) or waste removal by excavation and subsequent disposal (the MDA Removal Option).

If the waste at the MDAs remains in place, and some small contaminated areas in TA-49 are capped, the final covers would require 750,000 to 2,000,000 cubic yards (570,000 to 1,500,000 cubic meters) of crushed tuff through fiscal year (FY) 2016. Up to 460,000 cubic yards (350,000 cubic meters) of additional rock, gravel, topsoil, and other bulk materials would be required for the final surface and erosion control. The total quantity of crushed tuff, rock and other bulk materials would range from 1.2 to 2.5 million cubic yards (0.92 to 1.9 million cubic meters). If the waste were removed, approximately 1,300,000 cubic yards (1,000,000 cubic meters) of backfill would be needed to replace the excavated waste and contaminated soil, as well as 61,000 cubic yards (47,000 cubic meters) of rock, gravel, topsoil, and other bulk materials for erosion control and site restoration. In addition, from 220,000 to 600,000 cubic yards (170,000 to 460,000 cubic meters) of crushed tuff and about 160,000 cubic yards (120,000 cubic meters) of topsoil, rock, and other bulk materials would be needed for capping the remaining disposal units at Area G in TA-54, and for capping other landfills and contaminated areas such as those in TA-49. A total of 1.8 to 2.2 million cubic yards (1.4 to 1.7 cubic meters) of crushed tuff, rock, and other bulk materials would be needed.

For economic and feasibility reasons, these materials would need to be excavated from borrow pits and quarries in the LANL area (Stephens and Associates 2005). Obtaining the materials locally would minimize transportation impacts. The only borrow pit now in use at LANL is the East Jemez Road Borrow Pit in TA-61. There would be sufficient tuff available at the pit to provide the needed volumes of crushed tuff. Other sources, however, would be required to provide the other materials (such as soil and coarse material for erosion control) needed to complete the MDA remediation. There are 24 stone and aggregate mines or quarries in the surrounding counties (Rio Arriba, Sandoval, and Santa Fe Counties) producing sand, gravel, base course, caliche, crushed rock, rip-rap, scoria, fill dirt and top soil (Pfeil et al. 2001). Borrow materials also could be collected from onsite areas of opportunity such as facility construction or DD&D areas where excess uncontaminated soils that meet the backfill or capping criteria have been excavated. Use of excavated soils as fill or cap material would minimize the need to import geologic materials from outside the immediate LANL area.

Water Resources

Activities at LANL, in combination with other activities in the vicinity, could affect regional water resources. To assess the cumulative effects on surface water, current and reasonably foreseeable future activities within the watersheds and streams that receive surface water from LANL were considered. The effects of past projects are reflected in the description of the affected environment and current surface water conditions. Most watersheds have headwaters on Santa Fe National Forest or Bandelier National Monument land. The region of consideration for cumulative impacts on groundwater extends from LANL further east toward Santa Fe and focuses on impacts on the regional aquifer due to the activities of landowners and managers other than LANL.

Past effluent discharges from LANL activities, in some cases occurring at least 50 years ago, have contaminated sediments in several canyons and continue to affect the quality of stormwater runoff and stream flows (LANL 2005h). As described in Chapter 4, Section 4.3.1, of this SWEIS, however, current monitoring documents that regional water quality does not exceed state standards downstream from LANL and the existing contamination is expected to diminish over time regardless of the SWEIS alternative selected. The reach of the Rio Grande between San Ildefonso Pueblo and Cochiti Reservoir, which receives surface water flows from LANL, has been identified by the New Mexico Environment Department (NMED 2004a) as impaired because it does not support its designated uses as a cold water or warm water fishery. Turbidity is identified as the probable cause of impairment, but the impairment stems from unknown natural sources. Although turbidity could be exacerbated by earthmoving activities anywhere in the watershed, planned mitigation measures for Federal and state projects would keep soil erosion to a minimum and ensure that additional turbidity is not a reasonably foreseeable cumulative impact.

Fire and Vegetation Management

Fire and fuels management is an annual activity within the Santa Fe National Forest and Bandelier National Monument. Management of the areas within the watersheds upstream from LANL are of primary interest because activities such as prescribed burns, mechanical and manual thinning, native plant revegetation, and establishment of fire breaks could accelerate erosion and sediment delivery to streams, which would affect surface water quality and quantity.

Since 1981, areas within Bandelier National Monument along the southern LANL boundary have been treated with prescribed burns. An area parallel to the southern LANL boundary was thinned from 2002 to 2004 (NPS 2005b). The Fire Management Plan (NPS 2005b), the working document for guiding wildland fire management actions and activities in Bandelier National Monument, identifies two primary fire management areas. Most of the area near LANL falls within the Wildland Fire Use unit where most natural ignitions will be allowed to burn. A small area including the entire Upper Frijoles watershed near the southern LANL boundary and the detached Tsankawi unit located east of State Highway 4 and near San Ildefonso Pueblo fall within the Fire Suppression unit. In the Fire Suppression unit, all natural ignitions are declared unwanted wildland fires and are suppressed, but prescribed burns are utilized as needed.

The Santa Fe National Forest Schedule of Planned Operations does not list specific fire management or other actions in the watersheds that cross LANL over the next year (USFS 2006), but some actions are likely to occur within the next 5 to 10 years. The Santa Fe National Forest and Bandelier National Monument fire management policies and procedures include requirements for mitigation and stabilization measures to ensure that vegetation is re-established and offsite erosion and sedimentation are minimized. For this reason, fire management activities in the region, together with those planned at LANL, are not expected to adversely affect surface water quality or quantity. Instead, these actions may benefit surface water bodies by reducing the potential for the impacts of severe wildfires like the Cerro Grande Fire.

An estimated 300 to 800 acres (121 to 324 hectares) will be treated annually in the Santa Fe National Forest to control invasive weeds (USFS 2005a). Treatments will combine biological, chemical, and mechanical methods. Some of the areas to be treated are likely to be within watersheds that cross LANL, but mitigation measures will be implemented to ensure that there are no adverse effects to water resources. These activities, combined with those planned for LANL, will not affect surface water resources.

Cerro Grande Fire Structures

Structures installed in and around LANL after the Cerro Grande Fire altered surface water flows to retain sediment. The Northern Rio Grande Resource Conservation and Development Council led an effort to rebuild fences, bridges, culverts, and other structures on private land that were destroyed by the Cerro Grande Fire (NRCS 2004). On the Santa Clara and San Ildefonso Pueblos, 15 flood prevention projects were implemented by the U.S. Army Corps of Engineers, including strengthening an existing levee system, installing grade control structures, upgrading water crossings, and installing protection around facilities (ACE 2000). Most private structures are likely to remain in place, but removal of some structures is planned by the U.S. Army Corps of Engineers, in addition to removal of those at LANL; their removal could increase sediment loads temporarily. Where structures are removed, the responsible agencies will likely install temporary sediment traps to minimize downstream sediment transport that would adversely affect surface water quality.

Land Conveyance and Transfer

The *Land Conveyance and Transfer EIS* projected minor increases in the amount of surface water runoff entering the stream system and an approximate 30 percent increase in groundwater withdrawals from the regional aquifer due to new residential development (DOE 1999d).

Rio Grande Flows

Proposed changes in the operations of Abiquiu Dam, Cochiti Dam, and other water structures downstream are currently under consideration by the U.S. Army Corps of Engineers, Bureau of Reclamation, and New Mexico Interstate Stream Commission (ACE, Reclamation, ISC 2006). These changes would slightly affect stream flows in the Rio Chama and Rio Grande, depending on which alternative is selected for implementation, but none would affect the surface water flows of the tributaries that flow through and immediately downstream of LANL. Changes to flows below Abiquiu Dam are not projected to affect hydropower generation used to supplement electricity in Los Alamos County (ACE, Reclamation, ISC 2006).

The city of Albuquerque is currently constructing a dam across the Rio Grande at Albuquerque to divert as much as 94,000 acre-feet per year (11,600 hectare-meters per year) to fully consume their San Juan-Chama Project water. A Final EIS evaluating the impacts of this action was published on March 5, 2004 (Reclamation 2004) and the ROD was issued on June 1, 2004. Direct effects on hydrology from any of the action alternatives were projected to include a constant increase of about 60 to 70 cubic feet per second (1.7 to 2.0 cubic meters per second) from flows of the city's San Juan-Chama Project water between Abiquiu Reservoir and Albuquerque at any time the diversion system is operating (Reclamation 2004). Contamination from canyons flowing through LANL that outlet into the Rio Grande and any potential changes in Rio Grande flows from proposed changes at LANL under any action alternative are not likely to affect Albuquerque's water quality or quantity because any contaminated sediments would be trapped behind the dam and flows would be regulated by water operations at Cochiti Dam.

The city of Santa Fe is proposing to install a diversion dam on the east bank of the Rio Grande across from San Ildefonso Pueblo and upstream from White Rock. The purpose of this project is to seek "sustainable means of accessing surface water supplies that would use the applicants' water rights by diverting San Juan-Chama Project water and native Rio Grande water while reducing their reliance on over-taxed ground water resources" (BLM and USFS 2007). The Buckman Well Field currently consists of thirteen wells that draw from the regional aquifer, but well yields have been reduced and groundwater levels have declined since its inception, depleting nearby streamflows (BLM and USFS 2007). The diversion, which would divert up to 5,230 acre-feet per year from the river (BLM and USFS 2007), would be located in the Rio Grande near the area where Mortandad Canyon outlets on the west side of the river and downstream from the outlets of Pueblo, Sandia, and Los Alamos Canyons.

Santa Fe proposes to continue providing residual offsets from past pumping of the Buckman Well Field (currently about 2,500 acre-feet per year). Under this proposal, pumping from the

Buckman Well Field would be scaled back to a long-term average of approximately 1,000 acre-feet per year. The cone of depression in the regional aquifer from current pumping of the well field has been modeled to extend to the west side of the Rio Grande, encompassing White Rock and the eastern part of LANL (BLM and USFS 2007). The *Final Environmental Impact Statement for the Buckman Well Field Project* predicts that, if the proposed project were implemented, direct diversions with reduced pumping from the Buckman Well Field would result in a 1 percent reduction in Rio Grande flows below the diversion and a significantly smaller cone of depression after the diversion project is established because pumping and aquifer depletions would be greatly reduced (BLM and USFS 2007). The projected reductions of aquifer depletions from reduced pumping of the Buckman Well Field would help offset projected increases in water use by LANL and Los Alamos County.

Under the Radioactive Liquid Waste Treatment Facility action to construct liquid effluent evaporation tanks with the goal of zero discharges from the facility into Mortandad Canyon, reduction of contaminant contributions by eliminating the outfall would positively impact surface water quality and possibly benefit Santa Fe's project. Improved water quality monitoring would also have positive impacts.

Los Alamos County and the San Ildefonso Pueblo are considering diverting Rio Grande water. There also may be other projects similar to the Buckman Project that would divert San Juan-Chama and native waters from the Rio Grande in the vicinity of LANL. The San Ildefonso Pueblo installed a single unit infiltration collector well as a pilot project in 2001. These projects may contribute to cumulative effects on the regional surface water system, but are less well defined, so the effects are impossible to predict at this time (BLM and USFS 2007).

Groundwater Quality

Additional modeling and monitoring wells are being installed to determine the foreseeable future impacts on the regional aquifer from radionuclides and other contaminants that are thought to be migrating through the bedrock. Questions about the rate and direction of contaminant movement must be more thoroughly investigated before the cumulative effects on water resources can be evaluated. LANL will conduct future data collection activities and analyze existing data to better define the interaction between groundwater and the rock matrix. This understanding of the hydrologic and chemical components at the site will aid in developing sound conceptual models of flow and transport through the fractures and matrix of the vadose zone into the saturated zone. The new data, coupled with improvements in numerical flow and transport models and improved calculational techniques, will enable better prediction of flow and transport of groundwater in the LANL region and more accurately define the ultimate impacts on the regional groundwater resources below LANL. Recent news of chromium in the regional aquifer (Snodgrass 2006) also will require additional research to determine the source of the contaminant.

The North Railroad Avenue groundwater contamination plume located over 12 miles (19 kilometers) from the LANL boundary is undergoing remediation. Tetrachloroethylene (perchloroethylene) is the leading concern from this plume because it is the most widespread and is found in the highest concentrations in groundwater. Other contaminants present with possible health effects include trichloroethylene, cis-1,2dichloroethylene, and trans-1,2dichloroethylene (EPA 2006b). For this plume, bioremediation pilot testing began in May 2007 (NMED 2007a).

Because this contamination plume will be remediated to protect drinking water and the Rio Grande from future chlorinated groundwater solvents, it is not expected to migrate into groundwater and surface water impacted by past or present LANL operations.

Air Quality and Noise

Table 5–80 presents the estimated maximum cumulative air quality concentrations offsite or at the site boundary from operations of both the Expanded Operations Alternative and the Complex Transformation consolidated nuclear production center. No data are available at this time related to operation of the GNEP advanced fuel cycle facility. Cumulative concentrations of all of the criteria pollutants except the 24-hour standard for nitrogen dioxide and total suspended particulates are expected to remain in compliance with Federal and state ambient air quality standards. The 24-hour standard for nitrogen dioxide and total suspended particulates could be exceeded on occasion. Based on these potential exceedances, more detailed site-specific analyses would need to be performed if LANL is selected as the site for construction of the consolidated nuclear production center. Cumulative air quality impacts for the No Action Alternative or the Reduced Operations Alternative in combination with the proposed consolidated nuclear production center would be lower than those shown in the table.

Table 5–80 Estimated Maximum Cumulative Air Quality Concentrations at the Site Boundary (micrograms per cubic meter)

Criteria Pollutant	*Averaging Period*	*LANL SWEIS Expanded Operations and Consolidated Nuclear Productions Center* [a]	*Most Stringent Standard or Guideline* [a]
Carbon monoxide	8 Hours 1 Hour	286 1,349	7,900 11,900
Nitrogen dioxide	Annual 24 Hours	26 161	75 150
Sulfur dioxide	Annual 24 Hours 3 Hours	13 93 480	42 209 1,050
Total suspended particulates	Annual 24 Hours	9.7 202	60 150
PM_{10}	Annual 24 Hours	26 143	50 150

PM_{10} = particulate matter less than or equal to 10 microns in diameter, TA = technical area.

[a] Data from Table 5–8 of this *LANL SWEIS* and Table 5.1.4-12 of the Draft *Complex Transformation SPEIS* (DOE 2007b). Criteria pollutants released from LANL operations are emitted primarily from combustion sources such as boilers and emergency generators. Although motor vehicle emissions have an impact on local air quality, no quantitative analysis of vehicle emissions was performed as part of the *LANL SWEIS*. The contribution of vehicle emissions was assumed to be included in the background monitoring concentrations discussed in the current and *1999 SWEIS*. The results of the modeling demonstrate that simultaneous operation of LANL's air emission sources at maximum capacity as described in the Title V permit application would not exceed any state or Federal ambient air quality standards. All of the equipment at the TA-3 Co-Generation Complex, including additional combustion turbine generators that would be constructed in the 2007 to 2013 timeframe, would operate within the emission limits specified in the air quality permit.

Effects on air quality from construction, excavation, and remediation activities could result in temporary increases in air pollutant concentrations at the site boundary and along roads to which the public has access. These impacts would be similar to the impacts that would occur during construction of a housing project or a commercial complex. Emissions of fugitive dust from these activities would be controlled with water sprays and other engineering and management practices as appropriate. The maximum ground-level concentrations offsite and along roads to which the public has regular access would be below the ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide for certain projects that could occur near the site boundary. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements. The impact on the public would likely be minor.

The increase in employee vehicles and the increase in other vehicles resulting from the population increase projected by the state would result in increases in vehicle emissions along the routes used to access the site. As discussed in Section 4.4.2.1 the area around Los Alamos and most of New Mexico is designated as attaining for the National Ambient Air Quality Standards for carbon monoxide, nitrogen oxides, ozone, and the other criteria pollutants (40 CFR 81.332). Even with the continuing growth in population there has been a decreasing or steady trend in concentrations in the region of carbon monoxide, nitrogen oxides, and ozone. Carbon monoxide and nitrogen oxides concentrations are well below the ambient standards (EPA 2006a).

The impacts of toxic air pollutants were assessed based on the analysis in the *1999 SWEIS* and the emission estimates in the LANL Yearbooks. In all but two cases, the estimated toxic pollutant emissions were below the corresponding guideline values established for the screening analysis in the *1999 SWEIS*. Guideline values are the levels established to screen emission rates for further analysis. The two cases where estimated emission rates were above guideline values and were referred to the human health and ecological risk assessment processes were: (1) emissions from High Explosives Firing Facilities operations at TA-14, TA-15, TA-36, TA-39, and TA-40; and (2) additive emissions from all pollutants from all TAs on receptor sites located near the Los Alamos Medical Center. The risk assessment analysis demonstrated that the pollutants released for these two cases would not be expected to cause air quality impacts that would affect human health and the environment.

Cumulative air quality impacts from offsite construction and operation activities were also evaluated. The maximum impacts from construction activities (including fugitive dust) for oil and gas development in the region were shown to occur very close to the source, with concentrations decreasing rapidly with distance (BLM 2003b). Therefore, it is expected that offsite air emissions from disturbance and construction would not contribute substantially to cumulative impacts at LANL.

Impacts of inert pollutants (pollutants other than ozone and its precursors) are generally limited to a few miles downwind from a source (BLM 2003b). For emissions from the well fields analyzed in the *Farmington Proposed Resource Management Plan and Final Environmental Impact Statement* (BLM 2003b), the distance where the nitrogen dioxide concentrations drop below their significance levels would be 15.6 to 24.9 miles (25 to 40 kilometers). Therefore, it is expected that emissions from operation of offsite facilities would not contribute substantially to cumulative impacts at LANL, which is about 100 miles (160 kilometers) away.

In contrast, the maximum effects of volatile organic compounds and nitrogen oxides emissions on ozone levels usually occur several hours after they are emitted and many miles from the sources (BLM 2003b). Although LANL is outside the study areas for the Northern San Juan Basin Coalbed Methane Project, the EIS for this project (BLM 2004a) determined that the cumulative impacts of oil and gas development combined with regional emissions from other sources could exceed visibility thresholds (9 to 25 days annually) in the Class I Areas of the Weminuche Wilderness and Mesa Verde National Park. These impacts could be reduced to 1 to 17 days annually if stricter emissions controls are required for new emission sources of nitrogen oxide (BLM 2004a). LANL is approximately 100 miles (161 kilometers) from the Bloomfield Farmington and San Juan Basin Coalbed Methane Project areas, and it is unclear whether such distant emissions could contribute to cumulative visibility impacts at the Bandelier National Monument.

The air quality analysis in the *Farmington Proposed Resource Management Plan and Final Environmental Impact Statement* (BLM 2003b) included consideration of air emissions from the highly industrialized Bloomfield gas corridor, El Paso Blanco compressor station, Conoco San Juan Gas Plant, and Four Corners and San Juan Power Plants (BLM 2003a). Although LANL is outside the study areas for the *Farmington Proposed Resource Management Plan and Final Environmental Impact Statement* (BLM 2003b), the ROD for this study (BLM 2003c) included a number of mitigation measures designed to reduce cumulative air quality impacts from gas and oil wells and pipelines. One of the more significant mitigation measures requires that new and replacement wellhead compressors limit nitrogen oxide emissions to levels less than 10 grams per horsepower-hour, and that each pipeline compressor station limit its total nitrogen oxide emissions to levels less than 1.5 grams per horsepower-hour. This requirement would apply to all new and replacement compressor engines unless the proponent can demonstrate (using air pollutant dispersion modeling) that a specific higher emission rate would not cause or contribute to exceedance of any ambient air quality standard. This measure is intended to substantially reduce the level and extent of emissions that form ozone throughout the region and to reduce visibility impacts on Class I Areas such as Mesa Verde National Park and Bandelier National Monument (BLM 2003b).

The incremental increase in criteria and toxic pollutant emissions identified in the *Conveyance and Transfer EIS* would not be major and would not cause or contribute to exceedance of any ambient air quality standard.

Ecological Resources

The continuing conveyance and transfer of LANL land would result in the cumulative impacts of the conveyance and transfer of 770 acres (312 hectares) of undeveloped habitat that could be developed. A transfer of resource protection responsibility may also result in a less rigorous environmental protection review process. Electrical power system upgrades would have minimal effects on vegetation and temporary impacts on wildlife. The Wildfire Hazard Reduction Program would have short-term impacts on wildlife, create historic forest conditions, and positively affect the Mexican spotted owl by providing a healthier habitat. Disposition of flood retention structures would have short-term impacts on wildlife and its habitat and potentially on downstream wetlands as well due to possible habitat disturbance and changes in the water flow rate. The Trails Management Program would have short-term impacts on wildlife and increase the diversity of wildlife where trails are closed. Section 5.5 of this SWEIS has a detailed discussion of the effects of each alternative on ecological resources.

Impacts associated with construction of the *Complex Transformation SPEIS* consolidated nuclear production center or the GNEP advanced fuel cycle facility at LANL would include the loss of habitat and of less mobile wildlife, such as reptiles and small mammals. More mobile species, such as birds or large mammals, would be displaced as a result of construction activities; however, these species could relocate to adjacent less developed areas. Successful relocation of more mobile species may not occur due to competition for resources and the carrying capacity limitations of areas outside the proposed development. Best management practices and implementation measures set forth in the LANL *Threatened and Endangered Species Habitat Management Plan* would be used during construction activities to minimize the potential for adverse effects to plant and animal communities and on threatened and endanger or special interest species. Proposed construction sites would be surveyed for the presence of special status species before construction begins, and mitigation actions would be developed. After construction, temporary structures would be removed and the sites reclaimed.

Human Health

Table 5–81 presents the estimated cumulative impacts from radiological emissions and radiation exposure from the LANL SWEIS alternatives and the Complex Transformation consolidated nuclear production center (the GNEP advanced fuel cycle facility is not represented in the table because available preliminary data do not include offsite radiological impacts). Cumulative impacts to the public would likely remain within the maximum level of impacts forecast under the SWEIS Expanded Operations Alternative. The offsite impacts from the addition of the consolidated nuclear production center would be essentially unchanged due to the assumed closure of existing LANL facilities whose functions would be included in the new center. No LCFs would be expected for the MEI or in the general population. The dose to the offsite MEI would be expected to remain within the 10 millirem per year limit required by 40 CFR 61, Subpart H, National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities. There would be no increase in the risk of LCFs among the general public.

Collective worker doses would increase if the Expanded Operations Alternative MDA Removal Option were to be implemented. Collective worker doses would increase from about 280 person-rem per year to an annual average of 540 person-rem per year. The 540 person-rem dose corresponds to an annual risk of an LCF in the worker population of 0.3 (or for each 3 years of operation, 1 chance of an LCF in the worker population). Worker doses would decrease by about 140 person-rem per year after the MDA remediation work was completed. Individual worker dose would be maintained ALARA and within applicable regulatory limits. Worker doses would be expected to increase from operation of the consolidated nuclear production center at LANL. The net increase in collective worker dose would be approximately 105 person-rem per year. The increased annual risk of an LCF in the worker population would be 0.06 (or for each 17 years of operation, 1 additional LCF might be expected in the worker population). The most recent preliminary data for the GNEP advanced fuel cycle facility do not include a worker population dose estimate.

Table 5–81 Estimated Cumulative Radiological Impacts

Activity	*General Public*				*Worker Population*	
	MEI		*Population Within 50 Miles*			
	Dose (millirem per year)	*LCF Risk per Year*	*Collective Dose (person-rem per year)*	*Excess LCFs per Year*	*Collective Dose (person-rem per year)*	*Excess LCFs per Year*
LANL SWEIS Alternatives						
No Action	7.8	4.7×10^{-6}	30	0.018	280	0.17
Reduced Operations	0.78	4.7×10^{-7}	6.1	0.0037	257	0.15
Expanded Operations	8.2	4.9×10^{-6}	36	0.022	543	0.33
Complex Transformation SPEIS [a]						
Consolidated Nuclear Production Center	NC	NC	0.38	2.3×10^{-4}	386	0.23
Minus Plutonium Facilities Complex	NC	NC	-0.20	-1.2×10^{-4}	-220	-0.13
Minus CMR Building	NC	NC	-0.43	-2.6×10^{-4}	-61	-0.04
Total (SPEIS and Expanded Operations)	8.2	4.9×10^{-6}	36	0.022	648	0.39
Dose Limit [b]	10	NA	NA	NA	NA	NA

MEI = maximally exposed individual, LCF = latent cancer fatality, NA = not applicable, NC = no change, CMR = Chemistry and Metallurgy Research.

[a] *Complex Transformation SPEIS*, Tables 5.1.11-2 and 5.1.11-3 (DOE 2007b).

[b] 10 millirem per year limits as required by 40 CFR 61, Subpart H.

Monitoring results for radioisotopes and chemicals in groundwater, surface water, sediments, and soil in and around LANL (see Appendix F, Section F.3) account for any contaminants that have accumulated since the beginning of operations at LANL. Appendix C presents detailed LANL radiological emissions and radiation dose data; all doses are a very small fraction of the normal background dose received by the population in and around LANL. Section 4.6.1 of this SWEIS provides detailed information on cancer mortality and incidence rates in New Mexico and all counties surrounding LANL. These data, along with the final LANL Public Health Assessment, issued on August 31, 2006 by the U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR 2006), show that, "there is no evidence of contamination from LANL that might be expected to result in ill health to the community" and "[o]verall, cancer rates in the Los Alamos area are similar to cancer rates found in other communities." The Centers for Disease Control and Prevention is in the early phase of the dose reconstruction efforts at LANL. As described in their January 2006 publication titled *Interim Report of the Los Alamos Historical Document Retrieval and Assessment Project* (CDC 2006), dose reconstruction is a five phase process involving: (1) retrieval and assessment of data; (2) initial source term development and pathway analysis; (3) screening dose and exposure calculations; (4) development of methods for assessing environmental doses; and (5) calculation of environmental exposures, doses, and risks. The Centers for Disease Control and Prevention project at LANL is still in the initial information gathering phase. Therefore, this information is not available to include in the cumulative impacts analysis.

Cultural Resources

Actions proposed under the *Land Conveyance and Transfer EIS* would result in the cumulative impacts of the conveyance and transfer of cultural resources out of the responsibility and protection of the DOE. A consequence of this conveyance and transfer would be potential damage to cultural resources due to future development and impacts to the protection and accessibility of Native American sacred sites. The environmental justice cumulative impacts section contains additional information regarding cultural resources with respect to environmental justice.

Proposed sites for the *Complex Transformation SPEIS* consolidated nuclear production center facilities in TA-16 or TA-55 and the GNEP advanced fuel cycle facility in TA-36 that involve undisturbed lands are likely to contain archaeological resources due to the high density of these resources in the region. The potential impacts to cultural resources would not be known until a specific footprint on the ground is selected for the proposed facilities. Prior to any ground-disturbing activity, DOE would identify and evaluate any cultural resources that could potentially be impacted by construction activities. Methods for identification could include archival research and consultation with interested Native American tribes. DOE would determine the possibility for impacts to National Register of Historic Places-eligible resources and implement appropriate measures to avoid, reduce, or mitigate the impacts. Identification, evaluation, determination of impact, and implementation of measures would be conducted in consultation with the New Mexico State Historic Preservation Officer and in accordance with *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006f). If previously unknown cultural or paleontological resources, such as subsurface resources, were discovered during construction, activities in the area of the discovery would stop and the discovery would be evaluated and treated appropriately, as determined by DOE in consultation with the New Mexico State Historic Preservation Officer and other interested parties.

Socioeconomics

Important cumulative socioeconomic impacts occur when the net effect of regional projects or activities would substantially alter the location and distribution of regional populations, substantially raise the unemployment rate, substantially affect the local housing market, or result in the need for new social services. Past and present economic conditions associated with continued operations of LANL are described in Chapter 4, Section 4.8.1, of this SWEIS.

As shown in **Table 5–82**, there are four other major activities that could have significant socioeconomic impacts on the region in the future. These include operation of the Los Alamos Research Park, the conveyance and transfer of land from LANL in accordance with the provisions of Public Law 105-119, the potential siting of a new consolidated nuclear production center, and the potential siting of a GNEP advanced fuel cycle facility at LANL.

By 2011, LANL operations under the No Action Alternative could account for approximately 20 percent of employment in the tri-county area (Los Alamos, Rio Arriba, and Santa Fe Counties) and an even higher percentage of wages due to the large difference in average wages for LANL employees versus the county averages. Under the Expanded Operations Alternative, direct employment at LANL could increase by another 14 percent by 2011 leading to the creation of approximately 1,890 direct and 2,000 indirect jobs. About 1,600 direct jobs and 1,700 indirect jobs would be held by residents of the tri-county area, increasing the estimated percentage of the population employed in the tri-county area as a result of LANL operations activities to 22 percent.

Table 5–82 Estimated Cumulative Socioeconomic Impacts

Activity	*Direct Employment Residing in the Tri-County Area*	*Projected Indirect Jobs*	*LANL-Related Jobs*	*Projected Employment in the Tri-County Area in 2011*
LANL Operations (through 2011)				
– No Action Alternative	11,564	12,236	23,800	120,609
– Reduced Operations Alternative	11,138	11,785	22,923	119,732
– Expanded Operations Alternative	13,182	13,948	27,130	123,939
Research Park [a]	1,600	1,693	3,293	+ 3,293
Conveyance & Transfer of Lands [b]	6,080	6,433	12,513	+ 12,513
Consolidated Nuclear Production Center [c]	1,528	1,617	3,145	+ 3,145
Advanced Fuel Cycle Facility [d]	1,138	1,204	2,342	+ 2,342
Maximum LANL-Related Activity	23,528	24,895	48,423	145,232

[a] DOE 1997b.
[b] DOE 1999d.
[c] DOE 2007b.
[d] DOE 2008.

The Los Alamos Research Park was created on land within LANL that has been leased to Los Alamos County for private sector use as discussed in the *Research Park EA* (DOE 1997b). Under this proposal, one 83,000-square-foot building was completed in 2001, and industry has been leasing space in the building and collaborating with LANL on research activities in the hopes of accelerating economic development in the region. As estimated in the Research Park EA, up to 1,600 direct jobs could eventually be created at the Park (DOE 1997b). If this were to happen, it could lead to the creation of another 1,700 indirect jobs in the region. As of January 2007, there were 19 companies employing approximately 150 individuals working in the Research Park (Holsapple 2007). There is land available within the Research Park for additional buildings and other buildings are expected to be constructed as the demand for available space increases.

In addition, LANL is conveying land to Los Alamos County that may be used for commercial and residential uses as discussed in Section 4.1.1 of this LANL SWEIS. As estimated in the *Land Transfer and Conveyance EIS*, approximately 6,100 direct jobs could be created on these lands (DOE 1999d). This could lead to the creation of another 6,400 indirect jobs in the region. To date, 152 acres of approximately 1,803 acres of land to be conveyed to the County have been conveyed.

If the maximum number of jobs estimated to be created under the *Research Park EA* and the *Land Transfer and Conveyance EIS* were also created by 2011, there could be additional socioeconomic impacts in the region of influence. Cumulatively, the Expanded Operations Alternative and these activities could result in nearly 21,000 direct and 22,000 indirect jobs in the region. This scenario would increase the estimated percentage of the population employed by LANL-related activity to 31 percent of the region of influence. Under this scenario, the rate of population growth in the region would likely exceed current rates placing additional strain on regional infrastructure and social services. For example, additional demand would be placed on regional water and electrical systems, roads would be more heavily traveled, additional housing would need to be constructed, and there may be demands for additional schools and hospitals.

There would also be beneficial gains in terms of average wages and benefits flowing into the local economy since many of these jobs should be relatively higher paying jobs (for example, research jobs), and the unemployment rate would be likely to fall.

At this time, the level of direct employment related to the Research Park and the land conveyances is very low compared to the estimates analyzed in the earlier NEPA documents and it is too early to accurately predict whether these estimates will actually be reached. If they are not reached, the cumulative socioeconomic impacts for the region would be closer to those described in Section 5.8.1 for LANL operations.

It is assumed that approximately 86 percent of the new employees needed to operate the consolidated nuclear production center (1,785) and the advanced fuel cycle facility (1,330) would reside in Los Alamos, Rio Arriba, or Santa Fe County in keeping with current LANL employee preferences. Together with the Research Park and the jobs that could be created as a result of the land transfer and conveyance, these activities could result in the addition of up to 10,300 new direct employees related to LANL and another 10,900 indirect jobs in the tri-county area. Cumulatively these activities could increase the LANL-related jobs in the tri-county area by 78 percent over the levels expected under the Expanded Operations Alternative. Employment in the tri-county area could increase by approximately 17 percent over the levels projected under the Expanded Operations Alternative and the LANL-related jobs would increase to 33 percent of the worker population in the region of influence.

Increases in employment related to the proposed consolidated nuclear production center and the advanced fuel cycle facility would occur further in the future because these facilities would need to be constructed and are not expected to begin operating until at least 2020. In the meantime, regional planning could be undertaken in anticipation of projected increases associated with these facilities to alleviate potential shortfalls such as the need for additional housing, schools, or improved public transportation.

Infrastructure

Table 5–83 presents the estimated cumulative infrastructure requirements within the LANL region of influence for electricity, natural gas, and water. Cumulative infrastructure requirements include usage projections through 2011 for LANL and other Los Alamos County users that rely on the same utility system. Therefore, the projections provided in Section 5.8.2 and adopted here already consider cumulative future usage of these utilities by DOE and non-DOE entities. Projections of future utility use in Los Alamos County are largely related to increased usage due to population growth and associated industrial and commercial development.

As shown in Table 5–83, total combined electric power and water demands under the Expanded Operations Alternative could approach the electric-peak load capacity and total available water rights, respectively. Electrical energy capacity at LANL would not be exceeded under any of the proposed SWEIS alternatives. If the consolidated nuclear production center facilities were sited at LANL, the system capacities for electric-peak load and water could be exceeded and additional resources might need to be identified to satisfy the projected demand. The additional 45 megawatts electric-peak load and 117 million gallons of water usage from the GNEP advanced fuel cycle facility (DOE 2008) would further exacerbate the availability issues. The projection of electric-peak load system capacity does not take into account completion of a new transmission line and other ongoing power grid upgrades that could help offset potential deficits in peak load capacity and ensure electrical energy availability for operations. Also, LANL has provisions to install a second new turbine at the TA-3 Co-Generation Complex that would add an additional 20 megawatts (175,200 megawatt-hours per year) of generating capacity, if needed. A study of the Los Alamos County water system would be required to determine whether the current water supply and distribution systems are adequate to meet additional projected annual water demand due to consolidated nuclear production center operations, the GNEP advanced fuel cycle facility, or both. It is likely that significant modifications would be required and LANL would need to obtain greater water resources, or significantly reduce its potable water use through mitigative measures. Overall LANL work assignments might have to be revamped, reduced, or eliminated so that existing potable water supplies would be adequate to support the assigned LANL work load.

Table 5–83 Estimated Cumulative Infrastructure Requirements for the Los Alamos National Laboratory Region of Influence

Activity	*Electricity*		*Natural Gas (decatherms per year)*	*Water (millions of gallons per year)*
	(megawatt-hours per year)	*Peak load (megawatts)*		
LANL SWEIS Alternatives Projected through 2011 [a]				
No Action	645,000	111	2,215,000	1,621
Reduced Operations	516,000	80.6	2,181,000	1,544
Expanded Operations	827,000	144	2,331,000	1,763
Complex Transformation SPEIS				
Consolidated Nuclear Production Center [b]	264,000	41	Information not available	395
Minus 80 pit manufacturing capability [c] under Expanded Operations	-9,000	- 1	- 28,000	- 8
GNEP PEIS				
Advanced Fuel Cycle Facility [d]	Information not available	45	Information not available	117
Total (Expanded Operations, Consolidated Nuclear Production Center, and Advanced Fuel Cycle Facility)	Information not available	229	Information not available	2,267
System Capacity [e]	1,314,000	150	8,070,000	1,806

[a] Data from Table 5–34, 5–35, and 5–36. Projections through 2011 for electrical energy, peak load, natural gas, and water also include projected usage for other Los Alamos County users that rely upon the same utility system.
[b] Data from Draft *Complex Transformation SPEIS* Tables 5.1.3-2 and 5.1.5-2.
[c] Rounded estimates from Section 5.8.2.3.
[d] Preliminary data for GNEP advanced fuel cycle facility (DOE 2008).
[e] Data from Table 5–33. Electrical energy and peak load capacity reflect the current import capacity of the electric transmission lines that deliver electric power to the Los Alamos Power Pool and completion of upgrades at the TA-3 Co-Generation Complex adding 40 megawatts (350,400 megawatt-hours) of generating capacity. Water system capacity reflects the total water rights from the regional aquifer managed by Los Alamos County.
Note: A decatherm is equivalent to 1,000 cubic feet.

Los Alamos County, as owner and operator of the Los Alamos Water Supply System, is currently pursuing the use of San Juan-Chama Transmountain Diversion Project water to secure additional water rights and supply for its water customers, including LANL. This would supply the Los Alamos area with up to an additional 391 million gallons (1,500 million liters) of water per year. Without the San Juan-Chama water, demand could exceed the available water supply in the future.

In the near term, no infrastructure capacity constraints are anticipated. LANL operational demands on key infrastructure resources, including electricity and water, have been below projected levels and within site capacities. Any potential shortfalls in available capacity would be addressed as increased site requirements are more fully understood.

Waste Management

Table 5–84 presents the estimated amount of radioactive and chemical waste that would be generated by the LANL SWEIS Alternatives (through 2016). Cumulative waste generation rates for all waste types are expected to be substantial, largely due to future remediation and DD&D of facilities. Although this is the case under all of the proposed LANL SWEIS Alternatives, the quantities of wastes projected under the Expanded Operations Alternative are significantly greater than those projected under the other alternatives due to the extensive environmental restoration cleanup projects associated with the MDAs and DD&D activities. Actual waste volumes from environmental remediation may be smaller, depending on regulatory decisions by the New Mexico Environment Department, and on use of waste volume reduction techniques.

Table 5–84 Estimated Cumulative Waste Generation at Los Alamos National Laboratory (2007 to 2016)

Activity	*Transuranic (cubic yards)*	*Low-Level Radioactive (cubic yards)*	*Mixed Low-Level Radioactive (cubic yards)*	*Construction and Demolition Waste (cubic yards)*	*Chemical (pounds)*
LANL SWEIS Alternatives (2007-2016) [a]					
No Action	3,500 to 5,900	72,000 to 167,000	1,800 to 2,800	198,000	19,000,000 to 37,000,000
Reduced Operations	3,500 to 5,900	72,000 to 148,000	1,800 to 2,800	197,000	19,000,000 to 36,000,000
Expanded Operations	5,300 to 33,000	277,000 to 1,414,000	3,900 to 183,000	642,000 to 722,000	64,000,000 to 129,000,000
Total (range) [c]	3,500 to 33,000	72,000 to 1,414,000	1,800 to 183,000	198,000 to 722,000	19,000,000 to 129,000,000

[a] Data rounded from Table 5–37.
[b] The total range includes the minimum and maximum values from the LANL SWEIS Alternatives. The total may not equal the sum of the contributions due to rounding.

The waste estimates under the Expanded Operations Alternative in this SWEIS include waste generated from expanding pit production to up to 80 pits per year from 20 pits per year under the No Action Alternative.

Increases in the cumulative waste generation rate may require construction of additional facilities and assignment of additional staff to manage the wastes. All waste categories are expected to increase generation rates, including solid, chemical, low-level radioactive, transuranic, and mixed wastes. Substantial quantities of low-level radioactive wastes and solid wastes (primarily uncontaminated debris from excavation, construction, and demolition activities) are projected. Efforts will be made to recycle as much of the uncontaminated fill as reasonably possible to reduce the need to bring additional fill from offsite sources to satisfy LANL's ongoing requirement. Most wastes, with the exception of some low-level radioactive wastes, are disposed of offsite at permitted facilities.

Low-level radioactive waste generation rates would increase under all alternatives, but the most significant increase would be under the Expanded Operations Alternative if all waste from MDAs were removed. Depending on the actual volumes generated by remediation, the expansion of TA-54 Area G into Zone 4, and eventually Zone 6, is expected to provide onsite low-level radioactive waste disposal capacity for operations waste through the 2016 timeframe and beyond. In addition, offsite disposal options for low-level radioactive waste include NNSA's Nevada Test Site and commercial facilities. For commercial facilities, some restrictions apply to acceptance of waste based on the origin (state of origin, and DOE or non-DOE generated) and radiological characteristics of the waste. Mixed low-level radioactive waste generation also is expected to increase, but the quantity is projected to be less than two percent of the quantity of low-level radioactive waste. Mixed low-level radioactive wastes may be sent offsite for treatment of the hazardous component and possibly returned to LANL (or disposed of elsewhere) as low-level radioactive waste.[8]

The ROD for the *WIPP SEIS* allows for disposal of 175,600 cubic meters (229,667 cubic yards) of transuranic waste at WIPP (63 FR 3624), of which 21,000 cubic meters (27,466 cubic yards) of contact-handled transuranic waste and 230 cubic meters (301 cubic yards) of remote-handled transuranic waste were anticipated to originate from LANL (DOE 1997a). Transuranic waste generated under the Expanded Operations Alternative and the total cumulative transuranic generation shown in Table 5–84 could exceed the amount assumed to come from LANL. About two-thirds of the projected transuranic waste in Table 5–84, however, is from the assumed removal of transuranic waste, most of which was buried before 1970 in certain MDAs. As noted above, actual transuranic waste volumes will depend on regulatory decisions and on implementation of volume reduction techniques. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste plus all transuranic waste buried before 1970 across the DOE complex (63 FR 3624). Decisions about disposal of transuranic waste from full removal of LANL MDAs, if generated, will be based on the needs of the entire DOE complex.

Transuranic waste from MDA removal without a disposal pathway would be safely stored onsite until additional disposal capacity at WIPP or elsewhere was identified. The impacts of disposal of transuranic waste at WIPP are evaluated in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a).

Although routine generation of chemical wastes is expected to decline under all alternatives compared to current operations at LANL, significant quantities of this waste type are expected due to environmental restoration activities, and to a lesser extent, DD&D activities. This increase would be particularly evident under the Expanded Operations Alternative, if all wastes were removed from MDAs. Offsite treatment options are available at commercial facilities across the country, including treatment and disposal facilities in Nevada, Colorado, Utah, and Texas (ACE 2006).

---

[8] *Mixed waste that is successfully treated for a characteristic would no longer be mixed waste. Listed mixed waste is always mixed. No mixed waste is currently disposed of onsite at LANL.*

Significant quantities of nonradioactive solid wastes, including construction and demolition debris, would be generated under all alternatives. The most significant increase would occur under the Expanded Operations Alternative, if all wastes were removed from MDAs. The planned closure of the Los Alamos County Landfill by the end of 2008 means that, in the future, solid wastes will be disposed of via the Los Alamos County Transfer Station, where wastes would be segregated and then transported to an appropriately permitted solid waste landfill. Construction and demolition wastes would be recycled and reused to the extent practicable. Debris that cannot be recycled would be disposed of at solid waste landfills or construction and demolition debris landfills. Los Alamos County is currently evaluating regional solid waste landfills within 120 miles of LANL for a possible contract for disposal of LANL and Los Alamos County waste, including the Rio Rancho, Sandoval County, and Torrance County/Bernalillo County Landfills. In 2006, the New Mexico Environment Department Solid Waste Bureau estimated that the state had approximately 30 years of landfill capacity remaining (NMED 2006b).

Wastes would be generated during construction of the consolidated nuclear production center if it were sited at LANL. Wastes anticipated from proposed construction would include up to 10,000 cubic yards (7,600 cubic meters) of low-level waste that would be processed and packaged for disposal at TA-54. Other construction wastes that could be generated include hazardous waste and nonhazardous solid and liquid waste. The quantities of hazardous waste that could be generated from construction are small compared to the amount of hazardous waste disposal capacity available in the region. Nonhazardous solid wastes would be recycled to the extent practicable and the remainder would be shipped offsite for disposal at approved commercial landfills located within the state. Nonhazardous liquid waste generated during construction would be processed at the TA-46 Sanitary Wastewater System Plant.

Operation of the consolidated nuclear production center at LANL would result in the generation of additional radioactive waste. Up to 850 cubic yards (650 cubic meters) of transuranic waste and 310 cubic yards (240 cubic meters) of mixed transuranic waste could be generated annually. This waste would be packaged in accordance with the WIPP WAC, placed in TRUPACT-II shipping containers, and shipped to WIPP for disposal. In addition, operations would generate up to 11,640 cubic yards (8,900 cubic meters) of low-level radioactive waste and up to 72 cubic yards (55 cubic meters) of mixed low-level radioactive waste annually. Low-level radioactive waste would be processed and packaged for disposal at TA-54. Mixed low-level radioactive waste could require permitted treatment and disposal in an appropriate facility. Treatment could occur at one of the new facilities that is proposed to have a RCRA-permitted mixed waste treatment capability. Operations could also generate up to 8,925 gallons (33,785 liters) of liquid low-level radioactive waste and up to 3,622 gallons (13,710 liters) of liquid mixed low-level radioactive waste annually. These wastes would be solidified, processed, and packaged for disposal at the waste processing portion of the proposed new consolidated nuclear production center, or at existing facilities in TA-54, and then disposed of in accordance with their regulatory status. Approximately 1,370 cubic yards (1,050 cubic meters) of solid hazardous waste and 8,850 gallons (33,500 liters) of liquid hazardous waste could be generated annually at LANL as a result of consolidated nuclear production center operation. The capacity to collect these wastes, accumulate them at existing storage facilities, solidify the liquid waste, and ship these wastes offsite for treatment and disposal at a commercial facility, presently exists and would be sufficient to handle these volumes. Because operation of the proposed consolidated nuclear production center would not be expected to start until after 2016, these waste quantities have not been included in Table 5–84.

The volumes of low-level (up to 3,450 cubic yards [2,640 cubic meters]) and mixed low-level radioactive waste (up to 4.4 cubic yards [3.4 cubic meters]) projected to be generated annually by the GNEP advanced fuel cycle facility (DOE 2008) would be managed within the current waste management program. The facility could generate up to 928 cubic yards (710 cubic meters) annually of nondefense transuranic waste (DOE 2008), which is not eligible for disposal at WIPP. Transuranic waste without a disposal pathway would be safely stored until a disposal facility became available. The project could also generate up to 34 cubic yards (26 cubic meters) of high-level radioactive waste annually (DOE 2008). Facilities to safely manage high-level radioactive waste until it could be sent to a geologic repository would have to be provided by the project since no high-level radioactive waste is currently managed at LANL.

Transportation

The collective doses, cumulative health effects, and traffic fatalities resulting from approximately 130 years of radioactive material and waste transport across the United States are estimated in **Table 5–85**. The total collective worker doses from all types of shipments (general transportation, historical DOE shipments, reasonably foreseeable actions, and the LANL SWEIS Alternatives) were estimated to be 381,700 to 382,400 person-rem, which would result in about 229 LCFs among the affected transportation workers. The total collective doses to the general public were estimated to be 343,680 to 343,900 person-rem, which would result in about 206 excess LCFs among the affected general population. The total estimated traffic fatalities associated with accidents involving radioactive material and waste transports would be up to 119. The majority of the collective doses for workers and the general population are associated with the general transportation of radioactive material. Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level waste to commercial disposal facilities. The majority of the traffic fatalities are due to the general transportation of radioactive materials (28 fatalities) and reasonably foreseeable actions (85 fatalities).

Table 5–85 presents the transportation impacts over ten years for each of the SWEIS alternatives. The data show that the impacts of each of the alternatives evaluated in this LANL SWEIS are quite small compared with the overall transportation impacts associated with radioactive materials and waste shipments across the United States. LANL SWEIS Alternatives are expected to result in no worker or public cancer deaths (LCFs) and no more than three traffic fatalities (through 2016); therefore, they would not substantially contribute to cumulative impacts. For perspective, in 2004, there were 522 traffic fatalities in New Mexico and 58 in the three neighboring counties (Los Alamos, Rio Arriba, and Santa Fe) (see Chapter 4, Table 4–56). Nationwide, in 2004, there were more than 42,000 traffic fatalities (NCSA 2006).

Table 5–85 Cumulative Impacts of Radioactive Material and Waste Transport (1943 to 2073) [a]

Activity	Worker		General Public		Traffic Fatalities
	Collective Dose (person-rem)	*Latent Cancer Fatality*	*Collective Dose (person-rem)*	*Latent Cancer Fatality*	
LANL SWEIS Alternatives [b]					
No Action	Up to 164	0.098	53 to 58	0.035	0.27
Reduced Operations	Up to 147	0.088	49 to 53	0.032	0.24
Expanded Operations	Up to 910	Up to 0.15	Up to 287	Up to 0.17	Up to 2.7
Other Past, Present, and Reasonably Foreseeable Future Actions					
General Transportation (1943 to 2073) [c]	350,000	210	300,000	180	28
Historical DOE Shipments [c]	330	0.20	230	0.14	No data
Reasonably Foreseeable Actions [c]	25,300	15.2	42,200	25.3	85
High Level Waste and Spent Nuclear Fuel Disposal at Yucca Mountain (up to 2073) [c, d]	5,900	3.5	1,200	0.72	2.8
Total [e]	381,700 to 382,400	229	343,680 to 343,900	206	~119

[a] Collective dose, health effects, and traffic fatalities associated with transporting radioactive materials and waste.
[b] From Table 5–51.
[c] From *Draft Yucca Mountain SEIS* (DOE 2007a) and Table K–10 of this SWEIS.
[d] From *Draft Yucca Mountain SEIS* (DOE 2007a), Proposed Action; mostly rail alternative.
[e] Total is a range that includes the minimum and maximum values from the LANL SWEIS Alternatives. Total may not equal the sum of the contributions due to rounding.
Note: LCFs calculated using a conversion of 0.0006 LCFs per person-rem.

The major radiological transportation actions involving Category I/II special nuclear material related to the Complex Transformation consolidated nuclear production center at LANL would be:

- Pits currently stored at the Pantex Plant would be transported to LANL; and
- Highly enriched uranium currently stored at the Y-12 Complex would be transported to LANL.

After completion of these shipments, there would be no annual shipment of pits and secondaries. The estimated radiological health impacts of the one-time transportation of pits from Pantex, and highly enriched uranium from Y-12, to LANL under this proposal would:

- The general public would receive a collective dose of approximately 118 person-rem from incident-free transportation, resulting in approximately 0.071 LCFs.
- The collective dose to workers handling pits and highly enriched uranium materials for transportation would be about 1,100 and 4,420 person-rem, respectively; this corresponds to an estimated 3.3 LCFs. It should be noted that the annual maximum individual dose is administratively limited to 2 rem (DOE 1999e); this would be a risk of 0.001 of developing an LCF.

Nonradiological impacts associated with this transportation would be expected to result in zero fatalities (0.018) as a result of traffic accidents.

The major transportation actions involving radioactive materials related to the *GNEP PEIS* advanced fuel cycle facility at LANL would be (DOE 2008):

- 39 shipments of light-water reactor spent fuel;
- 50 shipments of transmutation fuel;
- 50 shipments of fast reactor spent fuel; and
- approximately 1,430 waste shipments.

Local Transportation

Potential impacts to traffic at the main access points to LANL are estimated in **Table 5–86**. The No Action Alternative would not be expected to result in an increase in traffic over current levels. If the Reduced Operations Alternative were chosen for this SWEIS, traffic would be expected to decrease by 4 percent compared to the No Action Alternative. The largest estimated daily traffic increase would occur if the SWEIS Expanded Operations Alternative – MDA Removal Option were selected. Under this scenario, daily traffic could increase by up to 18 percent (averaged across all LANL entrances).

Table 5–86 Summary of Changes in Traffic Flow at the Entrances to Los Alamos National Laboratory

Alternative	*Average Daily Vehicle Trips*				
	Diamond Drive Across Los Alamos Canyon	***Pajarito Road at NM 4***	***East Jemez Road at NM 4***	***West Jemez Road at NM 4***	***DP Road at Trinity Drive***
Baseline	24,545	4,984	9,502	2,010	1,255
LANL SWEIS					
Reduced Operations Alternative	-900	-200	-400	-90	-50
Expanded Operations – MDA Removal Option – Increase in Daily Trips	+1,400	+4,200	+1,200	+200	+440
Total Change in Daily Vehicle Trips	-900 to +1,400	-200 to +4,200	-400 to +1,200	-90 to +200	-50 to +440
Percent Change from Baseline	-4 to + 6	- 4 to +84	-4 to +13	-4 to +10	-4 to +35

MDA = material disposal area.
Note: Incremental changes for LANL SWEIS Alternatives may not match earlier tables due to rounding.

Some temporary and intermittent disruption of traffic flow is expected to occur during construction of the Security Driven Transportation Modification Project (DOE 2002k) as well as under the Expanded Operations Alternative of this SWEIS. These traffic disruptions are not expected to affect recreation, habitat management, or timber production in U.S. Forest Service and Bandelier National Monument areas adjacent to LANL.

Development of land conveyed under the *Land Conveyance and Transfer EIS* ROD could, after the land was remediated, increase traffic in the vicinity of the airport and TA-21 based on current Los Alamos County plans for light industry, retail, and residential development on these tracts. This action, combined with increased traffic due to DD&D activities at TA-21, could cause excessive traffic loads on NM 502. Similarly, increases in employment levels at the Los Alamos Research Park could increase traffic, but currently only 150 are employed there.

The addition of proposed facilities and an increased number of workers for the consolidated nuclear production center in TA-16 as analyzed in the *Complex Transformation SPEIS* would likely result in increased traffic along NM 4 from White Rock to West Jemez Road and on West Jemez Road to the center of the LANL. The option to consolidate the facilities in TA-16 would help to alleviate current concerns related to increased traffic along Pajarito Road under the Expanded Operations Alternative somewhat, because there could be a corresponding decrease in traffic along Pajarito Road from NM 4 to TA-55 if the activities at the TA-55 Plutonium Facilities Complex were relocated to TA-16. Conversely, the proposed location of the GNEP advanced fuel cycle facility in TA-36 could lead to increased traffic along Pajarito Road from NM 4.

Environmental Justice

Environmental justice impacts would occur when the net effect of regional projects or activities would result in disproportionately high adverse human and environmental effects to minority or low-income populations. The previous analysis indicates no high and adverse cumulative human health and environmental impacts, including economic impacts and impacts from special pathways. Therefore, no disproportionately high and adverse human and environmental effects to minority or low-income populations are expected as a result of implementing any of the three alternatives under consideration for continued LANL operations in the SWEIS.

Under the Expanded Operations Alternative, as discussed in Section 5.8.1, employment at LANL and in the surrounding region is expected to increase thus creating additional employment opportunities for local individuals. As additional funding flows into the regional economy, increased opportunities for low-income and minority populations should be realized. Also, under the *Land Conveyance and Transfer EIS*, lands currently considered part of LANL would be transferred to the U.S. Department of the Interior to be held in trust for the Pueblo of San Ildefonso, thus benefiting these people.

As discussed in the *Land Conveyance and Transfer EIS*, there is the possibility that transfer activities may impact traditional cultural properties that could be present on the tracts of land being transferred or in adjacent areas (DOE 1999d). This is also true for areas that LANL is cleaning up under its ongoing environmental restoration program. In 2005 and 2006 the Los Alamos Site Office reaffirmed the 1992 accords with the four Pueblos (the Santa Clara, San Ildefonso, Jemez and Cochiti Pueblos) that recognize the Pueblos as sovereign entities that can interact with the Los Alamos Site Office on a government-to-government basis. Los Alamos Site Office has also signed the LANL Pueblo Cooperative Agreements which provide a procedural framework for consultation, as well as committing to provide information and input in long-term planning and decision making. In addition, the LANL management and operating contractor has prepared *A Plan for the Management of the Cultural Heritage at Los Alamos National*

Laboratory, New Mexico (LANL 2006f) in which specific aspects of the consultation process are spelled out. NNSA is committed to continuing to interface with the Pueblos in accordance with these agreements and plan. When a project is planned at LANL, archaeological records are searched to determine if any cultural resource sites are known to exist at the project area. If archaeological records do not exist for the project area, LANL personnel conduct the necessary surveys prior to any work taking place. If it is determined that traditional cultural properties are present on any of the lands to be transferred or those being cleaned-up, the consultations called for under the appropriate accord and the management plan will be undertaken.

Based on the impacts for resource areas, few high and adverse impacts are expected from the construction and operation of a consolidated nuclear production center or the GNEP advanced fuel cycle facility at LANL. To the extent that any impacts may be high and adverse, NNSA expects the impacts to affect all populations in the area equally (DOE 2007b).

5.14 Mitigation Measures

The regulations promulgated by the Council on Environmental Quality to implement the procedural provisions of NEPA (42 U.S.C. §4321) require that an EIS include a discussion of appropriate mitigation measures (40 CFR 1502.14[f]; 40 CFR 1502.16[h]). The term “mitigation” includes the following:

- Avoiding an impact by not taking an action or parts of an action;
- Minimizing impacts by limiting the degree of magnitude of an action and its implementation;
- Rectifying an impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact by preservation and maintenance operations during the life of the action; and
- Compensating for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20).

This section describes mitigation measures that are built into the alternatives analyzed as well as additional measures that will be considered by DOE to further mitigate the adverse impacts identified earlier in this chapter. These measures address the range of potential impacts of continuing to operate LANL (including those areas where lack of information regarding resources and mechanisms for assessing impacts to resources result in substantial uncertainty in the impact analyses). The mitigation measures built into the alternatives analyzed (see Section 5.14.1 and 5.14.2) are of two types: (1) existing programs and controls (including regulations, policies, contractual requirements, and administrative procedures); and (2) specific measures built into the alternatives that serve to minimize the effects of activities under the alternatives. The existing programs and controls are too numerous to list here; but a general description is provided, as well as the role of existing programs in operating LANL and pertinent examples of how these programs mitigate adverse impacts. Additional mitigation measures that could further reduce the adverse impacts identified in this chapter are discussed in Section 5.14.3. The description of these measures in this chapter does not constitute a commitment to undertake any of these measures. Any such commitments would be reflected in the ROD following this SWEIS, with a more detailed description and implementation plan provided in a Mitigation Action Plan following the ROD.

5.14.1 Existing Programs and Controls

The activities undertaken at LANL are performed within the constraints of applicable regulations, applicable DOE orders, contractual requirements, and approved policies and procedures. Laws and regulations applicable to Federal facilities are discussed in Chapter 6; many of these requirements are established to protect human health and the environment. It is assumed that these or similar regulatory controls will continue to be in place. When complied with, these regulations mitigate the potentially adverse impacts of operations to the public, the worker, and the environment. For example, the Clean Air Act (42 U.S.C. §7401) regulates air emissions and the Clean Water Act (33 U.S.C. §1251) regulates liquid effluent discharges in a manner designed to protect human health and reduce the adverse environmental effects of routine operations. In addition to the regulations applicable to LANL, Chapter 6 also discusses other requirements (including DOE Orders and external standards and regulations that would not otherwise apply to Federal facilities) that apply to operations at LANL through the contract between DOE and its management and operating contractor. As discussed in Chapter 6, these requirements are established and enforced through contractual mechanisms. As with the regulations that apply to LANL, it is assumed that these or similar controls will continue. These requirements also mitigate the potential for adverse impacts. For example, the application of DOE design standards results in facility designs for modern nuclear facilities that reduce the potential for catastrophic releases from these facilities in the event of earthquakes, high winds, or other natural phenomena. Similarly, the application of occupational safety and health regulations in 29 CFR Part 1900, et seq, and other standards promulgated by the American National Standards Institute, the U.S. Department of Defense, and DOE, as well as the use of other life safety and fire safety codes and manuals, limit worker exposures to workplace hazards, which reduces the potential for adverse worker health effects. DOE and LANL also have instituted policies and procedures applicable to work conducted at LANL to mitigate potentially adverse effects of operations. It is assumed that these or similar policies and procedures will continue. These policies and procedures are numerous and include, but are not limited to:

- Procedures that institute integrated safety management to control work conducted at LANL (to ensure that work conducted is planned and reviewed, funded, within the applicable regulations and requirements, within the range of risks accepted by DOE and its management and operating contractor, and is otherwise authorized);

- Policies regarding the knowledge, skills, and abilities of personnel assigned to perform hazardous work (including required training);

- Policies reflected in agreements with other entities (such as the Accords with the four Pueblos located nearest to LANL) that establish policies and protocols regarding consultations and other discussions regarding LANL activities;

- Policies and procedures regarding stoppage and restart of work where unexpected hazards or resources are identified (for example, policies regarding recovery of information from archaeological sites uncovered by excavation).

Work controls reduce potential impacts by ensuring that work conducted falls within the range of activities that have been studied for potential environmental and human health effects. Policies regarding the knowledge, skills, and abilities of personnel conducting work at LANL reduce potential impacts by ensuring that only personnel having an appropriate understanding of the work and its potential hazards may undertake that work (which minimizes the potential for adverse human health and environmental effects from inadvertent actions due to a lack of such understanding). Policies for consultations and discussions with other entities mitigate effects by providing an opportunity to avoid or change actions that could cause adverse impacts. For example, consultation with the Pueblos could identify a potential for impacts to traditional cultural properties prior to implementing a construction project or operations, as well as identify alternative siting or operational approaches that would avoid the impacts. Policies and procedures regarding the stoppage and restart of work are similar in effect to work controls; when unexpected situations occur that impose unexpected hazards or reveal unexpected resources (for example, cultural resources), work is stopped as soon as stoppage can be accomplished safely until work plans and authorizations can be modified in consideration of the new information. This reduces potential impacts in a manner similar to work controls, as discussed above.

DOE also has established programs and projects at LANL to increase the level of knowledge regarding the environment around LANL, the health of LANL workers, the health of the public around LANL, and the effects of LANL operations on these elements, as well as to avoid or reduce impacts and remediate contamination from previous LANL activities. These programs and projects reduce potentially adverse impacts by providing a heightened understanding of the resources that could be impacted; avoidance of some impacts (where mechanisms for impacts to specific resources are known and avoidable); early identification of impacts (which can enable stoppage or mitigation of the impacts); reduction of ongoing impacts; or beneficial management opportunities for natural, cultural, and sensitive resources, where appropriate. It is assumed that such activities will continue at LANL. Examples of these programs and projects include:

- The Environmental Surveillance and Compliance Program at LANL monitors LANL for permit and environmental management requirements. This program also includes evaluations of samples from various environmental media for radioactive materials and other hazardous materials locally and regionally (see Chapter 4, Section 4.6.1.2). The data generated under this program are collected routinely, publicly reported at least annually, and analyzed to determine regulatory compliance and environmental trends over long periods.

- The Threatened and Endangered Species Habitat Management Plan is intended to provide long-range planning information for future LANL projects and to protect the habitats of endangered species at LANL (see Chapter 4, Section 4.5.4).

- A recently completed *Cultural Heritage Management Plan* for LANL (see Chapter 4, Section 4.7) has undergone public review and is being implemented through a programmatic agreement between DOE, the New Mexico State Historic Preservation Office, and the Advisory Council on Historic Preservation.

- Flue gas recirculation equipment installed in 2002 on the boilers at the TA-3 power plant has reduced nitrogen oxides emissions by 64 percent. Such equipment and administrative controls are applied to the steam plant and other sources to comply with the emission source limitations and the facility-wide emission limitations specified in LANL's air permit (see Chapter 4, Section 4.4.2).

- Studies of public and worker health in and around LANL have been conducted (some by DOE and some by other agencies) to assess both human health in the region and the potential for adverse human health effects due to LANL operations (see Chapter 4, Section 4.6).

- The Health, Safety, and Radiation Protection Program is conducted by LANL to promote the health and safety of its workers. This program addresses the possible impacts that could result from working with ionizing and non-ionizing radiation, hazardous and chemical materials, and biohazard materials. Appropriate controls that protect the health and safety of workers are determined primarily by the type of hazard and the work environment. The level or amount of controls is commensurate with the risk associated with the hazards that would be encountered by the workers for each job activity.

- LANL's NPDES Industrial Stormwater Permit Program regulates stormwater runoff from industrial activities under a Multi-Sector General Permit. Stormwater monitoring and erosion controls are required at these sites. An integrated Stormwater Monitoring Program monitors stormwater runoff on a watershed basis and at individual solid waste management units. LANL recently began to implement these programs in response to the 2004 Federal Facility Compliance Agreement between the EPA and DOE. The NPDES Construction Stormwater Program regulates stormwater from construction activities disturbing 1 acre (0.4 hectares) or more (see Chapter 4, Section 4.3.1.3).

- LANL's Groundwater Protection Management Program assesses current groundwater conditions and monitors and protects groundwater. A Hydrogeologic Work Plan also supplements and verifies existing information on the environmental setting at LANL and collects analytical data on groundwater contamination (see Chapter 4, Section 4.3.2). An Interim Facility-wide Groundwater Monitoring Plan has been submitted to the New Mexico Environment Department as required by the 2005 Consent Order (LANL 2006g).

- The Safeguards and Security Program restricts unauthorized access to areas of LANL that have a high potential for impacts to human health and the environment. Such access restrictions limit the potential for intentional or inadvertent actions that could result in environmental or human health effects.

- LANL's Emergency Management and Response Program effectively combines Federal and local emergency response capabilities and provides planning, preparedness, and response capabilities that can aid in containing and remediating the effects of accidents or adverse operational impacts (see Chapter 4, Section 4.6.4).

- LANL's Fire Protection Program ensures that personnel and property are adequately protected against fire or related incidents, including fire protection and life safety (see Chapter 4, Section 4.6.4).

- An Interagency Wildfire Management Team has been established to coordinate activities related to reducing the fuel loading surrounding the site (see Chapter 4, Section 4.5.1). On the site, LANL is implementing actions around individual facilities that have moderate or higher vulnerability to burning as a result of wildfire.

- Waste minimization and pollution prevention efforts at LANL are coordinated by the Pollution Prevention Program, which works to reduce wastes generated and to some extent effluents and emissions from facilities (see Chapter 4, Section 4.9).

- Water and energy conservation programs at LANL are intended to reduce use of these resources, which should assist in mitigating the effects of water withdrawal and electrical consumption that occasionally exceed supply (see Chapter 4, Section 4.8.2).

- The LANL environmental restoration program (which includes DD&D) assesses and remediates contaminated sites that either were or still are under LANL control (see Chapter 4, Section 4.12). The LANL environmental restoration program serves an important role in reducing the potential for future impacts to human health and the environment due to legacy contaminants in the environment. This analysis assumes that current mitigation practices used in remediation actions will continue.

While this list is not all-inclusive, it reflects the importance of these programs in mitigating the potentially adverse impacts of operating LANL.

5.14.2 Mitigation Measures Incorporated in the SWEIS Alternatives

Several specific mitigation measures are included in the SWEIS alternatives. Unless otherwise noted below, the analyses in this chapter assume that the following measures would be implemented.

- NNSA intends to implement actions necessary to comply with the Consent Order, regardless of decisions it makes on other actions analyzed in the SWEIS; however, specific remediation actions have not been selected. Removal of contamination from MDAs and other PRSs, if necessary, would be conducted in a manner that protects the environment and public and worker health and safety. Removal of waste from some large MDAs may require use of temporary enclosures to limit possible releases of contaminated material to the environment to levels within applicable standards and ALARA. The MDAs where use of enclosures or equivalent measures may be required for safe removal operations include MDAs A, B, T, AB, and G (Expanded Operations Alternative – MDA Removal Option).

- Under all alternatives, nonradioactive air emissions, such as from construction equipment, would be controlled by proper maintenance of equipment.

- Under the Expanded Operations Alternative, noise impacts on sensitive wildlife species during MDA remediation, DD&D, and construction activities would be mitigated by planning activities outside of the breeding season for sensitive species, if any sensitive species' habitat is identified in the area and if the habitat is occupied or the status is uncertain. If appropriate, other protective measures could be employed, such as hand digging.

- Under the No Action and Expanded Operations Alternatives, radiological air emissions would be monitored and tracked to maintain the annual dose to the public from LANSCE emissions under the administrative limit.

- Under the Expanded Operations Alternative, the Science Complex would be constructed on a site in Northwest TA-62, located west of the Research Park area. This site is bounded to the north by an unpaved utility corridor access road with forested land beyond. The utility corridor access road may be paved in the future to provide all-weather access to areas of the Santa Fe National Forest and a local recreational ski facility.

- Under the Expanded Operations Alternative, traffic improvements would be implemented for operation of the new Science Complex on West Jemez Road in TA-62 and the consolidated Warehouse and Truck Inspection Station on East Jemez Road in TA-72 to mitigate the effect of these facilities on traffic flow.

- Under all alternatives, actions would be taken to mitigate the risks of a wildfire on waste storage domes in TA-54. In 2000, the Cerro Grande Fire burned a heavily forested canyon area to within about 0.75 miles (1.2 kilometers) of the waste storage domes in TA-54, but none were burned and there were no radiological releases from domes. Additional fuel reduction has been conducted since the Cerro Grande Fire, both to the vegetation surrounding the TA-54 area and within the domes themselves (for example, wooden pallets have been replaced with metal pallets), to further decrease the potential for a waste storage dome fire occurring as a result of a site wildfire. The LANL management and operating contractor would continue its wildfire management activities (for example, forest thinning) and further reduce risks by shipping legacy transuranic waste, currently stored in the domes, to WIPP.

5.14.3 Other Mitigation Measures Considered

In addition to those mitigation measures described above, other feasible mitigation measures considered in the preparation of this SWEIS are presented below.

- Expanded sealed source program procedures would be instituted under the Expanded Operations Alternative that would ensure adequate controls on the quantities and methods of storing sealed sources containing cobalt-60, iridium-192, or cesium-137 to mitigate the effects of potential accidents. This would reduce the potential direct gamma radiation-streaming dose from a postulated accident that could compromise the shielding around these gamma-emitting radioisotopes.

- Los Alamos County has recently completed a 40-year water plan (Stephens 2006) to address water service needs, balance the uses of water resources, and make recommendations for a water conservation program tailored to meet specific water supply customer needs in the county, including LANL. Only the Expanded Operations Alternative is projected to have water demands that would approach the available water rights from the regional aquifer. Los Alamos County's plans to use up to 391 million gallons (1,500 million liters) of water per year from the San Juan-Chama Transmountain Diversion Project as early as 2010 would alleviate any potential shortfall between future demand and current groundwater rights. LANL's water use would be mitigated somewhat by the use of recycled water from the Sanitary Effluent Recycle Facility for cooling water.

- Ongoing upgrades are being made to the electrical power transmission and distribution system, including construction of a third transmission line to allow import of additional power into the Los Alamos Power Pool and to support a higher electric peak load beyond 2006. In addition, an EA (DOE/EA 1430) was prepared and a FONSI was issued in December 2002 for a project to install two new (20 megawatt) gas-fired combustion turbine generators and to upgrade the existing steam turbines at the TA-3 Co-Generation Complex (DOE 2000f). As discussed in Chapter 4, Section 4.8.2, upgrades and installation of one new combustion turbine generator were completed in September 2007. Although DOE currently has no timeframe for installing a second combustion turbine generator, its installation in the future would add 20 megawatts (equivalent to 175,200 megawatt-hours) of electrical power generating capacity at LANL.

- Under all of the alternatives, particulate matter (fugitive dust) emissions from exposed soil and roadways during construction activities would be controlled using routine watering as appropriate. As necessary, air pollutant emissions from construction activities and MDA remediation activities would be controlled using standard construction emissions controls. Application of chemical stabilizers to exposed areas and administrative controls such as planning, scheduling, and use of special equipment could further reduce emissions under all of the alternatives.

- Use of containment vessels for high explosives testing under all of the alternatives could further reduce air pollutant emissions, such as beryllium and depleted uranium, from this activity. The use of vessels for certain tests could reduce emissions from these tests by close to 100 percent.

- The possibility exists that traffic into and out of LANL could increase over the next several years. Additional traffic studies should be undertaken to determine if activities under consideration in the SWEIS would increase traffic to unacceptable levels and to identify possible solutions in the event such problems are identified.

- Traffic and noise impacts on residents of the Royal Crest Mobile Home Park and Los Alamos Town Center due to increased truck traffic under the Expanded Operations Alternative could be mitigated by scheduling activity for off-peak hours, rerouting truck traffic, using multiple shifts, using alternative entries and exits, and, in the case of TA-21 remediation and DD&D, possible construction of a bridge or another road off of DP Mesa to allow alternate routing of traffic. Stockpiling fill and cover materials on the sites during off-peak hours also could be considered to avoid frequent trips during peak hours.

- To alleviate concerns associated with additional employees commuting to LANL from areas such as Rio Arriba and Santa Fe Counties, it may be necessary to expand the park-and-ride bus services that are currently offered from Española and Santa Fe.

5.15 Resource Commitments

This section describes the unavoidable adverse environmental impacts that could result from changes in ongoing activities at LANL; the relationship between short-term uses of the environment and maintenance and enhancement of long-term productivity; and irreversible and irretrievable commitments of resources. Unavoidable adverse environmental impacts are impacts that would occur after implementation of all feasible mitigation measures. The relationship between short-term uses of the environment and maintaining and enhancing long-term productivity addresses issues associated with the condition and maintenance of existing environmental resources used to support the Proposed Action and the utility of these resources after their use. Resources that would be irreversibly and irretrievably committed are those that cannot be recovered or recycled and those that are consumed or reduced to unrecoverable forms.

5.15.1 Unavoidable Adverse Environmental Impacts

Ongoing activities at LANL under any of the three alternatives analyzed in this SWEIS could result in unavoidable adverse impacts on the human environment. In general, these impacts would be minimal and would come from incremental impacts attributed to ongoing LANL operations.

Ongoing activities at LANL will continue to result in unavoidable radiation and chemical exposure to workers and the public. Generation of radioactive isotopes under any of the three alternatives is unavoidable. Radioactive waste generated during operations would be collected, treated, stored, and eventually removed for suitable recycling or disposal in accordance with applicable DOE and EPA regulations.

Operations at LANL under any of the three alternatives would have minimal unavoidable adverse impacts from air emissions. Air emissions include various chemical or radiological constituents in the routine emissions typical of nuclear facility operations. Decontamination and decommissioning of buildings could result in the one-time generation of radioactive and nonradioactive waste material that could affect storage requirements. This could produce unavoidable impacts on the amount of available and anticipated storage space and the requirements of disposal facilities at LANL.

Temporary construction impacts associated with the construction of new facilities at LANL also would be unavoidable. These impacts would include generation of fugitive dust, and noise, as well as increased construction vehicle traffic.

5.15.2 Relationship Between Local Short-Term Uses of the Environment and Maintenance and Enhancement of Long-Term Productivity

Ongoing operations at LANL under any of the three alternatives would require short-term commitments of resources and permanent commitments of certain resources (such as energy). Environmental resources have already been committed to continuing operations at LANL.

Additional commitments would serve to maintain existing environmental conditions with little or no impact on the long-term productivity of the environment.

Short-term commitments of resources would include space and materials required to construct new buildings; new operations support facilities; transportation; and disposal resources and materials for continued LANL operations. Workers, the public, and the environment could be exposed to increased amounts of hazardous and radioactive materials over the period of this SWEIS analysis due to relocation of materials, including process emissions, and handling of radioactive waste.

Regardless of changes in the location and levels of activities at LANL Key Facilities, additional air emissions could introduce small amounts of radiological and nonradiological constituents to the air in the region around LANL. These emissions would result in additional loading and exposure, but would not be expected to impact compliance with air quality or radiation exposure standards at LANL. There would be no significant residual environmental effects on long-term environmental viability.

Management and disposal of additional sanitary solid waste and nonrecyclable radiological waste would require the use of energy and space at LANL treatment, storage, or disposal facilities or at replacement offsite disposal facilities. Regardless of location, the land required to meet solid waste needs at LANL would require a long-term commitment of terrestrial resources. Activities being considered at LANL, such as consolidation of new facilities, could result in further disturbance, use, and commitment of previously undisturbed land. Ultimately, after closure of facilities at LANL, NNSA plans to decontaminate and decommission the buildings and equipment and restore them to brownfield sites that could be made available for future reuse.

5.15.3 Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable commitments of resources unanticipated in the *1999 SWEIS* would include mineral resources consumed during the life of certain projects and energy and water used to operate buildings and facilities at LANL. Commitments of capital, energy, labor, and materials are generally irreversible.

Energy expended would be in the form of fuel for equipment and vehicles, electricity for facility operations, and human labor. Changes in LANL operations could generate nonrecyclable waste streams such as radiological and nonradiological solid waste and some wastewater. Certain materials and equipment used during operations, however, could be recycled when buildings are decontaminated and decommissioned.

Operations at LANL require water, electricity, and diesel fuel. These resources are discussed in Section 5.8.2.

Disposal of hazardous and radioactive wastes also would cause irreversible and irretrievable commitments of land, mineral, and energy resources.

CHAPTER 6
APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

6.0 APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

Chapter 6 provides an update to the laws, regulations, agreements, and consultations that relate to environmental protection at the Los Alamos National Laboratory (LANL).

As part of the National Environmental Policy Act (NEPA) process, an agency must consider whether an action could threaten a violation of any Federal, state, or local law or requirement (40 *Code of Federal Regulations* [CFR] 1508.27) or require a permit, license, or other entitlement (40 CFR 1502.25). This chapter identifies and summarizes the major environmental requirements, agreements, and permits that could be required to support the *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS).

A number of Federal environmental laws affect environmental protection, health, safety, compliance, and consultation at every U.S. Department of Energy (DOE) location. In addition, certain environmental requirements have been delegated to state authorities for enforcement and implementation and state legislatures have passed laws to protect human health and safety and the environment. It is DOE policy to conduct its operations in a manner that ensures the protection of public health, safety, and the environment through compliance with all applicable Federal and state laws, regulations, DOE Orders, and other requirements.

The alternatives analyzed in this SWEIS involve either the operation of existing DOE facilities or the construction and operation of new DOE facilities. Actions required to comply with laws, regulations, and other Federal and State of New Mexico requirements may depend on whether a facility is newly built (preoperational), operational, undergoing decontamination and decommissioning, or incorporated in whole or in part into an existing facility.

Requirements governing the continuation of LANL operations arise primarily from six sources: the Congress, Federal agencies, Executive Orders, legislatures of the affected states, state agencies, and local governments. In general, Federal statutes establish national policies, create broad legal requirements, and authorize Federal agencies to create regulations that conform to the statutes. Detailed implementation of these statutes is delegated to various Federal agencies such as DOE, the U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA). For many environmental laws under EPA jurisdiction, state agencies may be delegated responsibility for the majority of program implementation activities, such as permitting and enforcement, but EPA usually retains oversight of the delegated program.

Some applicable laws such as NEPA, the Endangered Species Act, and the Emergency Planning and Community Right-To-Know Act require specific reports and consultations rather than ongoing permits or activities. These are satisfied through the legal and regulatory process, including the preparation of this SWEIS.

Other applicable laws establish general requirements that must be satisfied, but do not include processes (such as the issuance of permits or licenses) that consider compliance prior to specific violations or other events that trigger their provisions. These include the Toxic Substances Control Act (TSCA) (affecting polychlorinated biphenyl transformers and other designated substances); the Federal Insecticide, Fungicide, and Rodenticide Act (affecting pesticide and herbicide applications); the Hazardous Materials Transportation Act; and (in the event of a spill of a hazardous substance) the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund).

Executive Orders establish policies and requirements for Federal agencies. Executive Orders are applicable to Executive branch agencies, but do not have the force of law or regulation.

In addition to implementing some Federal programs, state legislatures develop their own laws to supplement as well as implement Federal laws for protection of air and water quality and groundwater. State legislation in New Mexico addresses solid and hazardous waste management programs, locally rare or endangered species, and local resource, historic, and cultural values. The laws of local governments add a further level of protection of the public, often focusing on zoning, utilities, and public health and safety concerns.

Regulatory agreements and compliance orders also may be initiated to establish responsibilities and timeframes for Federal facilities to comply with provisions of applicable Federal and state laws. Other agreements, memoranda of understanding, and formalized arrangements also establish cooperative relationships and requirements.

The actions being considered in this SWEIS would be all located on LANL property controlled by the National Nuclear Security Administration (NNSA). NNSA has authority to regulate some environmental activities, as well as the health and safety aspects of nuclear facilities operations. The Atomic Energy Act of 1954, as amended, is the principal authority for DOE regulatory activities not externally regulated by other Federal or state agencies. Regulation of DOE activities is primarily established through the use of DOE Orders and regulations.

External environmental laws, regulations, and Executive Orders can be categorized as applicable to either broad environmental planning and consultation requirements or regulatory environmental protection and compliance activities, although some requirements are applicable to both planning activities and ongoing operations.

Section 6.1 of this chapter discusses major applicable Federal laws, regulations, and permits that impose nuclear safety and environmental protection requirements on the activities conducted at LANL. Each of the applicable regulations and statutes establishes how activities are to be conducted or how potential releases of pollutants are to be controlled or monitored. They include requirements for issuing permits or licenses for new operations or new emission sources and for amending existing permits or licenses to allow new types of operations at existing sources.

Section 6.2 discusses new or revised Executive Orders that may be applicable to LANL activities. Section 6.3 identifies DOE Orders for compliance with the Atomic Energy Act, the Occupational Safety and Health Act, and other environmental, safety, and health requirements that may be applicable to LANL activities. Section 6.4 identifies state and local laws, regulations, permits and ordinances, as well as local agreements that potentially impact LANL. Consultations with applicable agencies and federally recognized Native American Nations are discussed in Section 6.5.

6.1 Applicable Federal Laws, Regulations, and Permits

This section describes the Federal environmental, safety, and health laws and regulations and permits that could apply to LANL. These regulations address such areas as energy conservation, administrative requirements and procedures, nuclear safety, and classified information. Activities under all alternatives would need to be conducted in compliance with applicable Federal laws, regulations, and permits. Chapter 4 describes the resources at LANL that are potentially addressed by these laws, regulations, and permits. Chapter 5 discusses the potential impacts to those resources under each alternative. Consultations with applicable agencies and federally recognized Native American Nations as required by Federal laws and regulations are discussed in Section 6.5.

The major Federal laws and regulations, Executive Orders, and other requirements that currently apply or could apply in the future to the various alternatives analyzed in this SWEIS are identified in **Table 6–1**. For ease of identification, laws are identified in the table with a *United States Code* (U.S.C.) or Public Law citation; regulations are identified with a CFR citation; and Executive Orders are listed in italics. This table does not include DOE Orders, which are provided in Section 6.3, nor does it include state requirements, which are provided in Section 6.4.

American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996)—This Act reaffirms American Indian religious freedom under the First Amendment and sets U.S. policy to protect and preserve the inherent and constitutional right of American Indians to believe, express, and exercise their traditional religions. The Act requires that Federal actions avoid interfering with access to sacred locations and traditional resources that are integral to the practice of religions.

Antiquities Act of 1906, as amended (16 U.S.C. 431 *et seq*.)—This Act protects historic and prehistoric ruins, monuments, and antiquities, including paleontological resources, on federally controlled lands from appropriation, excavation, injury, and destruction without permission.

Archaeological and Historic Preservation Act of 1960, as amended (16 U.S.C. 469 *et seq.* 469c-1)—The purpose of this Act is to preserve historical and archaeological data (including relics and specimens) that might otherwise be irreparably lost or destroyed as the result of Federal actions.

Table 6–1 Potentially Applicable Environmental, Safety, and Health Laws, Regulations, and Executive Orders

Laws, Regulations, Orders, Other Requirements	***Citation***
Radioactive Materials and Waste Management	
Atomic Energy Act of 1954, as amended	42 U.S.C. 2011 *et seq.*
"Byproduct Material"	10 CFR Part 962
"Environmental Radiation Protection Standards for Management of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Materials"	40 CFR Part 191
Low-Level Radioactive Waste Policy Act of 1980, as amended	42 U.S.C. 2021 *et seq.*
Waste Isolation Pilot Plant Land Withdrawal Act, as amended	Public Law 102-579
Ecological Resources	
Bald and Golden Eagle Protection Act of 1973, as amended	16 U.S.C. 668 *et seq*.
Endangered Species Act of 1973, as amended	16 U.S.C. 1531 *et seq.*
Fish and Wildlife Coordination Act	16 U.S.C. 661 *et seq.*
Invasive Species	Executive Order 13112
Migratory Bird Treaty Act of 1918, as amended	16 U.S.C. 703 *et seq.*
Protection of Wetlands	Executive Order 11990
Cultural and Paleontological Resources	
American Indian Religious Freedom Act of 1978	42 U.S.C. 1996
Antiquities Act of 1906, as amended	16 U.S.C. 431 *et seq.*
Archaeological and Historic Preservation Act of 1960, as amended	16 U.S.C. 469 *et seq.*
Archaeological Resources Protection Act of 1979, as amended	16 U.S.C. 470aa *et seq.*
Consultation and Coordination with Indian Tribal Governments	Executive Order 13175
Department of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998	Public Law 105-119
Indian Sacred Sites	Executive Order 13007
Manhattan Project National Historical Park Study Act	Public Law 108-340
National Historic Preservation Act of 1966, as amended	16 U.S.C. 470 *et seq.*
National Historic Preservation	Executive Order 11593
Native American Graves Protection and Repatriation Act of 1990	25 U.S.C. 3001 *et seq.*
Preserve America	Executive Order 13287
"Protection of Historic and Cultural Properties"	36 CFR Part 800
Worker Safety and Health	
"Occupational Radiation Protection"	10 CFR Part 835
"Chronic Beryllium Disease Prevention Program"	10 CFR Part 850
"Worker Health and Safety Program"	10 CFR Part 851
Occupational Safety and Health Act of 1970	29 U.S.C. 651 *et seq.*
Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction	Executive Order 12699
Radiological Safety Oversight and Radiation Protection	
"Nuclear Safety Management"	10 CFR Part 830
Transportation	
Hazardous Materials Transportation Act of 1975, as amended	49 U.S.C. 5101 *et seq.*
"Packaging and Transportation of Radioactive Material"	10 CFR Part 71

Laws, Regulations, Orders, Other Requirements	***Citation***
Emergency Planning, Pollution Prevention, and Conservation	
Assignment of Emergency Preparedness Responsibilities	Executive Order 12656
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (also known as Superfund)	42 U.S.C. 9601 *et seq.*
Emergency Planning and Community Right-to-Know Act	42 U.S.C. 11001 *et seq.*
Energy Efficiency and Water Conservation at Federal Facilities	Executive Order 12902
Federal Compliance with Pollution Control Standards, as amended by Executive Order 12580, *Superfund Implementation*	Executive Order 12088
Federal Emergency Management, as amended	Executive Order 12148
Greening the Government through Efficient Energy Management	Executive Order 13123
Greening the Government through Leadership in Environmental Management	Executive Order 13148
Greening the Government through Waste Prevention, Recycling, and Federal Acquisition	Executive Order 13101
Pollution Prevention Act of 1990	42 U.S.C. 13101 et *seq.*
Proliferation of Weapons of Mass Destruction	Executive Order 12938
Right-to-Know Laws and Pollution Prevention Requirements	Executive Order 12856
Environmental Justice and Protection of Children	
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Executive Order 12898
Protection of Children from Environmental Health Risks and Safety Risks	Executive Order 13045
Environmental Quality	
"Council on Environmental Quality National Environmental Policy Act Regulations"	40 CFR Part 1500 *et seq.*
National Environmental Policy Act of 1969	42 U.S.C. 4321 *et seq.*
"National Environmental Policy Act Implementing Procedures"	10 CFR Part 1021
Protection and Enhancement of Environmental Quality	Executive Order 11514
Air Quality and Noise	
Clean Air Act of 1970, as amended	42 U.S.C. 7401 *et seq.*
"National Emission Standards for Hazardous Air Pollutants"	40 CFR Part 61
"National Emission Standards for Hazardous Air Pollutants for Source Categories"	40 CFR Part 63
Noise Control Act of 1972, as amended	42 U.S.C. 4901 *et seq.*
Water Resources	
Clean Water Act of 1972, as amended	33 U.S.C. 1251 *et seq.*
"Compliance with Floodplain/Wetlands Environmental Review Requirements"	10 CFR Part 1022
"EPA-Administered Permit Programs: The National Pollutant Discharge Elimination System"	40 CFR Part 122
Floodplain Management	Executive Order 11988
"National Primary Drinking Water Regulations"	40 CFR Part 141
Safe Drinking Water Act of 1974, as amended	42 U.S.C. 300(f) *et seq.*
Hazardous Waste and Materials Management	
Federal Facility Compliance Act of 1992	42 U.S.C. 6961 *et seq.*
"Select Agents and Toxins"	42 CFR Part 73 (see Appendix C of this SWEIS)
Solid Waste Disposal Act of 1965, as amended, including Resource Conservation and Recovery Act of 1976, as amended	42 U.S.C. 6901 *et seq.*)
Toxic Substances Control Act of 1976	15 U.S.C. 2601 *et seq.*

U.S.C. = *United States Code*, CFR = *Code of Federal Regulations*.

Archaeological Resources Protection Act of 1979, as amended (16 U.S.C. 470aa *et seq*.)— This Act requires a permit for any excavation or removal of archaeological resources from Federal or American Indian lands. Excavation must be undertaken to further archaeological knowledge in the public interest, and resources removed are to remain the property of the United States. The law requires that whenever any Federal agency finds that its activities may cause irreparable loss or destruction of significant scientific, prehistoric, or archaeological data, the agency must notify the U.S. Department of the Interior and may request that the Department of Interior undertake the recovery, protection, and preservation of such data. Consent must be obtained from the American Indian Tribe or Federal agency that has authority over the land on which a resource is located before issuance of a permit, and the permit must contain the terms and conditions requested by the Tribe or Federal agency.

Atomic Energy Act of 1954 (42 U.S.C. 2011 *et seq*.) as amended by the Price-Anderson Act and the Bob Stump National Defense Authorization Act—The Act provides fundamental jurisdictional authority to DOE and the U.S. Nuclear Regulatory Commission (NRC) over governmental and commercial use of nuclear materials. The Atomic Energy Act authorizes DOE to establish standards to protect health or minimize dangers to life or property for activities under DOE jurisdiction. DOE has issued a series of Departmental Orders to establish an extensive system of standards and requirements to ensure safe operation of DOE facilities (see Section 6.3).

DOE regulations are found in Title 10 of the CFR. The DOE regulations that are most relevant to radioactive materials, waste management, and worker health and safety include:

- "Nuclear Safety Management" (10 CFR Part 830),
- "Occupational Radiation Protection" (10 CFR Part 835),
- "Chronic Beryllium Disease Prevention Program" (10 CFR Part 850),
- "Worker Health and Safety Program" (10 CFR Part 851), and
- "Byproduct Material" (10 CFR Part 962).

The Atomic Energy Act also gives EPA the authority to develop generally applicable standards for protection of the general environment from radioactive materials. EPA has promulgated several regulations under this authority. The EPA regulation that is relevant to the radioactive waste and materials management activities addressed by this SWEIS is the "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes" (40 CFR Part 191). This regulation establishes radiation standards for the management and storage of spent nuclear fuel, high-level radioactive waste, and transuranic waste at facilities regulated by NRC or Agreement States, as well as radiation standards for management and storage of spent nuclear fuel, high-level radioactive waste, and transuranic waste at disposal facilities operated by DOE that are not regulated by NRC or Agreement States. The regulation also establishes limitations on radiation doses that might occur after closure of the disposal system. These standards include both individual protection requirements and groundwater protection standards.

The Price-Anderson Act – signed into law in 1957 as an amendment to the Atomic Energy Act of 1954—provides for payment of public liability claims in the event of a nuclear incident. The following are key features of this Act:

- Assures the availability of billions of dollars to compensate members of the public who suffer a loss as the result of a nuclear incident;
- Establishes a simplified claim process for the public to expedite recovery for losses;
- Provides for immediate emergency reimbursement for costs associated with any evacuation that may be ordered;
- Establishes liability limits for each nuclear incident involving commercial nuclear energy and government use of nuclear materials; and
- Guarantees that the Federal Government will review the need for compensation beyond that provided (NEI 2005).

The Bob Stump National Defense Authorization Act, enacted by the Congress in 2002, amended the Atomic Energy Act to add Section 234C requiring DOE to promulgate worker health and safety regulations to cover contractors with Price-Anderson indemnification agreements in their contracts. DOE promulgated regulations under this Act in February 2006 (71 FR 6857) as 10 CFR Part 851, "Worker Safety and Health Program." The regulations codified and enhanced the DOE worker protection program.

Bald and Golden Eagle Protection Act of 1973, as amended (16 U.S.C. 668 *et seq.*)—The Bald and Golden Eagle Protection Act, as amended, makes it unlawful to take, pursue, molest, or disturb bald (American) and golden eagles, their nests, or their eggs anywhere in the United States. A permit must be obtained from the U.S. Department of the Interior to relocate a nest that interferes with resource development or recovery operations.

Clean Air Act of 1970, as amended (42 U.S.C. 7401 *et seq*.)—The Clean Air Act is intended to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population." Section 118 of the Clean Air Act (42 U.S.C. 7418) requires that each Federal agency with jurisdiction over any property or facility engaged in any activity that might result in the discharge of air pollutants comply with "all Federal, state, interstate, and local requirements" regarding the control and abatement of air pollution.

Section 109 of the Clean Air Act (42 U.S.C. 7409 *et seq*.) directs EPA to set national ambient air quality standards for criteria pollutants. EPA has identified and set national ambient air quality standards under 40 CFR Part 50 for the following criteria pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. Section 111 of the Clean Air Act (42 U.S.C. 7411) requires establishment of national standards of performance for new or modified stationary sources of atmospheric pollutants. Section 160 of the Clean Air Act (42 U.S.C. 7470 *et seq*.) requires that specific emission increases be evaluated prior to permit approval to prevent significant deterioration of air quality. Section 112 of the Clean Air Act (42 U.S.C. 7412) requires specific standards for releases of hazardous air pollutants (including radionuclides).

Emissions of air pollutants are regulated by EPA under 40 CFR Parts 50 through 99. Emissions of radionuclides and hazardous air pollutants from DOE facilities are regulated under the

National Emissions Standards for Hazardous Air Pollutants Program (40 CFR Part 61 and 40 CFR Part 63**,** respectively).

Clean Water Act of 1972, as amended (33 U.S.C. 1251 *et seq*.)—The Clean Water Act, which amended the Federal Water Pollution Control Act, was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Clean Water Act prohibits the "discharge of toxic pollutants in toxic amounts" to navigable waters of the United States. Section 313 of the Clean Water Act requires all branches of the Federal Government engaged in any activity that might result in a discharge of runoff of pollutants to surface waters to comply with Federal, state, interstate, and local requirements.

Section 404 of the Clean Water Act gives the U.S. Army Corps of Engineers permitting authority over activities that discharge dredge or fill materials into waters of the United States, including wetlands.

The Clean Water Act also provides guidelines and limitations for effluent discharges from point-source discharges and establishes the National Pollutant Discharge Elimination System (NPDES) permit program. The NPDES program is administered by EPA, pursuant to regulations in 40 CFR Part 122 *et seq.*, and authority may be delegated to states. Sections 401 through 405 of the Water Quality Act of 1987 added Section 402(p) to the Clean Water Act, which requires EPA to establish regulations for permits for stormwater discharges associated with industrial activities, including construction activities disturbing 5 or more acres (2 hectares) (64 *Federal Register* [FR] 68721). After March 2003, the threshold for obtaining a permit was lowered to 1 acre (0.4 hectare). Stormwater provisions of the NPDES program are set forth at 40 CFR 122.26. Permit modifications are required if discharge effluent is altered. The State of New Mexico is now seeking authorization for the NPDES program so that it will have authority to administer the program instead of EPA. Currently, New Mexico is not authorized, and EPA Region 6 administers all LANL NPDES issues and permits. The State is expecting to be authorized by the end of 2006.

Many water-related permits for LANL have been issued or are awaiting approval (see **Table 6–2**). The EPA and DOE entered into a Federal Facility Compliance Agreement (Agreement) pursuant to the Clean Water Act (EPA 2005a). The purpose of the Agreement is to establish a compliance program for the regulation of stormwater discharges from Solid Waste Management Units and Areas of Concern at LANL until those sources are regulated by an individual stormwater permit issued by EPA pursuant to the NPDES. The purpose of the compliance program is to provide a schedule to ensure compliance with the NPDES stormwater-permitting program. The scope of this Agreement is limited to providing a compliance program for the regulation of stormwater discharges from solid waste management units (SWMUs) and Areas of Concern at LANL in lieu of LANL's Stormwater Multi-Sector General Permit (EPA 2005a).

The discharge of stormwater at LANL is regulated by NPDES Stormwater Multi-Sector General Permit Numbers NMR05A734 (University of California) and NMR05A735 (DOE) (the "General Permit"), which became effective on December 23, 2000, pursuant to 65 FR 64746 (October 30, 2000). The point source discharges of stormwater regulated by the General Permit include LANL's SWMUs (EPA 2005a).

Table 6–2 Federal Permits

Category	*Approved Activity*	*Issue Date*	*Expiration Date*
Clean Water Act/NPDES - Permit Number NM0028355	Discharge of industrial and sanitary liquid effluents. (This is a single permit covering many of LANL's industrial and sanitary discharges. The permit covers 17 total outfalls.)	August 1, 2007	July 31, 2012
Clean Water Act/NPDES Multi-Sector General Permit Number NMR05A734 (University of California) and NMR05A735 (DOE)	Multi-Sector General Permit-Stormwater discharges from industrial activities.	October 30, 2000	October 30, 2005 (Permit has been administratively continued pending issuance of a new permit, expected in 2007.)
Clean Water Act/NPDES	General Permit for Stormwater discharges from construction activities	Varies. A new General Construction Permit will be needed after 2008.	July 1, 2008
Clean Water Act Sections 404/401	Individual Dredge and Fill permits for work within perennial, intermittent, or ephemeral watercourses.	Varies	Varies
Toxic Substances Control Act Disposal Authorization	Disposal of polychlorinated biphenyls at Technical Area 54, Area G	June 25, 1996	June 25, 2001 (Permit has been administratively continued.)

NPDES = National Pollutant Discharge Elimination System.
Sources: EPA 2005a, LANL 2006h.

Since 2003, the General Permit has been in transition. Stormwater discharges from LANL SWMUs ultimately will be regulated under an individual NPDES permit specific to the SWMUs. LANL submitted the first part of the individual permit application in late 2004. When granted, this individual permit will replace existing SWMU coverage under the General Permit (see Table 6–2).

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 U.S.C. 9601 *et seq*.) (also known as Superfund)—CERCLA provides among other things: (1) a program for emergency response to and reporting of a release or threat of a release of a hazardous substance to the environment; and (2) a statutory framework for remediation of hazardous substance releases from private, state, and Federal sites. Using the Hazard Ranking System, contaminated sites are ranked and may be included on the National Priorities List. Section 120 of CERCLA specifies requirements for investigations, remediation, and natural resource restoration, as necessary, at Federal facilities, and also provides reporting requirements for hazardous substance contamination on properties to be transferred. LANL is not on the National Priorities List. Potential release sites at LANL are investigated and remediated under state authorities (see Section 6.4 for further discussion).

Department of Commerce, Justice, and State, the Judiciary, and Related Agencies Appropriations Act, 1998 (Public Law 105-119)—Section 632 of the Act directed the Secretary of Energy to identify and convey to the Incorporated County of Los Alamos, New Mexico, or to the designee of Los Alamos County, and to transfer to the Secretary of the Interior in trust for the Pueblo of San Ildefonso, parcels of land under the jurisdictional administrative control of the Secretary at or in the vicinity of LANL that meet certain identified criteria. DOE prepared the *Final Environmental Impact Statement for the Conveyance and*

Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico (DOE 1999d) to examine potential environmental impacts associated with conveyance and transfer of identified land parcels. A Record of Decision for this action was issued in December 1999. Remedial actions (required in some parcels) and conveyances and transfers are ongoing.

Emergency Planning and Community Right-to-Know Act (42 U.S.C. 11001 *et seq*.)—This amendment to CERCLA requires that facilities provide notice to and coordinate emergency planning with communities and government agencies concerning inventories and any unplanned releases of specific hazardous chemicals. EPA implements this Act under regulations found in 40 CFR Parts 355, 370, and 372. Under Subtitle A of this Act, Federal facilities are required to provide information to and coordinate with local and state emergency response planning authorities, to ensure that emergency plans are sufficient to respond to unplanned releases of hazardous substances. Implementation of the provisions of this Act at LANL began voluntarily in 1987, and chemical inventories and emissions have been reported annually since 1988.

Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq.*)—This Act is intended to prevent the further decline of endangered and threatened species and to restore these species and their habitats. Section 7 of the Act requires Federal agencies that have reason to believe that a prospective action may affect an endangered or threatened species or its habitat to consult with the U.S. Fish and Wildlife Service of the U.S. Department of the Interior or the National Marine Fisheries Service of the U.S. Department of Commerce to ensure the action does not jeopardize the species or destroy its habitat. If, despite reasonable and prudent measures to avoid or minimize such impacts, the species or its habitat would be jeopardized by the action, a review process is specified to determine whether the action may proceed as an incidental taking (50 CFR Part 17).

Federal Facility Compliance Act of 1992 (42 U.S.C. 6961 *et seq*.)—The Federal Facility Compliance Act, enacted on October 6, 1992, amended the Resource Conservation and Recovery Act (RCRA). The Act made Federal facilities subject to potential fines and penalties for violations of RCRA, the law that sets requirements for management of hazardous waste. Prior to its passage, mixed waste stored at DOE sites generally did not comply with RCRA mixed waste land-disposal restrictions because of a lack of treatment options. The Act required DOE to: (1) prepare and submit a national inventory report identifying its mixed waste volume, characteristics, treatment capacity, and available technologies; and (2) prepare and submit (to the appropriate state or EPA regulators) Site Treatment Plans for developing or using the needed treatment capacity along with schedules for treating the mixed waste at each DOE site.

LANL's approved Site Treatment Plan is enforced by a Compliance Order issued by the New Mexico Environment Department in October 1995. It is available for review at the DOE Headquarters reading room, the DOE Center for Environmental Management Information, and the LANL reading room (see Section 6.4 for further discussion).

Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq*.)—The Fish and Wildlife Coordination Act promotes effective planning and cooperation between Federal, state, public, and private agencies for the conservation and rehabilitation of the Nation's fish and wildlife and authorizes the U.S. Department of the Interior to provide assistance. This Act requires consultation with the U.S. Fish and Wildlife Service on the possible effects to wildlife from construction, projects, or activities affecting bodies of water in excess of 10 acres (approximately 4 hectares) in surface area. This Act also requires consultation with the head of the state agency that administers wildlife resources in the affected state.

Hazardous Materials Transportation Act of 1975, as amended (49 U.S.C. 5101 *et seq*.)—The Hazardous Materials Transportation Act of 1975, as amended, requires the U.S. Department of Transportation to prescribe uniform national regulations for transportation of hazardous materials (including radioactive materials). Most state and local regulations regarding such transportation that are not substantively the same as the U.S. Department of Transportation regulations are preempted (49 U.S.C. 5125). This, in effect, allows state and local governments to enforce only the Federal regulations, not to change or expand upon them.

This program is administered by the Research and Special Programs Administration of the U.S. Department of Transportation, which, when covering the same activities, coordinates its regulations with NRC (under the Atomic Energy Act) and EPA (under RCRA). The U.S. Department of Transportation regulations, which may be found under 49 CFR Parts 171 through 178 and 49 CFR Parts 383 through 397, contain requirements for identifying a material as hazardous or radioactive. These regulations interface with the NRC regulations for identifying material, but U.S. Department of Transportation hazardous material regulations govern the hazard communication (such as marking, labeling, vehicle placarding, and emergency response information) and shipping requirements. Requirements for transport by rail, air, and public highway are included. In addition, EPA regulations at 40 CFR Part 262 apply to offsite transportation of hazardous wastes from LANL.

Public access to many portions of the LANL facility is controlled at all times through the use of gates and guards. Onsite transportation of hazardous materials, wastes, and contaminated equipment that is conducted entirely on DOE property is subject to applicable DOE directives and safety requirements set forth in 10 CFR Part 830 Subpart B. Offsite transportation of hazardous materials, wastes, and contaminated equipment from LANL over public highways is subject to applicable U.S. Department of Transportation and EPA regulations, as well as to applicable DOE directives.

The NRC Packaging and Transportation of Radioactive Material (10 CFR Part 71) regulations include detailed packaging design requirements and package certification testing requirements. Complete documentation of design and safety analysis and the results of required certification tests are submitted to NRC to certify the package for use. This certification testing involves the following components: heat, physical drop onto an unyielding surface, water submersion, puncture by dropping the package onto a steel bar, and gas tightness.

Low-Level Radioactive Waste Policy Act of 1980, as amended (42 U.S.C. 2021 *et seq.*)—This Act amended the Atomic Energy Act to specify that the Federal Government is responsible for disposal of low-level radioactive waste generated by certain activities, and that each state is responsible for disposal of other low-level radioactive waste generated within its borders. It provides for and encourages interstate compacts to carry out state responsibilities. As a result of this Act, low-level radioactive waste owned or generated by DOE remains the responsibility of the Federal Government.

Manhattan Project National Historical Park Study Act (Public Law 108-340)—This Act was written to direct the Secretary of the Interior to conduct a study on the preservation and interpretation of the historic sites of the Manhattan Project for potential inclusion in the National Park System (October 18, 1998).

Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703 *et seq*.)—The Migratory Bird Treaty Act, as amended, is intended to protect birds that follow common migration patterns across the United States, Canada, Mexico, Japan, and Russia. It regulates the harvest of migratory birds by specifying conditions such as mode of harvest, hunting seasons, and bag limits. The Act stipulates that it is unlawful, unless permitted by regulations, to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, …any migratory bird…or any part, nest, or egg of any such bird." Although no permit for this project is required under the Act, DOE is required to consult with the U.S. Fish and Wildlife Service regarding impacts on migratory birds and to avoid or minimize these effects in accordance with the U.S. Fish and Wildlife Service Mitigation Policy. A split of authority currently exists between Federal courts regarding whether this Act applies to Federal agencies.

National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq*.)—The purposes of NEPA of 1969, as amended, are to: (1) declare a national policy that will encourage productive and enjoyable harmony between man and his environment, (2) promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man, (3) enrich the understanding of the ecological systems and natural resources important to the Nation, and (4) establish a Council on Environmental Quality (CEQ). NEPA establishes a national policy requiring that Federal agencies consider the environmental impacts of major Federal actions significantly affecting the quality of the human environment before making decisions and taking actions to implement those decisions. Implementation of NEPA requirements in accordance with CEQ regulations (40 CFR Parts 1500 to 1508) can result in a categorical exclusion, an environmental assessment and Finding of No Significant Impact, or an environmental impact statement. This SWEIS was prepared in accordance with NEPA requirements, CEQ regulations (40 CFR Part 1500 *et seq.*), and DOE provisions for implementing the procedural requirements of NEPA (10 CFR Part 1021; DOE Order 451.1B, Change 1). It discusses reasonable alternatives and their potential environmental consequences.

National Historic Preservation Act of 1966, as amended (16 U.S.C. 470 *et seq*.)—The Act provides that sites with significant national historic value be placed on the National Register of Historic Places, which is maintained by the Secretary of the Interior. The major provisions of the Act for DOE consideration are Sections 106 and 110. Both sections aim to ensure that historic properties are appropriately considered in planning Federal initiatives and actions. Section 106 is a specific, issue-related mandate to which Federal agencies must adhere. It is a reactive mechanism driven by a Federal action. Section 110, in contrast, sets out broad Federal agency responsibilities with respect to historic properties. It is a proactive mechanism that emphasizes ongoing management of historic preservation sites and activities at Federal facilities. No permits or certifications are required under the Act.

Section 106 requires the head of any Federal agency with direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking to ensure compliance with the provisions of the Act. It compels Federal agencies to "take into account" the effect of their projects on historical and archaeological resources and to give the Advisory Council on Historic Preservation the opportunity to comment on such effects. Section 106 mandates consultation during Federal actions if the undertaking has the potential to affect a historic property. This consultation normally involves State or Tribal Historic Preservation Officers, or both, and may include other organizations and individuals such as local governments and American Indian Tribes. If an adverse effect is found, the consultation often ends with the execution of a memorandum of agreement that states how the adverse effect will be resolved.

The regulations implementing Section 106, found in 36 CFR Part 800, were revised on December 12, 2000, to modify the process by which Federal agencies consider the effects of their undertakings on historic properties and provide the Advisory Council on Historic Preservation with a reasonable opportunity to comment on such undertakings, as required by Section 106 of the Act. In promulgating the new regulations, the Council sought to better balance the interests and concerns of various users of the Section 106 process, including Federal agencies, State Historic Preservation Officers, Tribal Historic Preservation Officers, American Indians and Native Hawaiians, industry, and the public.

Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 *et seq*.)— This Act establishes a means for Native Americans to request the return or repatriation of human remains and other cultural items presently held by Federal agencies or federally assisted museums or institutions. The Act also contains provisions regarding the intentional excavation and removal of, inadvertent discovery of, and illegal trafficking in Native American human remains and cultural items. Major actions under this law include: (1) establishing a review committee with monitoring and policymaking responsibilities; (2) developing regulations for repatriation, including procedures for identifying lineal descent or cultural affiliation needed for claims; (3) providing oversight of museum programs designed to meet the inventory requirements and deadlines of this law; and (4) developing procedures to handle unexpected discoveries of graves or grave goods during activities on Federal or Tribal lands. All Federal agencies that manage land or are responsible for archaeological collections obtained from their lands or generated by their activities must comply with the Act. DOE managers of ground-disturbing activities on Federal and Tribal lands are to be aware of the statutory provisions treating inadvertent discoveries of Native American remains and cultural objects. Regulations implementing the Act are found at 43 CFR Part 10.

Noise Control Act of 1972, as amended (42 U.S.C. 4901 *et seq*.)—Section 4 of the Noise Control Act of 1972, as amended, directs all Federal agencies to carry out "to the fullest extent within their authority" programs within their jurisdictions that further the national policy of promoting an environment free from noise that jeopardizes health and welfare. Federal, state, and local agencies enforce the standards and requirements of this Act to regulate noise at facilities such as LANL. DOE must comply with the Act for any of the activities being considered under this SWEIS.

Occupational Safety and Health Act of 1970 (29 U.S.C. 651 *et seq*.)—Section 4(b)(1) of the Occupational Safety and Health Act exempts DOE and its contractors from the occupational safety requirements of the Occupational Safety and Health Administration. However, 29 U.S.C. 668 requires Federal agencies to establish their own occupational safety and health programs for their places of employment, consistent with Occupational Safety and Health Administration standards. DOE Order 440.1A, "Worker Protection Management for DOE Federal and Contractor Employees," states that DOE will implement a written worker protection program that: (1) provides a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to their employees, and (2) integrates all requirements contained in paragraphs 4a to 4l of DOE Order 440.1A; 29 CFR Part 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters;" and other related site-specific worker protection activities.

Pollution Prevention Act of 1990 (42 U.S.C. 13101 *et seq*.)—The Pollution Prevention Act establishes a national policy for waste management and pollution control. Source reduction is given first preference, followed by environmentally safe recycling, with disposal or releases to the environment as a last resort. In response to the policies established by the Pollution Prevention Act, DOE committed to participation in the Superfund Amendments and Reauthorization Act, Section 313, EPA 33/50 Pollution Prevention Program. The goal for facilities involved in compliance with Section 313 was to achieve a 33-percent reduction (from a 1993 baseline) in the release of 17 priority chemicals by 1997. On November 12, 1999, then-U.S. Secretary of Energy Bill Richardson established 14 pollution prevention and energy efficiency goals for DOE to build environmental accountability and stewardship into DOE's decisionmaking process. Under these goals, DOE will strive to minimize waste and maximize energy efficiency as measured by continuous cost-effective improvements in the use of materials and energy, using the years 2005 and 2010 as interim measurement points.

Safe Drinking Water Act of 1974, as amended (42 U.S.C. 300(f) *et seq*.)—The primary objective of the Safe Drinking Water Act is to protect the quality of public drinking water supplies and sources. The implementing regulations, administered by EPA unless delegated to the states, establish standards applicable to public water systems. These regulations include maximum contaminant levels (including those for radioactivity) in public water systems, which are defined as water systems with at least 15 service connections that are used by year-round residents or regularly serve at least 25 year-round residents. EPA regulations implementing the Safe Drinking Water Act are found in 40 CFR Parts 141 through 149. For radioactive material, the regulations specify that the average annual concentration of beta particles and photon energy from manmade radionuclides in drinking water, as delivered to the user by such a system, shall not produce a dose equivalent to the total body or an internal organ greater than 4 millirem per year. They further specify a concentration limit for gross alpha particle activity (excluding radon and uranium) of 15 picocuries per liter and for uranium of 0.03 milligrams per liter (40 CFR 141.66). Other programs established by the Safe Drinking Water Act include the Sole Source Aquifer Program, the Wellhead Protection Program, and the Underground Injection Control Program.

Solid Waste Disposal Act of 1965, as amended by the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6901 *et seq.*)—The Solid Waste Disposal Act of 1965, as amended, governs the transportation, treatment, storage, and disposal of hazardous waste and nonhazardous waste (that is, municipal solid waste). Under the RCRA of 1976, which amended the Solid Waste Disposal Act of 1965, EPA defines and identifies hazardous waste; establishes standards for its transportation, treatment, storage, and disposal; and requires permits for persons engaged in hazardous waste activities. Section 3006 of RCRA (42 U.S.C. 6926) allows states to establish and administer these permit programs with EPA approval.

The EPA regulations implementing RCRA are found in 40 CFR Parts 260 through 283. The New Mexico Environment Department is authorized to administer the RCRA program in New Mexico and issued LANL's RCRA operating permit (see Section 6.4). Regulations imposed on a generator or on a treatment, storage, or disposal facility vary according to the type and quantity of hazardous waste generated, treated, stored, or disposed of and the methods of treatment, storage, and disposal.

Toxic Substances Control Act of 1976 (15 U.S.C. 2601 *et seq*.)—TSCA provides EPA with the authority to require testing of chemical substances entering the environment and to regulate them as necessary. The law complements and expands existing toxic substance laws, such as Section 112 of the Clean Air Act and Section 307 of the Clean Water Act. The Act requires compliance with the inventory reporting and chemical control provisions of the legislation to protect the public from risks of exposure to chemicals.

The Act also imposes strict limitations on the use and disposal of polychlorinated biphenyls, chlorofluorocarbons, asbestos, dioxins, certain metal-working fluids, and hexavalent chromium. EPA issued the disposal authorization documents to LANL for management of its polychlorinated biphenyls waste disposal facility at Technical Area 54.

Waste Isolation Pilot Plant Land Withdrawal Act (Public Law 102-579) and the Waste Isolation Pilot Plant Land Withdrawal Act Amendments (Public Law 104-201)—The Waste Isolation Pilot Plant Land Withdrawal Act withdrew land from the public domain for the purpose of creating and operating the Waste Isolation Pilot Plant (WIPP), the geologic repository in New Mexico designated as the national disposal site for defense transuranic waste. The Act also defined the characteristics and amount of waste that will be disposed of at the facility. Amendments to the Act exempt waste to be disposed of at WIPP from the RCRA land disposal restrictions. Prior to sending any transuranic waste from LANL to WIPP, DOE would have to determine whether the waste meets all statutory and regulatory requirements for disposal at WIPP.

6.2 Executive Orders

This section identifies environment-, health-, and safety-related Executive Orders applicable to LANL operations. Activities under all alternatives would need to be conducted in compliance with applicable Executive Orders. Chapter 4 describes the resources at LANL that are addressed by Executive Orders, and Chapter 5 discusses the potential impacts to those resources under each alternative. Consultations with applicable agencies and federally recognized Native American Nations as required by these Executive Orders are discussed in Section 6.5.

Executive Order 11514, *Protection and Enhancement of Environmental Quality* (March 5, 1970)—This Executive Order requires Federal agencies to continually monitor and control their activities to: (1) protect and enhance the quality of the environment, and (2) develop procedures to ensure the fullest practicable provision of timely public information and understanding of the Federal plans and programs that may have potential environmental impact so that views of interested parties can be obtained. DOE has issued regulations (10 CFR Part 1021) and DOE Order 451.1B to comply with this Executive Order.

Executive Order 11593, *National Historic Preservation* (May 13, 1971)—This Order directs Federal agencies to locate, inventory, and nominate properties under their jurisdiction or control to the National Register of Historic Places if they qualify. This process requires DOE to provide the Advisory Council on Historic Preservation an opportunity to comment on the possible impacts of proposed activities on any potentially eligible or listed resources.

Executive Order 11990, *Protection of Wetlands* (May 24, 1977)—This Order (implemented by DOE in 10 CFR Part 1022) requires Federal agencies to avoid any short- or long-term adverse impacts on wetlands wherever there is a practicable alternative. Each agency must also provide opportunities for early public review of any plans or proposals for new construction in wetlands.

Executive Order 11988, *Floodplain Management* (May 24, 1977)—This Order (implemented by DOE in 10 CFR Part 1022) requires Federal agencies to establish procedures to ensure that the potential effects of flood hazards and floodplain management are considered for any action undertaken in a floodplain, and that floodplain impacts are avoided to the extent practicable.

Executive Order 12088, *Federal Compliance with Pollution Control Standards*, (October 13, 1978) as amended by Executive Order 12580, *Superfund Implementation* (January 23, 1987)—This Order directs Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act, the Noise Control Act, the Clean Water Act, the Safe Drinking Water Act, TSCA, and RCRA.

Executive Order 12148, *Federal Emergency Management* (July 20, 1979), as amended by the Homeland Security Act of 2002 (Public Law 107-296) and Section 301 of Title 3 U.S.C.—This Order transfers functions and responsibilities associated with Federal emergency management to the Director of the Federal Emergency Management Agency. The Order assigns the Director the responsibility to establish Federal policies for, and to coordinate all civil defense and civil emergency planning, management, mitigation, and assistance functions of, Executive branch agencies. The amendment replaces the name, Federal Emergency Management Agency, wherever it appears with the name, Department of Homeland Security.

Executive Order 12656, *Assignment of Emergency Preparedness Responsibilities* (November 18, 1988)—This Order assigns emergency preparedness responsibilities to Federal departments and agencies.

Executive Order 12699, *Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction* (January 5, 1990)—This Order requires Federal agencies to reduce risks to occupants of buildings owned, leased, or purchased by the Federal Government, or buildings constructed with Federal assistance, and to persons who would be affected by failures of Federal buildings in earthquakes; to improve the capability of existing Federal buildings to function during or after an earthquake; and to reduce earthquake losses of public buildings, all in a cost-effective manner. Each Federal agency responsible for the design and construction of a Federal building shall ensure that the building is designed and constructed in accordance with appropriate seismic design and construction standards.

Executive Order 12856, *Right-to-Know Laws and Pollution Prevention Requirements* (August 3, 1993)—Executive Order 12856 directs Federal agencies to reduce and report toxic chemicals entering any waste stream; improve emergency planning, response, and accident notification; and meet the requirements of the Emergency Planning and Community Right-to-Know Act.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (February 11, 1994)—This Order requires each Federal agency to identify and address the disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

The CEQ, which oversees the Federal Government's compliance with Executive Order 12898 and NEPA, has developed guidelines to assist Federal agencies in incorporating the goals of Executive Order 12898 into the NEPA process. This guidance, published in 1997, is intended to "…assist Federal agencies with their NEPA procedures so that environmental justice concerns are effectively identified and addressed." As part of this process, DOE conducted an analysis to determine whether implementing any of the proposed alternatives would result in disproportionately high or adverse impacts on minority and low-income populations. The results of this analysis are discussed in the environmental justice sections of Chapter 4 of this SWEIS for each of the alternatives under consideration.

Executive Order 12902, *Energy Efficiency and Water Conservation at Federal Facilities* (March 8, 1994)—This Order requires Federal agencies to develop and implement a program to conserve energy and water resources. As part of this program, agencies are required to conduct comprehensive facility audits of their energy and water use.

Executive Order 12938, *Proliferation of Weapons of Mass Destruction* (November 14, 1994)—This Order states that the proliferation of nuclear, biological, and chemical weapons ("weapons of mass destruction") and the means of delivering such weapons constitute an unusual and extraordinary threat to the national security, foreign policy, and economy of the United States, and that a national emergency would be declared to deal with that threat.

Executive Order 13007, *Indian Sacred Sites* (May 24, 1996)—This Order directs Federal agencies, to the extent practicable, as permitted by law, and not clearly inconsistent with essential agency functions, to: (1) accommodate access to and ceremonial use of American Indian sacred sites by their religious practitioners, and (2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies are to maintain the confidentiality of sacred sites.

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (April 21, 1997), as amended by Executive Order 13229 (October 9, 2001)—This Order requires each Federal agency to give high priority to identifying and assessing environmental health risks and safety risks that may disproportionately affect children and to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

Executive Order 13101, *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition* (September 14, 1998)—This Order requires each Federal agency to incorporate waste prevention and recycling in its daily operations and to work to increase and expand markets for recovered materials. This Order states that it is national policy to prefer pollution prevention, whenever feasible. Pollution that cannot be prevented should be recycled; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner. Disposal should be employed only as a last resort.

Executive Order 13112, *Invasive Species* (February 3, 1999)—This Order requires Federal agencies to prevent the introduction of invasive species, to provide for their control, and to minimize their economic, ecological, and human health impacts.

Executive Order 13123, *Greening the Government through Efficient Energy Management* (June 8, 1999)—This Order sets goals for agencies to expand their use of renewable energy sources and to reduce greenhouse gas emissions from facility energy use, energy consumption per gross square foot of facilities, energy consumption per gross square foot or unit of production, use of petroleum within facilities, overall energy use, and water consumption and associated energy requirements.

Executive Order 13148, *Greening the Government through Leadership in Environmental Management* (April 21, 2000)—This Order requires agencies to integrate environmental accountability into day-to-day decisionmaking and long-term planning processes. The Order sets goals for implementing environmental management systems and audits, reporting pollution releases to the public, preventing pollution or reducing it at the source, and reducing toxic releases and transfers of toxic chemicals, use of toxic chemicals and hazardous substances, and generation of hazardous and radioactive waste types. It also sets goals for phasing out the use of Class I ozone-depleting substances and promoting environmentally sound landscaping practices.

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments* (November 6, 2000)—This Order supplements the Executive Memorandum (dated April 29, 1994) entitled, "Government-to-Government Relations with Tribal Governments," and states that each Executive branch department and agency shall consult, to the greatest extent practicable and to the extent permitted by law, with Tribal Governments prior to taking actions that affect federally recognized Tribal Governments. This Order also states that each Executive branch department and agency shall assess the impact of Federal Government plans, projects, programs, and activities on Tribal trust resources and assure that Tribal Government rights and concerns are considered during the development of such plans, projects, programs, and activities.

Executive Order 13287, *Preserve America* (March 3, 2003)—The goals of the initiative addressed by this Order include a greater shared knowledge about the Nation's past, strengthened regional identities and local pride, increased local participation in preserving cultural and natural heritage assets, and support for the economic vitality of our communities. The Order establishes Federal policy to provide leadership in preserving America's heritage by actively advancing the protection, enhancement, and contemporary use of the historic properties owned by the Federal Government and by promoting intergovernmental cooperation and partnerships for the preservation and use of historic properties.

6.3 Applicable DOE Orders

The Atomic Energy Act authorizes DOE to establish standards to protect health and minimize the dangers to life or property from activities under DOE's jurisdiction. Through a series of DOE Orders and regulations, an extensive system of standards and requirements has been established to ensure safe operation of DOE facilities. A number of DOE Orders have been issued in support of environmental, safety, and health programs. Many of these were revised and reorganized to reduce duplication and eliminate obsolete provisions. The new DOE Directives System is organized by series, with each Order identified by three digits, and is intended to include all DOE Orders, policies, manuals, requirement documents, notices, and guides. Existing DOE Orders (identified by four digits) are expected to be revised and converted to the new DOE numbering system. The major DOE Orders pertaining to the alternatives in this SWEIS are listed in **Table 6–3**.

DOE Order 151.1C, *Comprehensive Emergency Management System* (November 2, 2005)— This Order establishes policy to assign and describe roles and responsibilities for the DOE Emergency Management System. The Emergency Management System provides the framework for development, coordination, control, and direction of all emergency planning, preparedness, readiness assurance, response, and recovery actions. The Emergency Management System applies to DOE and to NNSA.

DOE Order 231.1A, *Environment, Safety, and Health Reporting* (August 19, 2003; Change 1, June 3, 2004)—This Order establishes responsibilities and requirements to ensure timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that DOE and NNSA are kept fully informed on a timely basis about events that could adversely affect the health and safety of the public, the workers, or the environment; the intended purpose of DOE facilities; or the credibility of DOE.

Table 6–3 Applicable DOE Orders and Directives (as of December 8, 2006)

DOE Order/Number	Subject (date)
Leadership/Management/Planning	
O 151.1C	Comprehensive Emergency Management System (11/02/05)
Information and Analysis	
O 231.1A	Environment, Safety, and Health Reporting (08/19/03; Change 1, 06/03/04)
Work Process	
O 413.3A	Program and Project Management for the Acquisition of Capital Assets (07/28/06)
O 414.1C	Quality Assurance (06/17/05)
O 420.1B	Facility Safety (12/22/05)
O 425.1C	Startup and Restart of Nuclear Facilities (03/13/03)
O 430.1B	Real Property Assessment Management (09/24/03)
O 433.1	Maintenance Management Program for DOE Nuclear Facilities (06/01/01)
O 435.1	Radioactive Waste Management (07/09/99; Change 1, 08/28/01)
O 440.1B	Worker Protection Management for DOE Federal and Contractor Employees (05/17/07)
O 450.1	Environmental Protection Program (01/15/03; Change 2, 12/07/05; Admin. Change 1, 01/03/07)
O 451.1B	National Environmental Policy Act Compliance Program, (10/26/00; Change 1, 09/28/01)
O 460.1B	Packaging and Transportation Safety (04/04/03)
O 460.2A	Departmental Materials Transportation and Packaging Management (12/22/04)
O 461.1A	Packaging and Transfer or Transportation of Materials of National Security Interest (04/26/04)
O 470.2B	Independent Oversight and Performance Assurance Program (10/31/02)
O 470.4	Safeguards and Security Program (08/26/05)
External Relationships	
O 1230.2	American Indian Tribal Government Policy (04/08/92) – as revised by DOE Notice 144.1 (10/20/06)
Environmental Quality and Impact	
O 5400.5	Radiation Protection of the Public and the Environment (02/08/90; Change 2, 01/07/93)
O 5480.19	Conduct of Operations Requirements for DOE Facilities (07/09/90; Change 1, 05/18/92; Change 2, 10/23/01)
O 5480.20A	Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities (11/15/94; Change 1, 07/12/01)
Emergency Preparedness	
O 5530.3	Radiological Assistance Program (01/14/92; Change 1, 04/10/92)
O 5530.5	Federal Radiological Monitoring and Assessment Center (07/10/92; Change 1, 12/02/92)
Office of National Nuclear Security Administration	
O 5660.1B	Management of Nuclear Materials (05/26/94)

DOE Order 413.3A, *Program and Project Management for the Acquisition of Capital Assets* (July 28, 2006)—This Order provides DOE, including NNSA, project management direction for the acquisition of capital assets that are delivered on schedule, within budget, and fully capable of meeting mission performance and environmental, safety, and health standards.

DOE Order 414.1C, *Quality Assurance* (June 17, 2005)—The objectives of this Order are to ensure that DOE, including NNSA, products and services meet or exceed customers' expectations and to achieve quality assurance for all work based upon the following principles:

- That quality is assured and maintained through a single, integrated, effective quality assurance program (management system);
- That management support for planning, organization, resources, direction, and control is essential to quality assurance;
- That performance and quality improvement require thorough, rigorous assessment and corrective action;
- That workers are responsible for achieving and maintaining quality; and
- That environmental, safety, and health risks and impacts associated with work processes can be minimized while maximizing reliability and performance of work products.

DOE Order 420.1B *Facility Safety* (December 22, 2005)—This Order establishes facility safety requirements related to nuclear safety design, criticality safety, fire protection, and mitigation of hazards related to natural phenomena.

DOE Order 425.1C, *Startup and Restart of Nuclear Facilities* (March 13, 2003)—This Order establishes DOE requirements for startup of new nuclear facilities and restart of existing nuclear facilities that have been shut down. The requirements specify a readiness review process that must demonstrate that it is safe to start (or restart) the subject facility. The facility must be started (or restarted) only after documented independent reviews of readiness have been conducted and the approvals specified in the Order have been received.

DOE Order 430.1B, *Real Property Asset Management* (September 24, 2003)—This Order establishes a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. This Order also identifies requirements and establishes reporting mechanisms and responsibilities for real property asset management. Planning for disposition must be initiated when real property assets are identified as no longer required for current or future programs. Disposition includes stabilizing, preparing for reuse, deactivating, decommissioning, decontaminating, dismantling, demolishing, and disposing of real property assets.

DOE Order 433.1, *Maintenance Management Program for DOE Nuclear Facilities* (June 1, 2001)—This Order defines the program for the management of cost-effective maintenance of DOE nuclear facilities. Guidance for compliance with this Order is contained in

DOE Guide 433.1-1, "Nuclear Facility Maintenance Management Program Guide for Use with DOE Order 433.1," which references Federal regulations, DOE directives, and industry best practices using a graded approach to clarify requirements and guidance for maintaining DOE-owned government property.

DOE Order 435.1, *Radioactive Waste Management* (July 9, 1999)—This Order and its associated manual and guidance establish responsibilities and requirements for the management of DOE high-level radioactive waste, transuranic waste, low-level radioactive waste, and the radioactive component of mixed waste. These documents provide detailed radioactive waste management requirements, including waste incidental to reprocessing determinations; waste characterization, certification, and treatment, storage, and disposal; and radioactive waste facility design and closure.

DOE Order 440.1B, *Worker Protection Management for DOE Federal and Contractor Employees* (May 17, 2007)—This Order establishes the framework for an effective worker protection program that reduces or prevents injuries, illnesses, and accidental losses by providing safe and healthful DOE Federal and contractor workplaces.

DOE Order 450.1, *Environmental Protection Program* (January 15, 2003; Change 2, December 7, 2005; Admin. Change 1, January 3, 2007)—Under DOE Order 450.1, it is DOE policy to conduct its operations in a manner that ensures the protection of public health, safety, and the environment through compliance with applicable Federal and state laws, regulations, Orders, and other requirements. The objective of this Order is to implement sound stewardship practices that protect the air, water, land, and other natural and cultural resources impacted by DOE operations. This objective is to be accomplished by implementing environmental management systems at DOE sites. An environmental management system is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals.

DOE Order 451.1B, *National Environmental Policy Act Compliance Program* (October 26, 2000; Change 1, September 28, 2001; DOE Notice 451.1, October 10, 2006)— The purpose of this Order is to establish DOE internal requirements and responsibilities for implementing NEPA, the CEQ Regulations Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500 to 1508), and the DOE NEPA Implementing Procedures (10 CFR Part 1021). The goal is to ensure efficient and effective implementation of DOE NEPA responsibilities through teamwork. A key responsibility for all participants is to control the cost and time for the NEPA process while maintaining its quality.

DOE Order 460.1B, *Packaging and Transportation Safety* (April 14, 2003)—This Order sets forth DOE policy and assigns responsibilities for proper packaging and transporting of DOE offsite shipments and onsite transfers of hazardous materials and for modal transport.

DOE Order 460.2A, *Departmental Materials Transportation and Packaging Management* (December 22, 2004)—This Order requires DOE operations to comply with all applicable international, Federal, state, local, and Tribal laws, rules, and regulations governing materials transportation that are consistent with Federal regulations, unless exemptions or alternatives are approved. This Order also states that it is DOE policy that shipments will comply with the

U.S. Department of Transportation 49 CFR 100 through 185 requirements, except those that infringe on maintenance of classified information.

DOE Order 461.1A, *Packaging and Transfer or Transportation of Materials of National Security Interest* (April 26, 2004)—This Order establishes requirements and responsibilities for offsite shipments of naval nuclear fuel elements, Security Category I and II special nuclear material, nuclear explosives, nuclear components, special assemblies, and other materials of national security interest; onsite transfers of naval nuclear fuel elements, Security Category I and II special nuclear material, nuclear components, special assemblies and other materials of national security interest; and certification of packages for Security Category I and II special nuclear material, nuclear components, and other materials of national security interest.

DOE Order 470.2B, *Independent Oversight and Performance Assurance Program* (October 31, 2002)—This Order establishes the Independent Oversight Program to enhance DOE safeguards and security; cyber security; emergency management; and environment, safety, and health programs by providing DOE, contractor managers, the Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and the effectiveness of line management performance in these and other critical functions as directed by the Secretary.

DOE Order 470.4, *Safeguards and Security Program* (August 26, 2005)—This Order establishes the roles and responsibilities for the DOE Safeguards and Security Program, which consists of six key elements: (1) program planning and management, (2) physical protection, (3) protective force, (4) information security, (5) personnel security, and (6) nuclear material control and accountability. Specific requirements for each of the key elements are contained in their respective programmatic manuals. The requirements identified in these manuals are based on national policy promulgated in laws, regulations, and Executive Orders to prevent unacceptable adverse impacts on national security, the health and safety of DOE and contractor employees, the public, and the environment.

DOE Order 1230.2, *American Indian Tribal Government Policy* (April 8, 1992) as revised by DOE Notice 144.1 (October 20, 2006)—This Order establishes responsibilities and transmits the DOE American Indian and Alaska Native Policy. The policy outlines the principles to be followed by DOE in its interactions with federally recognized American Indian Tribes. It is based on Federal policy treaties, Federal law, and DOE's responsibilities as a Federal agency to ensure that Tribal rights and interests are identified and considered pertinent during decisionmaking.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (February 8, 1990; Change 2, January 7, 1993)—This Order establishes standards and requirements for DOE operations to protect members of the public and the environment against undue risk from radiation. It is DOE policy to implement legally applicable radiation protection standards and to consider and adopt, as appropriate, recommendations by authoritative organizations; for example, the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection. It is also DOE policy to adopt and implement standards generally consistent with those of NRC for DOE facilities and activities that are not subject to NRC licensing authority.

DOE Order 5480.19, ***Conduct of Operations Requirements for DOE Facilities*** **(July 9, 1990; Change 1, May 18, 1992; Change 2, October 23, 2001)—**This Order provides requirements and guidelines for Departmental Elements including NNSA, to use in developing directives, plans, or procedures relating to the conduct of operations at DOE facilities.

DOE Order 5480.20A, ***Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities*** **(November 15, 1994; Change 1, July 12, 2001)**—This Order establishes the selection, qualification, and training requirements for DOE contractor personnel involved in the operation, maintenance, and technical support of DOE nuclear reactors and nonreactor nuclear facilities. DOE objectives under this Order are to ensure the development and implementation of contractor-administered training programs that provide consistent and effective training for personnel at DOE nuclear facilities. The Order contains minimum requirements that must be included in training and qualification programs.

DOE Order 5530.3, ***Radiological Assistance Program*** **(January 14, 1992; Change 1, April 10, 1992)—**This Order establishes DOE policy, procedures, authorities, and responsibilities for its Radiological Assistance Program. Through this program, DOE provides assistance to state, local, and Tribal jurisdictions in preparing for a radiological emergency. The Order requires DOE to establish response plans, maintain resources, and assist Federal, state, local, and Tribal governments in the event of a real or potential emergency.

DOE Order 5530.5, ***Federal Radiological Monitoring and Assessment Center*** **(July 10, 1992; Change 1, December 2, 1992)—**This Order establishes DOE policy, procedures, authorities, and requirements for the establishment of a Federal Radiological Monitoring and Assessment Center, as set forth in the Federal Radiological Emergency Response Plan (50 FR 46542).

DOE Order 5660.1B, ***Management of Nuclear Materials*** **(May 26, 1994)—**This Order establishes requirements and procedures for the management of nuclear materials within the DOE.

6.4 Applicable State of New Mexico and Local Statutes, Regulations, and Agreements

Certain environmental requirements have been delegated to state authorities for implementation and enforcement. It is DOE policy to conduct its operations in an environmentally safe manner that complies with all applicable statutes, regulations, and standards, including state laws and regulations. A list of applicable State of New Mexico and local statutes, regulations, agreements, and Orders are provided in **Table 6–4**.

Since the last SWEIS was published, the State of New Mexico has entered into a Compliance Order on Consent (Consent Order) with DOE and the University of California pursuant to Section 74-4-10 of the Hazardous Waste Act and 74-9-36(D) of the Solid Waste Act. The Consent Order requires DOE and the University of California (or its successor) to conduct a site-wide investigation and cleanup of contamination at LANL in accordance with the procedures and schedules set forth in the Consent Order. The Consent Order sets forth requirements to investigate and remediate a large number of potential release sites and areas of concern, including, but not limited to, several former material disposal areas.

Table 6–4 State and Local Requirements

Activity	*Citation*	*Requirements*
Endangered Plant Species	New Mexico Administrative Code (NMAC), Title 19, Chapter 21, Endangered Plants (revised November 30, 2006).	Establishes plant species list and rules for collection.
Environmental Oversight and Monitoring Agreement	Agreement in Principle Between DOE and the State of New Mexico, November 2000.	Provides DOE support for state activities in environmental oversight, monitoring, access, and emergency response.
Federal Facility Compliance Order	October 1995 (issued to both DOE and LANL).	Order used by the New Mexico Environment Department to enforce the Federal Facility Compliance Act. It requires compliance with the approved LANL Site Treatment Plan, which documents the development and use of treatment capacities and technologies, as well as use of offsite facilities for treating mixed radioactive waste stored at LANL.
Los Alamos County Noise Restrictions	Los Alamos County Code, Chapter 8.28.	Imposes noise restrictions and makes provisions for exceedances.
Environmental Improvement Act	New Mexico Statutes Annotated (NMSA) 1978, Sections 74-1-1 through 74-1-15; NMAC, 20.5.1 through 20.5.17, August 15, 2003. The New Mexico Environment Department recently changed their regulations for storage tanks, combining the regulations for aboveground and underground storage tanks into the Petroleum Storage Tank regulations. Petroleum Storage Tank regulations found in 20.5.1 NMAC through 20.5.17 NMAC; filed for publication in the *New Mexico Register* on July 16, 2003; effective August 15, 2003.	Aboveground tank regulations were modified to include requirements for the registration, installation, modification, repair, and closure or removal of aboveground storage tanks, as well as release detection, record-keeping, and financial responsibility in the State of New Mexico.
New Mexico Air Quality Control Act	NMSA, Chapter 74, "Environmental Improvement," Article 2, "Air Pollution" (revised 10/31/02), and implementing regulations at NMAC Title 20, "Environmental Protection," Chapter 2, "Air Quality" (revised October 31, 2002).	Establishes air quality standards and requires a permit prior to construction or modification of an air contaminant source. Also requires an operating permit for major producers of air pollutants and imposes emission standards for hazardous air pollutants.
New Mexico Cultural Properties Act	NMSA, Chapter 18, "Libraries and Museums," Article 6, "Cultural Properties."	Establishes the State Historic Preservation Office and requirements to prepare an archaeological and historic survey and consult with the State Historic Preservation Office.
New Mexico Groundwater Protection Act	NMSA, Chapter 74, Article 6B, "Groundwater Protection."	Establishes state standards for protection of groundwater from leaking underground storage tanks.
New Mexico Hazardous Chemicals Information Act	NMSA, Chapter 74, Article 4E-1, "Hazardous Chemicals Information."	Implements the hazardous chemical information and toxic release reporting requirements of the Emergency Planning and Community Right-to-Know Act of 1986 (SARA Title III) for covered facilities.

Activity	*Citation*	*Requirements*
New Mexico Hazardous Waste Act	NMSA, Chapter 74, Article 4, "Hazardous Waste," and implementing regulations found in NMAC Title 20, "Environmental Protection," Chapter 4, "Hazardous Waste" (revised June 14, 2000).	Establishes permit requirements for construction, operation, modification, and closure of a hazardous waste management facility and establishes state standards for cleanup of releases from leaking underground storage tanks.
New Mexico Endangered Plant Species Act	NMSA, Chapter 75, Miscellaneous Natural Resource Matters, Article 6, "Endangered Plants."	Requires coordination with the State.
New Mexico Night Sky Protection Act	NMSA, Chapter 74, Article 12 "Night Sky Protection:" 74-12-1 to 74-12-10) (House Bill 39/A, March 1, 1999).	Regulates outdoor night lighting fixtures to preserve and enhance the State's dark sky while promoting safety, conserving energy, and preserving the environment for astronomy.
New Mexico Radiation Protection Act	NMSA, Chapter 74, Article 3, "Radiation Control" and implementing regulations found in NMAC Title 20 Chapter 3, "Radiation Protection" (revised April 15, 2004) "Environmental Protection."	Establishes state requirements for worker protection.
New Mexico Raptor Protection Act	NMSA, Chapter 17, Article 2-14.	Makes it unlawful to take, attempt to take, possess, trap, ensnare, injure, maim, or destroy any of the species of hawks, owls, and vultures.
New Mexico Solid Waste Act	NMSA, Chapter 74, Article 9, Solid Waste Act, and implementing regulations found in NMAC Title 20, "Environmental Protection," Chapter 9, Solid Waste (revised November 27, 2001).	Requires permit prior to construction or modification of a solid waste disposal facility.
New Mexico Water Quality Act	NMSA, Chapter 74, Article 6, "Water Quality," and implementing regulations found in NMAC, Title 20, "Environmental Protection," Chapter 6, "Water Quality" (revised February 16, 2006).	Establishes water quality standards and requires a permit prior to the construction or modification of a water discharge source.
New Mexico Wildlife Conservation Act	NMSA, Chapter 17, Game and Fish, Article 2, Hunting and Fishing Regulations, Part 3, Wildlife Conservation Act.	Requires a permit and coordination if a project may disturb habitat or otherwise affect threatened or endangered species.
Compliance Order on Consent	March 1, 2005 (entered into by the State of New Mexico, DOE, and the University of California) (NMED 2005).	Requires site investigations of known or potentially contaminated sites at LANL and cleanup in accordance with a specified process and schedule.
Pueblo Accords	DOE 2006 Restatement of Accords with each of four Pueblos (Pueblos of Cochiti, Jemez, Santa Clara, and San Ildefonso).	Set forth the specifications for maintaining a government-to-government relationship between DOE and each of the four Pueblos closest to LANL.
Threatened and Endangered Species of New Mexico	NMAC Title 19, "Natural Resources and Wildlife," Chapter 33, "Threatened and Endangered Species," 19.33.6.8 (revised December 29, 2006).	Establishes the list of threatened and endangered species.

Table 6–5 lists the state permits that have been issued to LANL. Certain open burning permits that were previously included on this table were withdrawn from the regulatory authority (LANL 2006c).

Table 6–5 State Environmental Permits

Category/Approved Activity	***Permit***	***Date Issued***	***Expiration Date***
Air Permits			
Facilities with emissions greater than 100 tons per year of nitrogen oxide, volatile organic compound, and carbon monoxides (NMAC Operating Permit)	Operating Permit Number P100 M1	June 15, 2006	April 30, 2009
Beryllium Machining at TA-3-141	Construction Permit Number 634-M2	October 30, 1998	None
Beryllium Machining at TA-35-213	Construction Permit Number 632	December 26, 1985	None
Beryllium Machining at TA-55-4	Construction Permit Number 1081-M1-R6	July 1, 1994 (revised May 12, 2006)	None
TA-3 Power Plant	Construction Permit Number 2195-B-M1	July 30, 2004	None
TA-33 Generator	Construction Permit Number 2195-F	October 10, 2002	None
Asphalt Plant	Construction Permit Number GCP-3-2195G	October 29, 2002	None
Data Disintegrator	Construction Permit Number 2195-H	October 22, 2003	None
Chemistry and Metallurgy Research Replacement Facility, Radiological Laboratory, Office Building, and Utility Building	Construction Permit Number 2195-N	September 16, 2005	None
Hazardous Waste Permits			
Hazardous Waste Facility Permit and Mixed-Waste Storage and Treatment Permit	Permit Number NM0890010515	November 1989	November 1999 (Permit has been administratively continued)
TA-50 Part B Permit Renewal Application Revision 3.0	Permit Number NM0890010515	August 2002	None
General Part B Permit Renewal Application, Revision 2.0	Permit Number NM0890010515	August 2003	None
TA-54 Part B Permit Renewal Application, Revision 3.0	Permit Number NM0890010515	June 2003	None
TA-16 Part B Permit Renewal Application, Revision 4.0	Permit Number NM0890010515	June 2003	None
TA-55 Part B Permit Application, Revision 2.0	Permit Number NM0890010515	September 2003	None
General Part A Permit Application, Revision 4.0	Permit Number NM0890010515	December 2004	None
RCRA Corrective Activities	Permit Number NM0890010515	March 1990	December 1999 (Permit has been administratively continued)
Groundwater Discharge Permits			
Groundwater Discharge Plan, TA-46 Sanitary Wastewater Systems Plant	Not applicable	January 7, 1998	January 7, 2003 (Permit has been administratively continued)
Groundwater Discharge Plan, TA-50, Radioactive Liquid Waste Treatment Facility	Not applicable	Submitted August 20, 1996, approval pending	None

NMAC = New Mexico Administrative Code, TA = technical area, RCRA = Resource Conservation and Recovery Act.
Source: LANL 2006h.

6.5 Consultations

6.5.1 Consultation Requirements

Certain laws, such as the Endangered Species Act, the U.S. Fish and Wildlife Coordination Act, and the National Historic Preservation Act, require DOE to consult and coordinate with other governmental entities including other Federal agencies, state and local agencies, and federally recognized Native American Governments. In addition, the DOE American Indian and Alaska Native Tribal Government Policy requires DOE to consult with any Native American or Alaska Native Tribal Government regarding any property to which the Tribe attaches religious or cultural importance that might be affected by a DOE action. The following sections describe consultations and other interactions that took place during the preparation of this SWEIS.

6.5.1.1 Ecological Resources

Biotic resource consultations generally pertain to the potential for activities to disturb sensitive species or habitats. Under the terms of the LANL *Threatened and Endangered Species Habitat Management Plan* (LANL 2000b), NNSA submitted a *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species* (LANL 2006b) to the U.S. Fish and Wildlife Service on February 22, 2006. The U.S. Fish and Wildlife Service response to NNSA's consultation request is presented in Section 6.5.2.

6.5.1.2 Cultural Resources

Cultural resource consultations relate to the potential for disruption of important cultural resources and archaeological sites. As required by NEPA and Section 106 of the National Historic Preservation Act, DOE consults with the Advisory Council on Historic Preservation, the appropriate State Historic Preservation Officers, and Tribal Historic Preservation Officers. Under the terms of the *Programmatic Agreement for Management of Historic Properties at Los Alamos National Laboratory* (DOE 2006b), a copy of the Draft SWEIS was submitted to the State Historic Preservation Officer. The response to NNSA's request for consultation with the New Mexico State Historic Preservation Officer is presented in Section 6.5.2.

6.5.1.3 Tribal Consultations

Native American consultations are concerned with the potential for impacts on any rights and interests, including disturbance of Native American ancestral sites, sacred sites, and traditional and religious practices, or natural resources of importance to Native Americans. DOE is committed to meeting its responsibilities in maintaining its government-to-government relationships with federally recognized Native American Tribes. **Table 6–6** lists Executive Memoranda and DOE direction regarding government-to-government relations with Native American Tribal Governments.

Table 6–6 Government-to-Government Relationships with Tribal Governments

Date	*Title*
January 20, 2006	Memorandum for the Head of Departmental Elements from Secretary Samuel W. Bodman. DOE reaffirms government-to-government relationships with Tribal Governments (references American Indian and Alaska Natives Tribal Government Policy).
September 23, 2004	Memorandum for the Heads of Executive Departments and Agencies Government-to-Government Relationship with Tribal Governments (references Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, and Executive Order 13336, entitled "American Indian and Alaska Native Education"). This complements and partially supersedes the similar executive memorandum of April 29, 1994.
August 21, 2001	Secretary Abraham reaffirms DOE's Government-to-Government Relations with Native American Tribal Governments (references American Indian and Alaska Natives Tribal Government Policy).
April 29, 1994	Memorandum for the Heads of Executive Departments and Agencies, Government-to-Government Relations with Native American Tribal Governments.

DOE undertook an extensive effort to consult with Native American Tribal Governments during preparation of the 1999 *Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE/EIS-0238). DOE has initiated consultations with the appropriate Native American Tribal Governments, as required by Executive Memoranda and DOE Order 1230.2, "American Indian Tribal Government Policy," as revised by DOE Notice 144.1. NNSA continued its consultations with the pueblos during the preparation of this SWEIS.

As part of its Government-to-Government interactions, restatements of four Pueblo Accords were signed by the Governor of each pueblo (Cochiti, San Ildefonso, Jemez, and Santa Clara) and the Secretary of Energy in 2005 and 2006. Twice yearly, executive meetings are held among the Los Alamos Site Office Manager, the LANL Director, and the respective Accord Pueblo Governors. In addition, the Los Alamos Site Office Manager meets monthly with each governor of the two pueblos closest to LANL (San Ildefonso and Santa Clara) and with the other Accord Pueblo Governors on a less frequent basis. In both the executive meetings and the private meetings, the Los Alamos Site Office Manager discussed the SWEIS and the importance of the pueblos participating in the SWEIS preparation process.

The NNSA NEPA Document Manager requested the involvement of pueblo representatives during the SWEIS preparation period. In the spring of 2004 the Document Manager notified the Four Accord Pueblos of NNSA's intention to prepare a Supplement Analysis of the *1999 SWEIS* to determine whether a new or supplemental SWEIS should be prepared, and attended meetings at the four Accord Pueblos to brief Pueblo representatives on how the Supplement Analysis would be prepared.

When NNSA made the decision in late 2004, to prepare a supplement to the *1999 SWEIS*, the NNSA NEPA Document Manager sent notification letters inviting each of the Four Accord Pueblos to become Cooperating Agencies. Two pueblos (San Ildefonso and Santa Clara) responded that they wished to be involved. While neither signed formal agreements, over the next year both pueblos continued to participate in internal working meetings during preparation of the Draft SWEIS including review of sections and chapters of the document.

On January 5, 2005, NNSA issued a *Federal Register* Notice of Intent to prepare a *Supplemental Environmental Impact Statement to the Final Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (Supplemental SWEIS)* (70 FR 807). In the Notice of Intent, NNSA invited public comment on the *Supplemental SWEIS* proposal and listed the issues initially identified by NNSA for evaluation in the *Supplemental SWEIS*. The four Accord Pueblos were also invited to comment on the scope of the proposed action. A public scoping meeting was held in Pojoaque, New Mexico, on January 19, 2005. The public scoping period ended February 17, 2005.

A post-scoping internal working meeting was held on March 8, 2005, to discuss the scoping comments and proposed project reviews. The Four Accord Pueblos were invited to send representatives and two of the Accord Pueblos participated in the meeting.

The Draft SWEIS was issued to the public and LANL stakeholders, including approximately 23 American Indian Tribes who had expressed interest in LANL, on July 7, 2006, followed by a public comment period extending through September 20, 2006. During the review period, the Santa Clara Pueblo hosted a meeting to which the Eight Northern Pueblos and the two Accord Pueblos that are not members of the Eight Northern Pueblos (the Pueblo of Cochiti and the Pueblo of Jemez) were invited. The purpose of this meeting was for the Los Alamos Site Office Manager, the NNSA Document Manager, and LANL staff to discuss the Draft SWEIS. Several pueblos submitted comments on the Draft LANL SWEIS that were considered in completing the final document.

6.5.2 Consultation Letters

Consultation letters associated with this SWEIS are attached at the end of this section and include correspondence from the New Mexico Department of Cultural Affairs and the U.S. Fish and Wildlife Service. Letters from the latter organization are in response to the request for Section 7 consultation under the Endangered Species Act made by NNSA upon its transmittal of a biological assessment for continued operation of LANL (LANL 2006b).

Consultation Letters

STATE OF NEW MEXICO
DEPARTMENT OF CULTURAL AFFAIRS
HISTORIC PRESERVATION DIVISION

BATAAN MEMORIAL BUILDING
407 GALISTEO STREET, SUITE 236
SANTA FE, NEW MEXICO 87501
PHONE (505) 827-6320 FAX (505) 827-6338

BILL RICHARDSON
Governor

November 17, 2006

John Isaacson, Ph.D.
SWEIS and C&T Project leader
Environmental Division M887
Los Alamos National Laboratory
Los Alamos, NM 87544

Re: Draft SWEIS for Continued Operation of LANL, Los Alamos; HPD Log 78716.

Dear Dr. Isaacson:

Thank you for sending our office a copy of the June 2006 *Draft Site-Wide Environmental Impact Statement* [SWEIS] *for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico.* We look forward to receiving the Final document.

Currently, our Section 106 reviews follow the terms of the Programmatic Agreement (LA-UR-06-1975) between the U.S. Department of Energy, the National Nuclear Security Administration, the Los Alamos Site Office, the New Mexico State Historic Preservation Officer and the Advisory Council on Historic Preservation. This agreement and the management plan for cultural heritage at Los Alamos National Laboratory dated February 2006 guide the management for the historic properties of Los Alamos National Laboratory and our consultation process.

Thank you again, and we look forward to receiving the Final SWEIS.

Sincerely,

Katherine A. Slick
State Historic Preservation Officer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

March 20, 2006

Cons. # 22420-2006-I-0066

Ms. Elizabeth R. Withers
ESA Program Manager
National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

Dear Ms. Withers:

Thank you for your February 22, 2006, Biological Assessment (BA) of the Continued Operation of Los Alamos National Laboratory (LANL) on Federally Listed Threatened and Endangered Species. LANL reviewed eighteen projects that had not received U.S. Fish and Wildlife Service (Service) consultation or concurrence, as well as the two aspects of ongoing operations, ecological risk from legacy contaminants and the Outfall Reduction Project were determined to have the potential to affect Federally Listed species. Your letter requesting consultation for the proposed projects and their effects on the threatened Mexican spotted owl (owl) (*Strix occidentalis lucida*) and the threatened bald eagle (*Haliaeetus leucocephalus*) and the endangered southwestern willow flycatcher (flycatcher) (*Empidonax trailii extimus*) was received by the Service on February 22, 2006. You determined that proposed projects listed on Tables 1 and 2 "may affect, is not likely to adversely affect" the bald eagle, the flycatcher, and the owl, and requested concurrence.

LANL produced a Threatened and Endangered Species Habitat Management Plan (HMP) (LANL 1999). The HMP is a comprehensive plan that balances current LANL operations and future development with habitat of listed species. The HMP facilitates Department of Energy compliance with the Endangered Species Act of 1973, as amended (Act). The HMP defines site plans and monitoring plans for species that may occur on LANL. The owl, bald eagle, and flycatcher habitat is labeled areas of environmental interest (AEIs). As such, the HMP provides a list of activities named reasonable and prudent alternatives (RPAs), which, if they are conducted, will not adversely affect these species. The projects listed below adhere to the activities identified in the HMP. Our concurrences are listed for the owl, bald eagle, and flycatcher (Tables 1 and 2).

Ms. Elizabeth R. Withers 2

Table 1. LANL project determinations and concurrences for the bald eagle and flycatcher.

Project	Bald Eagle determination	Concurrence rationale:	Flycatcher determination	Concurrence rationale:
Ecological risk from legacy contaminants	May affect, not likely to adversely affect	1) RPAs will be applied. 2) LANL may consider a new bald eagle risk assessment.	May affect, not likely to adversely affect	1) LANL will continue to monitor/survey potential breeding sites, and evaluate areas that could develop into suitable habitat. 2) Available evidence indicates LANL does not contribute excess adverse risk to the flycatcher from environmental contaminants. 3) RPAs will be applied.
Science complex	May affect, not likely to adversely affect	1) The proposed project site is not near the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
TA-3 Replacement Office Buildings	May affect, not likely to adversely affect	1) The proposed project site is more than 4.6 miles from the bald eagle AEI. 2) Bald eagle foraging		

Ms. Elizabeth R. Withers 3

Project	Bald Eagle determination	Concurrence rationale:	Flycatcher determination	Concurrence rationale:
		habitat RPAs will be applied.		
Nuclear Materials Safeguards and Security Upgrade	May affect, not likely to adversely affect	1) The proposed project site is 6.6 miles from the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
Security-Driven Transportation Modification	May affect, not likely to adversely affect	1) The proposed project site is more than 5.5 miles from the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied		
Security-Driven Transportation Modifications Options	May affect, not likely to adversely affect	1) The proposed project site is more than 5.9 miles from the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
TA-48 Radiological Science Institute	May affect, not likely to adversely affect	1) The proposed project site is more than 4 miles from the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
Radioactive	May affect, not	1) The		

Ms. Elizabeth R. Withers 4

Project	Bald Eagle determination	Concurrence rationale:	Flycatcher determination	Concurrence rationale:
Liquid Waste Treatment Facility Replacement	likely to adversely affect	proposed project site is not near the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
TA-72 Warehouse and Truck Inspection Station	May affect, not likely to adversely affect	1) The proposed project site is more than 4.3 miles from the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
Disposition of the Flood Retention Structure and Steel Diversion Wall in Pajarito Canyon			May affect, not likely to adversely affect	1) The flycatcher AEI is 0.75 miles (downstream) from the proposed project site. 2) An RPA will ensure implementation of storm water protection plan measures to mitigate downstream impacts. 3) The proposed actions will not remove flycatcher foraging habitat.
Decontamination, Decommissioning,			May affect, not likely to	1) The proposed

Ms. Elizabeth R. Withers 5

Project	**Bald Eagle determination**	**Concurrence rationale:**	**Flycatcher determination**	**Concurrence rationale:**
and Demolition of TA-18			adversely affect	project is 890 feet from flycatcher AEI. 2) The proposed action will not remove any flycatcher foraging habitat. 3) An RPA will ensure that erosion does not occur into wetlands downstream.
Remediation of MDAs G, H, and L at TA-54			May affect, not likely to adversely affect	1) No suitable foraging or nesting habitat will be lost or compromised due to the proposed action. 2) Predicted noise levels are not likely to exceed 6 decibels above background in flycatcher AEI. 3) Surveys will be conducted and if a flycatcher is found, work will cease and the Service will be contacted and consultation reinitiated if

Ms. Elizabeth R. Withers

Project	Bald Eagle determination	Concurrence rationale:	Flycatcher determination	Concurrence rationale:
				needed. 4) RPAs will be followed.
DynEX Assembly Chamber	May affect, not likely to adversely affect	1) The proposed project site is not near the bald eagle AEI. 2) Bald eagle foraging habitat RPAs will be applied.		
Remediation of MDA D at TA-33	May affect, not likely to adversely affect	1) The proposed project site is in core and buffer habitat but it is already developed. 2) No roost trees will be disturbed. 3) Back-up indicators on trucks will be muted within safety standards. 3) Reseeding and erosion protection will follow where needed. 4) Bald eagle foraging habitat RPAs will be applied		

Table 2. LANL project determinations and concurrences for the owl.

Project	Owl determination	Concurrence rationale:

Ms. Elizabeth R. Withers 7

Project	**Owl determination**	**Concurrence rationale:**
Ecological risk from legacy contaminants	May affect, not likely to adversely affect	RPAs will be applied.
Science complex	May affect, not likely to adversely affect	1) No suitable nesting habitat would be removed. 2) Owls have not been detected in Los Alamos Canyon. 3) Consultation will be reinitiated if owls are found.
TA-3 Replacement Office Buildings	May affect, not likely to adversely affect	1) RPAs will be applied. 2) The project would remove approximately 11 acres of buffer habitat. 3) Owls have not been detected in Los Alamos Canyon
Nuclear Materials Safeguards and Security Upgrade	May affect, not likely to adversely affect	1) RPAs plus additions and qualifications identified in the BA for this project would be implemented. 2) The project would remove approximately7 acres of buffer habitat. 3) Owls were detected in Mortandad Canyon (2004 and 2005). 4) No core habitat would be developed.
TA-48 Radiological Science Institute	May affect, not likely to adversely affect	1) RPAs will be applied. 2) Most of the new construction would not be in owl habitat.
Characterization and Remediation of MDA C	May affect, not likely to adversely affect	1) Proposed project would not remove suitable roosting or nesting habitat.
Radioactive Liquid Waste Treatment Facility Replacement	May affect, not likely to adversely affect	1) Approximately 75 percent of the project area has been disturbed

Ms. Elizabeth R. Withers 8

Project	Owl determination	Concurrence rationale:
		by other construction. 2) RPAs will be applied. 3) Noise levels should attenuate below limits set in the HMP. 4) Project activities would take place within or adjacent to developed areas.
Disposition of the Flood Retention Structure and Steel Diversion Wall in Pajarito Canyon	May affect, not likely to adversely affect	RPAs will be applied. 2) Owls have not been detected within the proposed project area. 3) No trees greater than 8 inches diameter at breast height would be removed. 4) Owl core habitat is protected from disturbance by the mesa that separates Pajarito and Three-Mile canyons.
Decontamination, Decommissioning, and Demolition of TA-18	May affect, not likely to adversely affect	1) Noise disturbance would be temporary and short duration. 2) All disturbed soils would be reseeded with native seeds. 3) No trees greater than 8 inches diameter at breast height would be removed. 4) Back-up indicators on all trucks and heavy equipment would be muted consistent with the safety of human workers.
Remediation of MDAs A, T, and U at TA-21	May affect, not likely to adversely affect	1) RPAs from the BA (Appendix B) would be implemented. 2) No suitable foraging or

Ms. Elizabeth R. Withers 9

Project	Owl determination	Concurrence rationale:
		nesting habitat will be lost; 3) The proposed project area is already highly disturbed. 4) Owls have not been detected in Los Alamos Canyon. 5) If owls are detected the Service would be contacted and reinitiation would be needed.
Decontamination, Decommissioning, and Demolition of TA-21	May affect, not likely to adversely affect	1) RPAs from the BA (Appendix B) would be implemented. 2) No suitable foraging or nesting habitat will be lost. 3) The proposed project area is already highly disturbed. 4) Owls have not been detected in Los Alamos Canyon. 5) If owls are detected the Service would be contacted and reinitiation would be needed.
DynEX Assembly Chamber	May affect, not likely to adversely affect	1) No suitable roosting or nesting habitat will be lost. 2) Owl surveys in Canon de Valle would continue. 3) Approximately 2 acres would be developed. 4) RPAs from the BA (Appendix B) would be implemented. 5) If owls are detected within 0.25 mile of the construction site, activities would be suspended until September 1.

Ms. Elizabeth R. Withers 10

Project	Owl determination	Concurrence rationale:
Remediation of MDAs N and Z at TA-15	May affect, not likely to adversely affect	1) The proposed project would not remove nesting or roosting habitat. 2) Owl surveys would continue. 3) Approximately 2 acres of owl habitat would be disturbed. 4) RPAs from the BA (Appendix B) would be implemented. 5) If owls are detected within 0.25 mile of the construction site, activities would be suspended until September 1.

Cumulative effects were not analyzed by the Service for this letter of concurrence because under section 7 of the Act, those effects are future State and private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation. This definition applies only to section 7 analyses and should not be confused with the broader use of this term in the National Environmental Policy Act or other environmental laws. Cumulative effects under section 7 will be analyzed in a subsequent biological opinion for the Outfall Reduction Project, the Security-Driven Transportation Modifications Project, and the Security-Driven Transportation Modifications Options Project.

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. In the appendix, we enclose conservation recommendations for the bald eagle, the flycatcher, and other migratory birds.

This concludes the informal consultation for the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species. Please contact the Service if: (1) new information reveals effects of the agency action that may affect the species to an extent not considered in this consultation; (2) the agency action is subsequently modified in a manner that causes an effect to the species that was not considered by the proposed action, (3) owls or bald eagles or flycatchers are detected within any project area, and (4) a new species is listed or critical habitat designated that may be affected by the proposed project.

Ms. Elizabeth R. Withers 11

We appreciate the thorough analyses provided in the letter and the EA and your efforts to protect endangered and threatened species. In future communications regarding this consultation please refer to consultation #22420-2006-I-0066. If we can be of further assistance, please contact Santiago R. Gonzales or Nancy Baczek of my staff at (505) 761-4755 or (505) 761-4711, respectively.

Sincerely,

Brian Hanson

Russ Holder
Acting Field Supervisor

Enclosure
cc:
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico

Ms. Elizabeth R. Withers 12

Appendix A.

Species Specific Conservation Recommendations for BA of Continued Operation of Los Alamos National Laboratories

Flycatcher

- Cease project activity during May, the time period in which flycatchers most frequently migrate through LANL.
- Develop a habitat management plan to eradicate and control non-native invasive riparian/wetland vegetation. (Tamarisk sp., Russian Olive, and Siberian Elm)
- Enhance native riparian/wetland vegetation following drought and project impacts.
- A new state-wide assessment is recommended for the flycatcher and contaminants, considering that contaminant data, safe limits, and other modeling parameters have changed considerably. (RE: p.170 of BA)

Bald Eagle

- Develop an avian protection plan for power lines and towers. (RE: p. 171of BA)
- Because contaminant data reflective of the terrestrial portion (mostly carrion) of resident bald eagles diets have changed considerably since the last modeling assessment, and safe limits and other modeling parameters have changed considerably, consideration should be made for a new risk assessment on the bald eagle.

Migratory Birds

- Use "bird-glass" in new buildings and replacement of old glass.
- Use window blinds to shut out lab/office-light from night environment.
- Habitat disruption/removal should only take place during migratory bird non-nesting season, or following negative surveys.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

June 20, 2006

Cons. # 22420-2006-I-0091

Ms. Elizabeth R. Withers
ESA Program Manager
National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

Dear Ms. Withers:

Thank you for your February 22, 2006, biological assessment (BA) of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species – Outfall Reduction Project. The Los Alamos National Laboratory (LANL) proposes to eliminate seven industrial effluent outfalls. Your letter requesting consultation for the proposed project and its effects for the threatened Mexican spotted owl (owl) (*Strix occidentalis lucida*) was received by the U.S. Fish and Wildlife Service (Service) on February 22, 2006. The LANL has determined that proposed project "may affect, is likely to adversely affect" the owl.

You concluded that the Outfall Reduction Project may adversely affect the abundance and diversity of prey species along approximately 400 feet of perennial and intermittent stream by eliminating outfall discharges. It is our understanding that your determination is centered upon potential indirect impacts (eliminating outfalls may impact prey species habitat). We appreciate that you are taking a conservative approach for this project in your determination of "may affect likely to adversely affect" the owl. Nevertheless, we respectfully disagree with your conclusion for the following reasons: 1) the proposed elimination of an outfall is located within restricted habitat and will not directly affect owl; 2) nesting has not been documented in Mortandad-Sandia Canyon; 3) a perennial stream is present in the action area; 4) the closure of outfall 03A027 is not likely to have a substantial negative impact on the Sandia wetland; 5) outfall 03A130 contributes to a wetland that has no perennial streams or other outfalls; 6) reasonable and prudent alternatives would be implemented to reduce or avoid potential impacts; 7) effects from the proposed project are not expected to be adverse in the Canon de Valle Area of Environmental Interest (AEI); and 8) although 1.36 acres of wetland and 400 feet of perennial stream would be impacted in Mortandad-Sandia Canyon, we do not anticipate the owl or its prey will be adversely affected. For these reasons we conclude that, as described, the effects to the owl from the elimination of outfalls in Mortandad-Sandia Canyon will be insignificant and discountable, and will not result in adverse effects to the owl.

This concludes the informal consultation for the Outfall Reduction Project. Please contact the Service if: (1) new information reveals effects of the agency action that may affect the species to

Ms. Elizabeth R. Withers 2

an extent not considered in this consultation; (2) the agency action is subsequently modified in a manner that causes an effect to the species that was not considered by the proposed action, and (3) a new species is listed or critical habitat designated that may be affected by the proposed project.

We appreciate the thorough analyses provided in the letter and the BA and your efforts to protect endangered and threatened species. In future communications regarding this consultation please refer to consultation #22420-2006-I-0091. If we can be of further assistance, please contact Santiago R. Gonzales of my staff at (505) 761-4755.

Sincerely,

for Wally Murphy
Acting Field Supervisor

cc:
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

June 20, 2006

Cons. # 22420-2006-I-0092

Ms. Elizabeth R. Withers
ESA Program Manager
National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

Dear Ms. Withers:

Thank you for your February 22, 2006, biological assessment (BA) of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species – Security-Driven Transportation Modifications Project. The Los Alamos National Laboratory (LANL) proposes to upgrade and enhance security in the Pajarito Corridor West area. Construction of parking lots, pedestrian walkways, roads, and bridges associated with the proposed project would result in some temporary noise levels near new roads from construction equipment and activities and permanent increases in noise levels from vehicular and pedestrian traffic. There would be permanent light sources associated with the parking lots, walkways and roads. Your letter requesting consultation for the proposed project and its effects for the threatened Mexican spotted owl (owl) (*Strix occidentalis lucida*) was received by the U.S. Fish and Wildlife Service (Service) on February 22, 2006.

You concluded that the Security-Driven Transportation Modifications Project may adversely affect the owl foraging and nesting habitat. It is our understanding that your determination is centered upon potential indirect impacts (removal of approximately 20 acres of undeveloped habitat). We appreciate that you are taking a conservative approach for this project in your determination of "may affect likely to adversely affect" the owl. Nevertheless, we respectfully disagree with your conclusion for the following reasons: 1) the parking lot in TA-48 would be approximately 11 acres and would not be located in listed species habitat; 2) the parking lot at TA-63 would total approximately 20 acres and currently consists on open field and junipers and ponderosa pine woodland; and 3) reasonable and prudent alternatives would be implemented to reduce or avoid potential impacts. For these reasons we conclude that, as described, the effects to the owl from the construction activities associated with the proposed project will be insignificant and discountable, and will not result in adverse effects to the owl.

This concludes the informal consultation for the Security-Driven Transportation Modifications Project. Please contact the Service if: (1) new information reveals effects of the agency action that may affect the species to an extent not considered in this consultation; (2) the agency action is subsequently modified in a manner that causes an effect to the species that was not considered

Ms. Elizabeth R. Withers 2

by the proposed action, and (3) a new species is listed or critical habitat designated that may be affected by the proposed project.

We appreciate the thorough analyses provided in the letter and the BA and your efforts to protect endangered and threatened species. In future communications regarding this consultation please refer to consultation #22420-2006-I-0092. If we can be of further assistance, please contact Santiago R. Gonzales of my staff at (505) 761-4755.

Sincerely,

for Wally Murphy
Acting Field Supervisor

cc:
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

June 22, 2006

Cons. # 22420-2006-I-0093

Ms. Elizabeth R. Withers
Document Site-wide EIS Manager
National Nuclear Security Administration
Los Alamos Site Office
Los Alamos, New Mexico 87544

Dear Ms. Withers:

Thank you for your February 22, 2006, biological assessment (BA) of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species – Security Transportation Modifications (Optional Actions) Project. The Los Alamos National Laboratory (LANL) proposes Option A: Paving Sigma Mesa Road with a bridge over Mortandad Canyon and Option B: Bridge Over Sandia Canyon. Your letter requesting formal consultation for the proposed options and their effects on the threatened Mexican spotted owl (owl) (*Strix occidentalis lucida*) was received by the U.S. Fish and Wildlife Service (Service) on February 22, 2006.

The BA describes two options: 1) Paving Sigma Mesa Road with a bridge over Mortandad Canyon and 2) a bridge over Sandia Canyon. However, the BA does not identify which alternative LANL has selected. The BA also does not identify a specific location of the bridge crossing, nor does it describe the design of the bridge over Mortandad Canyon or Sandia Canyon. The Service cannot analyze the affects of these two options because LANL has not selected the preferred alternative. When LANL determines, through a biological assessment or other review, which action will be proposed, LANL should submit to the Service a request for consultation. The BA should only analyze the effects of your preferred alternative, not both alternatives.

The Service recommends bridge placement over Sandia Canyon and not over Mortandad Canyon. We believe that a bridge placement over Sandia Canyon would avoid adverse affects to the owl, whereas a bridge over Motandad Canyon would be place directly over the area where resident owls have been located and could cause adverse affects to the owl. Please contact the Service when you decide on the bridge placement and timetable for implementation of the proposed bridge project.

We appreciate the analyses provided in the BA and your efforts to protect endangered and threatened species. In future communications regarding this consultation please refer to

Ms. Elizabeth R. Withers 2

consultation #22420-2006-I-0093. If we can be of further assistance, please contact Santiago R. Gonzales of my staff at (505) 761-4755.

Sincerely,

Wally Murphy
Acting Field Supervisor

cc:
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico

CHAPTER 7
REFERENCES

7. REFERENCES

ACE (U.S. Army Corps of Engineers), 2000, "Corps builds flood control structures for Los Alamos", Engineer Update, (accessed January 16, 2006, www.hq.usace.army.mil/cepa/pubs/nov00/story7.htm), November.

ACE (U.S. Army Corps of Engineers), 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico*, Albuquerque District, Albuquerque, New Mexico, October.

ACE (U.S. Army Corps of Engineers), 2006, "Commercial Hazardous Waste Landfills," in *Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise Information – Treatment, Storage and Disposal Facilities (TSDF)* (accessed at www.environmental.usace.army.mil/library/pubs/tsdf/sec2-3/sec2-3.html).

ACE, Reclamation, and ISC (U.S. Army Corps of Engineers, Bureau of Reclamation, and New Mexico Interstate Stream Commission), 2006, *Upper Rio Grande Basin Water Operations Review and Draft Environmental Impact Statement*, Albuquerque District; Albuquerque Area Office, January.

AHA (American Hospital Association), 2007, "PHS Santa Fe Indian Hospital," *U.S. News & World Report* (available at health.usnews.com/usnews/health/hospitals/directory/glance_6850400.htm), July 31.

All Aboard America, 2005, *All Aboard America! Park and Ride, Northern New Mexico Park & Ride* (available at www.allaboardamerica.com/santafe/index.html), October 31.

Arrowsmith, J., 2005, Los Alamos County, Deputy Utilities Manager, Los Alamos, New Mexico, Personal communication (e-mail) to K. Folk, Science Applications International Corporation, Germantown, Maryland, "Response to Los Alamos County Gas and Water Consumption," November 3 and November 10.

Arrowsmith, J., 2006, Los Alamos County, Deputy Utilities Manager, Los Alamos, New Mexico, Personal communication (e-mail) to K. Folk, Science Applications International Corporation, Germantown, Maryland, "Response to Data Needs for Los Alamos County Water, Natural Gas, and Electric Power and Peak Load Use for FY/CY 2005-2006," October 18 and October 19.

Athas, W. F., 1996, *Investigation of Excess Thyroid Cancer Incidence in Los Alamos County*, Division of Epidemiology, Evaluation, and Planning, New Mexico Department of Health, Santa Fe, New Mexico, April.

Athas, W. F. and C. R. Key, 1993, *Los Alamos Cancer Rate Study: Phase I – Cancer Incidence in Los Alamos County, 1970-1990, Final Report*, Division of Epidemiology, Evaluation, and Planning, New Mexico Department of Health, March.

ATSDR (Agency for Toxic Substances and Disease Registry), 1997, *Dioxin and Dioxin-Like Compounds in Soil, Part 1: ATSDR Interim Policy Guideline*, Toxicology and Industrial Health, Vol. 13, No. 6, pp. 759-768, Atlanta, Georgia, August 21.

ATSDR (Agency for Toxic Substances and Disease Registry), 2006, *Public Health Assessment, Final, Los Alamos National Laboratory*, EPA Facility ID: NM0890010515, Site and Radiological Assessment Branch, Division of Health Assessment and Consultation, Atlanta, Georgia, August 31.

Balice, R. G., K. D. Bennett, and M. A. Wright, 2004, *Burn Severities, Fire Intensities, and Impacts to Major Vegetation Types from the Cerro Grande Fire*, LA-14159, Los Alamos National Laboratory, Los Alamos, New Mexico, December.

BEA (Bureau of Economic Analysis), 2007, "New Mexico Per Capita Personal Income," Regional Economic Information System, Washington, DC (available at www.bea.gov), April.

Bearzi, J. P., 2005, New Mexico Environmental Department, Letter to Mat Johansen and David McInroy, Los Alamos National Laboratory, Los Alamos, New Mexico, *Interim Measures Work Plan Requirement Groundwater Contaminants Detected In The Regional Aquifer at R-28 Los Alamos National Laboratory,* December 23.

Birdsell, K. H., B. D. Newman, D. E. Broxton, and B. A. Robinson, 2005, "Conceptual Models of Vadose Zone Flow and Transport beneath the Pajarito Plateau, Los Alamos, New Mexico," *Vadose Zone Journal*, 4, pp. 620-636.

BLM (Bureau of Land Management), (Undated) Environmental Assessment for the Treatment of Saltcedar and Other Noxious Weeds in the Chico Arroyo Watershed, EA-NM-010-02-032, Albuquerque Field Office, Albuquerque, New Mexico.

BLM (Bureau of Land Management), 1986, *Visual Resource Contrast Rating*, BLM Manual Handbook 8431-1, Washington, DC, January 17.

BLM (Bureau of Land Management), 2002, *Final Environmental Impact Statement for Santo Domingo Pueblo/Bureau of Land Management Land Exchange*, BLM/NM/PL-02-004-7122, Albuquerque Field Office, Albuquerque, New Mexico, March 3.

BLM (Bureau of Land Management), 2003a, *Final Air Dispersion Analyses Technical Report, Revision to the BLM Farmington Resource Management Plan and Amendment of the Rio Puerco Resource Management Plan*, Farmington Field Office, Farmington, New Mexico, February.

BLM (Bureau of Land Management), 2003b, *Farmington Proposed Resource Management Plan and Final Environmental Impact Statement*, BLM-NM-PL-03-014-1610, Farmington Field Office, Farmington, New Mexico, March.

BLM (Bureau of Land Management), 2003c, *Farmington Resource Management Plan with Record of Decision*, Farmington Field Office, Farmington, New Mexico, December.

BLM (Bureau of Land Management), 2004a, Factsheet: *San Juan Public Lands (San Juan Field Center & San Juan National Forest) Draft Environmental Impact Statement (EIS) Northern San Juan Basin Coalbed Methane Project*, San Juan Public Land Center, Durango, Colorado.

BLM (Bureau of Land Management), 2004b, Final Bureau of Land Management Finding of No Significant Impact and Decision Record, Taos Field Office, Taos, New Mexico, June 3.

BLM (Bureau of Land Management), 2006a, Rio Puerco Field Office Information (accessed at www.nm.blm.gov/aufo/aufo_home.html), and Taos Field Office Information (accessed at www.nm.blm.gov/tafo/tafo_home.html), February 15.

BLM (Bureau of Land Management), 2006b, *Mid-America Pipeline Company Western Expansion Project EA, Project Description* (accessed at www.nm.blm.gov/nmso/midam-pipline/project_description.html), February 15.

BLM (Bureau of Land Management), 2006c, *New Mexico Products Pipeline Environmental Impact Statement* (accessed at www.nm.blm.gov/aufo/nmpp/nmpp_index.html), February 15.

BLM and USFS (U.S. Department of the Interior, Bureau of Land Management and U.S. Department of Agriculture, Forest Service), 2007, *Final Environmental Impact Statement for the Buckman Water Diversion Project, Santa Fe National Forest and Taos Field Office of the BLM in Santa Fe County, New Mexico*, May 24.

BLS (Department of Labor, Bureau of Labor Statistics), 2005, "Workplace Injuries and Illnesses in 2004," Washington, DC, November 17.

Broxton, D. E., and D. T. Vaniman, 2004, "Geologic Framework of a Groundwater System on the Margin of a Rift Basin, Pajarito Plateau, North-Central New Mexico," *Vadose Zone Journal*, Vol. 4, p. 522-550, April 28.

Carter, K. E., and C. L. Winter, 1995, "Fractal natural and scaling of normal faults in the Española Basin, Rio Grande rift, New Mexico: implications for fault growth and brittle strain," *Journal of Structural Geology*, Vol. 17, No. 6, p. 863-873.

CDC (Centers for Disease Control and Prevention), 2006, *Interim Report of the Los Alamos Historical Document Retrieval and Assessment (LAHDRA) Project*, Version 4, National Center for Environmental Health, Division of Environmental Hazards and Health Effects, Radiation Studies Branch, Atlanta, Georgia, January.

CEQ (Council on Environmental Quality), 1997, *Environmental Justice, Guidance Under the National Environmental Policy Act*, Executive Office of the President, Washington, DC, December 10.

CFLHD (Central Federal Lands Highway Division), 2005, *CFLHD Projects (New Mexico)* (accessed at www.cflhd.gov/projects/NMHome.cfm), December 23.

Cummings, L., 2007, Los Alamos Site Office, Document Manager, *Environmental Impact Statement for the Operation of a Biosafety Level-3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0388D, Personal communication with K. Owens, Science Applications International Corporation, Germantown, Maryland, "BSL-3 Summary Update for LANL SWEIS," August 8.

Del Signore, J. C. and R. L. Watkins, 2005, *Radioactive Liquid Waste Treatment Facility Annual Report for 2004*, LA-UR-05-4395, Los Alamos National Laboratory, Los Alamos New Mexico, May.

Delucas, K., 2005, "Two Lab Employees Treated for Injuries", LANL News Bulletin (available at www.lanl.gov/news/index.php?fuseaction=nb.story&story_id=6682&nb_date=2005-06-01), June 1.

DOC (U.S. Department of Commerce), 2005, *Technical Documentation: Census 2000 Summary File 3 Technical Documentation*, SF3/10 (RV), Bureau of the Census, Washington, DC (available at www.census.gov), February.

DOC (U.S. Department of Commerce), 2006a, *DP-1, General Population and Housing Characteristics: 1990; Data Set: 1990 Summary Tape File 1 for New Mexico*, Bureau of the Census, Washington, DC (available at http://factfinder.census.gov), February.

DOC (U.S. Department of Commerce), 2006b, *Fact Sheet, Census 2000 Demographic Profile Highlights, New Mexico and Los Alamos, Rio Arriba, and Santa Fe Counties*, Bureau of the Census, Washington, DC (available at http://factfinder.census.gov), February.

DOC (U.S. Department of Commerce), 2006c, "Small Area Income & Poverty Estimates, Estimates for New Mexico Counties, 2004," Bureau of the Census, Washington, DC, (available at www.census.gov).

DOC (U.S. Department of Commerce), 2006d, Regional Input-Output Modeling System (RIMS II) "Total Multipliers for Output, Earnings, and Employment by Detailed Industry, Santa Fe, New Mexico, Region 2," Regional Economic Analysis Division, Bureau of Economic Analysis.

DOC (U.S. Department of Commerce), 2007, "New Mexico - County, GCT-T1 2006 Population Estimates," Bureau of the Census, Population Estimates Program, Washington, DC, (available at factfinder.census.gov).

DOE (U.S. Department of Energy), 1990, "Radiation Protection of the Public and the Environment," DOE Order 5400.5, Change 2: January 7, 1993, Washington, DC, February 8.

DOE (U.S. Department of Energy), 1995a, *Dual Axis Radiographic Hydrodynamic Test Facility Final Environmental Impact Statement*, DOE/EIS-0228, Albuquerque Operations Office, Los Alamos Area Office, Albuquerque, New Mexico, August.

DOE (U.S. Department of Energy), 1995b, *Environmental Assessment - Radioactive Source Recovery Program*, DOE/EA-1059, Los Alamos Area Office, Los Alamos, New Mexico, December 20.

DOE (U.S. Department of Energy), 1996, *Plutonium: The First 50 Years, United States Plutonium Production, Acquisition, and Utilization from 1944 through 1994,* DOE/DP-0137, Washington, DC, February.

DOE (U.S. Department of Energy), 1997a, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad Area Office, Carlsbad, New Mexico, September.

DOE (U.S. Department of Energy), 1997b, *Environmental Assessment for Lease of Land for the Development of a Research Park at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE-EA-1212, Los Alamos Area Office, Los Alamos, New Mexico, October 7.

DOE (U.S. Department of Energy), 1998, *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EA-1250, Los Alamos Area Office, Los Alamos, New Mexico, December 18.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Radioactive Waste Management Manual*, DOE M 435.1-1, Change 1: 6-19-01, Office of Environmental Management, Washington, DC, July 9.

DOE (U.S. Department of Energy), 1999c, *Environmental Assessment for the Proposed Construction and Operation of the Nonproliferation and International Security Center, Los Alamos National Laboratory, Los Alamos New Mexico,* DOE-EA-1238, Los Alamos Area Office, Los Alamos, New Mexico, July 21.

DOE (U.S. Department of Energy), 1999d, *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico,* DOE/EIS-0293, Los Alamos Area Office, Los Alamos, New Mexico, October.

DOE (U.S. Department of Energy), 1999e, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 2000a, *Environmental Assessment for Electrical Power System Upgrades at Los Alamos National Laboratory,* DOE/EA-1247, Los Alamos Area Office, Los Alamos, New Mexico, March 9.

DOE (U.S. Department of Energy), 2000b, *Preliminary Findings – Plutonium-238 Uptakes at Los Alamos National Laboratory*, Lessons Learned HQ-EH-2000-01, Washington, DC, May 24.

DOE (U.S. Department of Energy), 2000c, *Safety & Health Hazards Alert,* "Update June 28, 2000 – Preliminary Accident Investigation Findings from the Plutonium-238 Multiple Intake Event at the Los Alamos National Laboratory, Issue No, 2000-01A, DOE/EH-0518, Office of Environment, Safety and Health, Washington, DC, July.

DOE (U.S. Department of Energy), 2000d, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Certain Unwanted Radioactive Sealed Sources at Los Alamos National Laboratory*, DOE/EIS-0238-SA-01, Albuquerque Operations Office, Los Alamos, New Mexico, August.

DOE (U.S. Department of Energy), 2000e, *Environmental Assessment for the Wildfire Hazard Reduction and Forest Health Improvement Program at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EA-1329, Los Alamos Area Office, Los Alamos, New Mexico, August 10.

DOE (U.S. Department of Energy), 2000f, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2000g, *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*, DOE/EIS-0310, Office of Nuclear Energy, Science and Technology, Washington, DC, December.

DOE (U.S. Department of Energy), 2001, *Environmental Assessment for the Proposed Construction and Operation of a New Interagency Emergency Operations Center at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1376, Los Alamos Area Office, Los Alamos, New Mexico, July 26.

DOE (U.S. Department of Energy), 2002a, *DOE Standard, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities,* DOE-STD-1020-2002, Washington, DC, January.

DOE (U.S. Department of Energy), 2002b, *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, Washington, DC, February.

DOE (U.S. Department of Energy), 2002c, *Environmental Assessment for the Proposed Construction and Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1364, National Nuclear Security Administration, Office of Los Alamos Site Operations, Los Alamos, New Mexico, February 26.

DOE (U.S. Department of Energy), 2002d, *Environmental Assessment of the Proposed Disposition of the Omega West Facility at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1410, National Nuclear Security Administration, Office of Los Alamos Site Operations, Los Alamos, New Mexico, March 28.

DOE (U.S. Department of Energy), 2002e, *Environmental Assessment for the Proposed TA-16 Engineering Complex Refurbishment and Consolidation at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1407, National Nuclear Security Administration, Office of Los Alamos Site Operations, Los Alamos, New Mexico, April 23.

DOE (U.S. Department of Energy), 2002f, National Transuranic Waste Management Plan, DOE/NTP-96-1204, Revision 3, July.

DOE (U.S. Department of Energy), 2002g, *DOE Standard, A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, DOE-STD-1153-2002, Washington, DC, July.

DOE (U.S. Department of Energy), 2002h, *Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1409, National Nuclear Security Administration, Office of Los Alamos Site Operations, Los Alamos, New Mexico, July 24.

DOE (U.S. Department of Energy), 2002i, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, National Nuclear Security Administration, Washington, DC, August.

DOE (U.S. Department of Energy), 2002j, *Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EA-1408, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 8.

DOE (U.S. Department of Energy), 2002k, *Environmental Assessment for Proposed Access Control and Traffic Improvements at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1429, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 23.

DOE (U.S. Department of Energy), 2002l, *Environmental Assessment for the Installation and Operation of Combustion Turbine Generators at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1430, LA-UR-02-6482, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, December 11.

DOE (U.S. Department of Energy), 2003a, *Supplement Analysis, Security Perimeter Project,* National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, February 19.

DOE (U.S. Department of Energy), 2003b, *Environmental Assessment for the Proposed Los Alamos National Laboratory Trails Management Program, Los Alamos, New Mexico* DOE/EA-1431, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, September 2.

DOE (U.S. Department of Energy), 2003c, *Supplemental Analysis Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Supplement Analysis, Bolas Grande Project*, DOE/EIS-0238-SA-03, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, September 3.

DOE (U.S. Department of Energy), 2003d, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0350, Los Alamos Site Office, Los Alamos, New Mexico, November.

DOE (U.S. Department of Energy), 2003e, *Final Environmental Assessment for the Proposed Consolidation of Certain Dynamic Experimentation Activities at the Two-Mile Mesa Complex, Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EA-1447, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, November 3.

DOE (U.S. Department of Energy), 2003f, *DOE Occupational Radiation Exposure, 2003 Report*, DOE/EH-0688, Assistant Secretary for Environment, Safety and Health, Office of Corporate Performance Assessment, Washington, DC.

DOE (U.S. Department of Energy), 2004a, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Recovery and Storage of Strontium-90 (Sr-90) Fueled Radioisotope Thermal Electric Generators at Los Alamos National Laboratory*, DOE/EIS-0238-SA-04, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, January.

DOE (U.S. Department of Energy), 2004b, *Degradation and Failure of Stored Radiological Material Containers and Packages*, Lessons Learned HQ-EH-2004-01, Washington, DC, January 1.

DOE (U.S. Department of Energy), 2004c, Memo for Ralph Erickson, Los Alamos Site Operations Manager from Paul Longsworth, Deputy Administrator, Defense Nuclear Nonproliferation, National Nuclear Security Administration, "Expanded Scope for the Off-Site Source Recovery Program," March 2.

DOE (U.S. Department of Energy), 2004d, *Lessons Learned from Type B Accident Investigation of the August 5, 2003 Plutonium-238 Multiple Uptake Event at the Plutonium Facility, Los Alamos National Laboratory, New Mexico*, Lorence, Joanne D., presented at 2004 Facility Representative Workshop, Las Vegas, Nevada, May 20.

DOE (U.S. Department of Energy), 2004e, *Environmental Assessment for the Proposed Corrective Measures at Material Disposal Area H within Technical Area 54 at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1464, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, June 14.

DOE (U.S. Department of Energy), 2004f, *Implementation Guide, Wildland Fire Management Program for Use with DOE 450.1, Environmental Protection Program*, DOE-G-450-1.4, Office of Environment, Safety and Health, Washington, DC.

DOE (U.S. Department of Energy), 2005a, *Modification of a Special Use Permit to the Incorporated County of Los Alamos for the Construction and Operation of a Solid Waste Transfer Station at TA-61*, Accession No: 11228, LASO 05-003, Los Alamos, New Mexico, February 8.

DOE (U.S. Department of Energy), 2005b, *Final Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production*, DOE/EA-1532, National Nuclear Security Administration, Sandia Site Office, Albuquerque, New Mexico, June.

DOE (U.S. Department of Energy), 2005c, *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems* (DOE/EIS-0373D), Office of Nuclear Energy, Science and Technology, Washington, DC, June.

DOE (U.S. Department of Energy), 2005d, *Recommendations for the Nuclear Weapons Complex of the Future*, Secretary of Energy Advisory Board, Washington, DC, July 13.

DOE (U.S. Department of Energy), 2005e, "AEGLs, ERPGs, or Rev. 21 TEELs for Chemicals of Concern 2005, DKC-05-0002, Rev. 21," Washington, DC (accessed at www.eh.doe.gov/chem_safety/teeldef.html), September.

DOE (U.S. Department of Energy), 2005f, *Facility Safety*, DOE Order 420.1B, Washington, DC, December 22.

DOE (U.S. Department of Energy), 2006a, "DOE Strengthens Rules Governing Worker Safety," Office of Public Affairs, February 2.

DOE (U.S. Department of Energy), 2006b, "Programmatic Agreement for Management of Historic Properties at Los Alamos National Laboratory," LA-UR-06-1975, June 14.

DOE (U.S. Department of Energy), 2007a, *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1D, Office of Civilian Radioactive Waste Management, Las Vegas, Nevada, October.

DOE (U.S. Department of Energy), 2007b, *Draft Complex Transformation Supplemental Programmatic Environmental Impact Statement*, DOE/EIS-0236-S4, National Nuclear Security Administration, Washington, DC, December.

DOE (U.S. Department of Energy), 2008, Memorandum from A. R. Griffith, Office of Nuclear Energy to E. Withers, Los Alamos National Laboratory Site-Wide Environmental Impact Statement Document Manager, Subject: Advanced Fuel Cycle Facility (AFCF) Data for the Los Alamos National Laboratory (LANL) Site-wide Environmental Impact Statement (SWEIS), March 31.

DOE and LANL (U.S. Department of Energy and Los Alamos National Laboratory), 2005, *DOE/LANL List of Los Alamos National Laboratory Nuclear Facilities*, PS-SBO-401 Rev. 7, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, October.

DOJ (U.S. Department of Justice), 2004, *Law Enforcement Management and Administrative Statistics, 2000: Data for Individual State and Local Agencies with 100 or More Officers*, Bureau of Justice Statistics, NCJ 203350, April.

Environment Canada, 2002, "Canadian Environmental Quality Guidelines, Summary Table Update 2002," Ottawa, Ontario.

Environmental Laboratory, 1987, *Corps of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, U.S. Army Waterway Experiment Station, Vicksburg, Mississippi, January.

EPA (U.S. Environmental Protection Agency), 1974, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, EPA 550/9-74-004 (PB-239429), Office of Noise Abatement and Control, March.

EPA (U.S. Environmental Protection Agency), 1980, *Effects of Noise on Wildlife and Other Animals, Review of Research Since 1971*, EPA 550/9-80-100, Washington, DC, July.

EPA (U.S. Environmental Protection Agency), 2002, "National Recommended Water Quality Criteria: 2002," EPA Office of Science and Technology Document EPA-822-R-02-047, Washington, DC.

EPA (U.S. Environmental Protection Agency), 2003, *Glossary*, Office of Research and Development, U.S. EPA Region III, Philadelphia, Pennsylvania, September 8.

EPA (U.S. Environmental Protection Agency), 2005a, United States Department of Energy and the Los Alamos National Laboratory, Federal Facility Compliance Agreement, Region 6, Docket No. CWA-06-2005-1701, February 3.

EPA (U.S. Environmental Protection Agency), 2005b, *National Priorities List Sites in New Mexico* (accessed on December 23, www.epa.gov/superfund/sites/npl/nm.htm), August 22.

EPA (U.S. Environmental Protection Agency), 2005c, *Terms of Environment, Glossary*, Office of Research and Development, EPA Region III, Philadelphia, Pennsylvania (available at www.epa.gov/OCEPAterms/bterms.html), August 29.

EPA (U.S. Environmental Protection Agency), 2006a, *Mid-Atlantic Integrated Assessment, Appendix C, Glossary*, Office of Research and Development, EPA Region III, Philadelphia, Pennsylvania (available at www.epa.gov/maia/html/glossary.html), March 3.

EPA (U.S. Environmental Protection Agency), 2006b, *North Railroad Avenue Plume (Rio Arriba County) New Mexico*, EPA Region 6, Española, New Mexico, November 7.

EPA (U.S. Environmental Protection Agency), 2007a, "Region 6 Human Health Medium Specific Screening Levels 2007," Dallas, TX, February 21.

EPA (U.S. Environmental Protection Agency), 2007b, Authorization to Discharge Under the National Pollutant Discharge Elimination System, NPDES Permit No. NM0028355, Region 6, Dallas, TX, August 1.

FICN (Federal Interagency Committee on Noise), 1992, *Federal Agency Review of Selected Airport Noise Analysis Issues*, August.

Ford-Schmid, R. and D. Englert, 2004, *Post Cerro Grande Fire Stream Channel Morphology In Lower Pueblo Canyon, Reach P-4 East, Los Alamos County, New Mexico*, Department of Energy Oversight Bureau, New Mexico Environment Department, Santa Fe, New Mexico, January.

Ford-Schmid, R. D. Englert, and K. Bransford, 2004, *Post Cerro Grande Fire Channel Morphology in Lower Pueblo Canyon, Reach P-4 West: and Storm Water Transport of Plutonium 239/240 in Suspended Sediments, Los Alamos County, New Mexico,* U.S. Department of Energy Oversight Bureau, New Mexico Environment Department, Santa Fe, New Mexico, October.

Gallaher, B. M., and D. W. Efurd, 2002, *Plutonium and Uranium from Los Alamos National Laboratory in Sediments of the Northern Rio Grande Valley*, LA-13974-PR, Los Alamos National Laboratory, Los Alamos, New Mexico, August.

Gallaher, B. M., and R. J. Koch, 2004, *Cerro Grande Fire Impacts to Water Quality and Stream Flow Near Los Alamos National Laboratory: Results of Four Years of Monitoring*, LA-14177, Los Alamos National Laboratory, Los Alamos, New Mexico, September.

Gallegos, F., 2006, *Interview Record – Future Actions for Cumulative Impacts*, City of Santa Fe, Planning and Land Use, Personal communication with C. Brandenburg, Science Applications International Corporation, January 26.

Gilliom, R. J., D. K. Mueller, and L. H. Nowell, 1997, "Methods for Comparing Water-Quality Conditions Among National Water-Quality Study Units, 1992-1995," U.S. Geological Survey Open-File Report 97-589 (available at http://ea.water.usgs.gov/pnsp/rep/cfr97589).

Glasco, T., 2005, Los Alamos County, Deputy Utilities Manager, Los Alamos, New Mexico, Personal communication (e-mail) to K. Folk, Science Applications International Corporation, Germantown, Maryland, "Response to Los Alamos County Water Supply Planning", November 1, and November 9.

Glasco, T., 2008, Los Alamos County, Deputy Utilities Manager, Los Alamos, New Mexico, Personal communication (e-mail) to M. Gorden, Science Applications International Corporation, Germantown, Maryland, "Response to Status of the Bayo Wastewater Treatment Plant," January 18.

HHS (U.S. Department of Health and Human Services), 2007, *Biosafety in Microbiological and Biomedical Laboratories*, Centers for Disease Control and Prevention, National Institutes of Health, Health and Human Services, Fifth Edition, February.

Holsapple, K., 2007, *Interview Record – Number of Employees in the Los Alamos Research Park*, Los Alamos Development Corporation Leasing Manager, Personal communication with S. Schatzel, Science Applications International Corporation, January 16.

IFRAT (Interagency Flood Risk Assessment Team, Risk Assessment Working Group), 2002, *Assessment of Potential Risks from Enhanced Surface Water Runoff in CY2001 due to the Cerro Grande Fire*, New Mexico Environment Department, Hazardous Waste Bureau, Santa Fe, New Mexico, May 28.

Jacobson, K., S. Johnson, and J. Rishel, 2003, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, Los Alamos National Laboratory, Los Alamos, New Mexico, July.

Jeppson, G., 2006, *Interview Record – Future Actions for Cumulative Impacts*, Los Alamos County, Community Development Department, Planning and Zoning, Personal communication with C. Brandenburg, Science Applications International Corporation, January 18.

Johnson, P. E., and R. D. Michelhaugh, 2003, *Transportation Routing Analysis Geographic Information System (TRAGIS) – User's Manual*, ORNL/NTRC-006, Rev. 0, Oak Ridge National Laboratory, Oak Ridge, Tennessee (accessed through http://apps.ntp.doe.gov/ tragis/tragis.htm), June.

Keller, D., and S. Koch, 2001, *A Biological Information Document for the Potential Siting of the Advanced Hydrodynamic Facility at LANL*, LA-UR-01-1832, Los Alamos National Laboratory, Los Alamos, New Mexico, July 10.

Kraig, D., R. Ryti, D. Katzman, T. Buhl, B. Gallaher, and P. Fresquez, 2002, *Radiological and Nonradiological Effects After the Cerro Grande Fire*, LA-13914, Los Alamos National Laboratory, Los Alamos, New Mexico, March.

KSL (Kellog Brown and Root Government Services; Shaw Environmental and Infrastructure Inc.; and Los Alamos Technical Associates, Inc.), 2004, *LANL Roads/NM-4/502, 24 Hour Vehicular Traffic Counts, Directional AM and PM Peak Hour Traffic, September 12, 2004-September 18, 2004 and September 2003 (Map)*, Los Alamos, New Mexico, November 17.

LAC (Los Alamos County), 2004a, *Los Alamos County Comprehensive Plan, 2004-2014*, Preliminary Draft – October 2003-April 2004, Los Alamos, New Mexico.

LAC (Los Alamos County), 2004b, *Los Alamos County Department of Public Utilities – San Juan Chama Project Water Utilization Study* (accessed on December 23, 2005, www.lac-nm.us), Los Alamos, New Mexico, October 20.

LAC (Los Alamos County), 2005, *Traffic Data*, Public Works Department, Traffic Division, Los Alamos, New Mexico, February 15.

LAC (Los Alamos County), 2006a, Los Alamos Fire Department Page (accessed at www.lac-nm.us), March 10.

LAC (Los Alamos County), 2006b, “Board Celebrates San Juan/Chama Contract Conversion,” Los Alamos County New Mexico Website (accessed at www.losalamosnm.us/index.asp?Type=B_PR&SEC={40E7C209-CBE0-4386-941F-F392C2CBF502}&DE={88ED6579), September 22.

LAC (Los Alamos County), 2006c, *New Solid Waste Transfer Station: Moving Right Along* (accessed at www.lac-nm.us), News and Events, Los Alamos, New Mexico, October 27.

LAC (Los Alamos County), 2007, *Los Alamos County Department of Public Utilities – Los Alamos Solid Waste Transfer Station/Landfill Closure* (accessed on January 23, 2007, http://losalamos.govoffice.com), Los Alamos, New Mexico, February 16.

LAMC (Los Alamos Medical Center), 2006, Welcome Page (accessed at www.losalamosmedicalcenter.com/home.htm), March 10.

LANL (Los Alamos National Laboratory), 1996a, *Road Geology of Selected Sections in the Pajarito Plateau and the Jemez Mountains, North Central New Mexico*, Geology and Geochemistry Group (EES-1), Los Alamos, New Mexico (available at www.ees1.lanl.gov/roadgeology/RoadGeology.html).

LANL (Los Alamos National Laboratory), 1996b, *Environmental Surveillance at Los Alamos during 1995*, LA-13210-ENV, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 1997a, *Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G*, Report-54G-013, R.2.1, LA-UR-97-85, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 1997b, SWEIS Baseline and Alternatives Emission Rate Calculations for TA-50, ESH-17:97-175, April 15.

LANL (Los Alamos National Laboratory), 1997c, *Environmental Surveillance and Compliance at Los Alamos during 1996*, LA-13343-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 1998a, *Description of Technical Areas and Facilities at Los Alamos National Laboratory—1997*, LA-UR-97-4275, Site-Wide Environmental Impact Statement Project Office, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 1998b, *Storm Water/Surface Water Pollution Prevention Best Management Practices (BMPs) Guidance Document, Revision 1*, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1998c, *Threatened and Endangered Species Habitat Management Plan, Overview*, LALP-98-112, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 1999a, *Material Disposal Area Core Document*, LA-UR-99-4423, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1999b, *Environmental Surveillance at Los Alamos during 1998*, LA-13633-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 1999c, *SWEIS Yearbook—1998, Comparison of 1998 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-99-6391, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2000a, *Comprehensive Site Plan 2000, Los Alamos National Laboratory Project Management and Planning*, LA-UR-99-6704, Los Alamos, New Mexico, January 31.

LANL (Los Alamos National Laboratory), 2000b, *Threatened and Endangered Species Habitat Management Plan*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2000c, *A Review of Criticality Accidents, 2000 Revision*, LA-13638, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2000d, *Effects of the Cerro Grande Fire (Smoke and Fallout Ash) on Soil Chemical Properties Within and Around Los Alamos National Laboratory*, LA-13769-MS, P. R. Fresquez, W. R. Velasquez, and L. Naranjo, Jr., Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2000e, *Environmental Surveillance at Los Alamos during 1999, 30th Anniversary Editi*on, LA-13775-ENV, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2000f, *SWEIS Yearbook—1999, Comparison of 1999 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-00-5520, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2001a, *LANL Site-Wide Water Conservation Program Plan*, LA-UR-01-6377, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2001b, *Wildfire Hazard Reduction Project Plan*, LA-UR-01-2017, Ecology Group, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2001c, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2001d, *ESH-20 NEPA Determination Document 10, High Explosives Testing Facility*, LA-UR-01-3040, Los Alamos, New Mexico, May 24.

LANL (Los Alamos National Laboratory), 2001e, *SWEIS Yearbook—2000, Comparison of 2000 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-01-2965, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2001f, *Environmental Surveillance at Los Alamos during 2000*, LA-13861-ENV, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2001g, *Cerro Grande Fire One Year After: An Update on ER Activities to Reduce the Potential Movement of Contamination at Potential Release Sites*, LA-UR-01-4122, Water Quality & Hydrology Group (ESH-18), Environmental Restoration Project, Los Alamos, New Mexico, November 15.

LANL (Los Alamos National Laboratory), 2002a, *Site + Architectural Design Principles*, LA-UR-01-5383, Site Planning and Development Group, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2002b, *Department of Energy Land Conveyance Data Recovery Plan and Research Design for the Excavation of Archaeological Sites Located within Selected Parcels to be Conveyed to the Incorporated County of Los Alamos, New Mexico, Cultural Resources Report No. 201*, LA-UR-02-1284, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2002c, *A Floodplains and Wetlands Assessment of the Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory*, LA-UR-02-3919, Los Alamos, New Mexico, August 7.

LANL (Los Alamos National Laboratory), 2002d, *Environmental Surveillance at Los Alamos during 2001*, LA-13979-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2002e, *SWEIS Yearbook—2001, Comparison of 2001 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-02-3143, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2002f, "Dig that crazy bone!" *Los Alamos National Laboratory News*, Public Affairs Office, October 2.

LANL (Los Alamos National Laboratory), 2002g, *Cerro Grande Fire Assessment Project: An Assessment of the Impact of the Cerro Grande Fire on Cultural Resources at Los Alamos National Laboratory, New Mexico Cultural Resource Report No. 211*, Survey No. 818, LA-UR-02-5713, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2002h, *Radiological Facility List*, PS-OAB-403, Rev. 1, Los Alamos, New Mexico, November 14.

LANL (Los Alamos National Laboratory), 2002i, *A Citizens Guide*, LALP-01-181, Environmental Restoration Project, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2003a, *Preliminary Chemistry and Metallurgy Research Building Disposition Study*, LA-UR-03-1122, Los Alamos, New Mexico, February 11.

LANL (Los Alamos National Laboratory), 2003b, *Water Supply at Los Alamos 1998 – 2001,* LA-13985-PR, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2003c, *Groundwater Annual Status Report for Fiscal Year 2002*, LA-UR-03-0244, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2003d, *Corrective Measures Study Report for Material Disposal Area H, Solid Waste Management Unit 54-004, at Technical Area 54*, LA-UR-03-3354, Risk Reduction and Environmental Stewardship Division, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2003e, *Waste Volume Forecast*, LA-UR-03-4009, Attachment G to *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238),* Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003f, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, Meteorology and Air Quality Group, Environmental Stewardship Division, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2003g, *Noise and Temperature Stresses: Laboratory Implementation Requirements*, LIR 402-820-01.1, Los Alamos, New Mexico, Revised August 20.

LANL (Los Alamos National Laboratory), 2003h, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2004b, *LANL Engineering Standards Manual*, OST220-03-01-ESM, Section G10, Site Preparation, Rev. 1, Los Alamos, New Mexico, August 16.

LANL (Los Alamos National Laboratory), 2004c, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004d, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004e, *Nonradioactive Ambient Air Monitoring at Los Alamos National Laboratory 2001-2002*, LA-14169, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004f, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004g, *Waste Volume Forecast, Revision 1*, LA-UR-04-6682, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004h, *LANL Investigation of a Laser Eye Injury*, Los Alamos, New Mexico (available at www.lanl.gov/news/index.php?fuseaction=home.story&story_id=5657&view=print), September 21.

LANL (Los Alamos National Laboratory), 2004i, *Findings, recommendations of laser incident investigation team presented at briefing*, Public Affairs Office, Los Alamos, New Mexico (available at www.lanl.gov/news/index.php?fuseaction=home.story& story_id=5896&view=print), November 18.

LANL (Los Alamos National Laboratory), 2004j, *LANL Master Construction Specifications*, Section 01560, Compliance Requirements, Rev 2, November 18.

LANL (Los Alamos National Laboratory), 2004k, *Environmental Division Performance Highlights*, Los Alamos, New Mexico, November 24.

LANL (Los Alamos National Laboratory), 2004l, *2004 Pollution Prevention Roadmap*, LA-UR-04-8973, Los Alamos, New Mexico, December.

LANL (Los Alamos National laboratory), 2004m, *Burn Severities, Fire Intensities, and Impacts to Major Vegetation Types from the Cerro Grande Fire*, LA-14159, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2004n, "Memo Updates Work Force on Resumption of Operations," *Los Alamos National Laboratory News Bulletin* (accessed through www.lanl.gov/news/index.shtml), December 20.

LANL (Los Alamos National Laboratory), 2005a, *Siting Study for Los Alamos County Solid Waste Transfer Station*, Steven Booth, LA-UR-05-0338, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2005b, *Site Screening Study for Los Alamos County Sanitary Landfill*, LA-UR-03-1349, Energy and Environmental Analysis (D-4) Infrastructure, Facilities, and Construction, Los Alamos, New Mexico, February.

LANL (Los Alamos National Laboratory), 2005c, *Los Alamos National Laboratory Storm Water Monitoring Plan*, Revision 1, LA-UR-05-2247, Environmental Stewardship Division, Los Alamos, New Mexico, March 31.

LANL (Los Alamos National Laboratory), 2005d, TRU Waste Processing Facility, INP Meeting Slide Presentation by Craig Bachmeier, PADNWP, May 18.

LANL (Los Alamos National Laboratory), 2005e, *Status Report for Integrated Closure Activities at Technical Area 54*, LA-UR-05-6767 (NWIS-DIV-REPORT-0202), NWIS-Division Office, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2005f, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005g, *Management Review Draft, Los Alamos National Laboratory Wildland Fire Management Plan*, LA-UR-05-0286, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005h, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, September.

LANL (Los Alamos National Laboratory), 2005i, *Los Alamos National Laboratory's Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998-2004)*, LA-14263-MS, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2005j, *Water Quality and Stream Flow After the Cerro Grande Fire*, *A Summary*, LALP-05-009, Albuquerque, New Mexico.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006c, "University of California and U.S. Department of Energy, NSR Air Quality Permit Nos. 2195-J and 2195-K," Letter from K. Hargis, Los Alamos National Laboratory and J. Ordaz, Los Alamos Site Office, to R. Goodyear, New Mexico Environment Department, Santa Fe, New Mexico, January 10.

LANL (Los Alamos National Laboratory), 2006d, *Interim Measures Work Plan for Chromium Contamination in Groundwater*, LA-UR-06-1961, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006e, *Storm Water Pollution Prevention Plan for SWMUs and AOCs (Sites) and Storm Water Monitoring Plan*, LA-UR-06-1840, Environmental Stewardship Division, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006f, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, March.

LANL (Los Alamos National Laboratory), 2006g, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006h, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Environment and Remediation Support Services Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006i, *Emissions Inventory Report Summary for Los Alamos National Laboratory for Calendar Year 2005*, LA-14309-SR, Ecology and Air Quality Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006j, "WIPP shipment milestone highlights improved processes, productivity," *Los Alamos National Laboratory NewsLetter*, Week of October 23, 2006, Vol. 7, No. 22, Los Alamos, New Mexico, October 23.

LANL (Los Alamos National Laboratory), 2006k, *Interim Measures Investigation Report for Chromium Contamination in Groundwater*, LA-UR-06-8372, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2006l, Los Alamos National Laboratory Transfer Map, LA-UR-06-8860, Land Transfer Project, Los Alamos, New Mexico, November 13.

LANL (Los Alamos National Laboratory), 2007a, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Design Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2007b, Letter to J. Vozella, National Nuclear Security Administration, from R. McQuinn, Nuclear High Hazards Operations, Justification for Continued Operation, LANL Site-Wide Nuclear and High Hazard Operations, Reference No. AD-NHHO:07-145, Los Alamos, New Mexico, June 22.

LANL (Los Alamos National Laboratory), 2007c, *LANL Engineering Standards Manual*, ISD 341-2, Chapter 5 - Structural, Rev. 4, Los Alamos, New Mexico, June 19.

Lansford, R. R., L. D. Adcock, L. M. Gentry, and S. Ben-David, 1996, *The Economic Impact of Los Alamos National Laboratory on North-Central New Mexico and the State of New Mexico, Fiscal Year 1995*, U.S. Department of Energy, Albuquerque Operations Office, in cooperation with the University of New Mexico, Albuquerque, New Mexico, and New Mexico State University, Las Cruces, New Mexico, August.

Lenderman, A., 2005, *DOE Probes Another LANL Mishap*, "The New Mexican" (available at www.freenewmexican.com/news/31106.html), August 10.

Loftin, S. R., 2001, *A Biological Assessment of the Potential Effects of the Wildfire Hazard Reduction Project on Federally Listed Threatened and Endangered Species*, LA-UR-01-2253, Los Alamos National Laboratory, Los Alamos, New Mexico, May 3.

LSC (LSC Transportation Consultants, Inc.), 2004, *Average Weekday Traffic Counts, Figure 5 (Map)*, Colorado Springs, Colorado.

LSC (LSC Transportation Consultants, Inc.), 2005, *LANL Science Center Traffic Impact and Access Analysis*, November 15.

Malm, W. C., 1999, *Introduction to Visibility, Cooperative Institute for Research in the Atmosphere*, NPS Visibility Program, Colorado State University, Fort Collins, Colorado, May.

McKown, B., S. W. Koch, R. G. Balice, and P. Neville, 2003, *Land Cover Map for the Eastern Jemez Region*, LA-14029, Los Alamos National Laboratory, Los Alamos, New Mexico, June.

McLin, S. G., 1992, *Determination of 100-Year Floodplain Elevations at Los Alamos National Laboratory*, LA-12195-MS, Los Alamos National Laboratory, Los Alamos, New Mexico.

McLin, S. G., M. E. Van Eeckhout, and A. Earles, 2001, *Mapping 100-Year Floodplain Boundaries Following the Cerro Grande Wildfire*, LA-UR-01-5218, Los Alamos National Laboratory, Los Alamos, New Mexico.

NCI (National Cancer Institute), 2006, *NCI State Cancer Profiles* (available at http://statecancerprofiles.cancer.gov/index.html), November 10.

NCSA (National Center for Statistics and Analysis of the National Highway Traffic Safety Administration), 2006, *Traffic Safety Facts 2004, A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, U.S. Department of Transportation, Washington, DC, January.

NEI (Nuclear Energy Institute), 2005, Renewal of Price-Anderson Act, Frequently Asked Questions (available at www.nei.org).

Neuhauser, K. S., and F. L. Kanipe, 2003, *RADTRAN 5 User Guide*, revised by R. F. Weiner SAND2003-2354, Sandia National Laboratories, Albuquerque, New Mexico (accessed through http://ttd.sandia.gov/risk/doc_list.htm), July.

Newman, D., 2006, “Water deal inked,” *Los Alamos Monitor* (accessed at www.lamonitor.com/articles/2006/09/20/headline_news/news03.txt), September 20.

NMAC 19.21.2 (New Mexico Administrative Code, Title 19, Chapter 21, Part 2), “Endangered Plant Species List and Collection Permits,” Energy Minerals and Natural Resource Department, Forestry and Resources Conservation Division.

NMAC 20.6.2 (New Mexico Administrative Code, Title 20, Chapter 6, Part 2), “Ground and Surface Water Protection,” Water Quality Control Commission.

NMAC 20.6.4 (New Mexico Administrative Code, Title 20, Chapter 6, Part 4), “Standards for Interstate and Intrastate Surface Waters,” Water Quality Control Commission.

NMAC 20.9.1 (New Mexico Administrative Code, Title 20, Chapter 9, Part 1), “Solid Waste Management Regulations,” effective November 30.

NMAQB (New Mexico Air Quality Bureau), 2003, *Dispersion Modeling Guidelines*, July.

NMDGF (New Mexico Department of Game and Fish), 2004a, *Threatened and Endangered Species of New Mexico*, Santa Fe, New Mexico, (available at www.wildlife.state.nm.us/conservation/threatened_endangered_species/index.tm), November 30.

NMDGF (New Mexico Department of Game and Fish), 2004b, *New Mexico Species of Concern*, Santa Fe, New Mexico (available at www.wildlife.state.nm.us/conservation/share_with_wildlife/documents/speciesofconcern.pdf), December 2.

NMDOE (New Mexico Department of Education), 2002, Total Student Enrollment By District School Year 2000-2001, Data Collection and Reporting Unit, updated August 14.

NMDOL (New Mexico Department of Labor), 2005, *New Mexico Department of Labor, Economic Research and Analysis Table A - Civilian Labor Force, Employment, Unemployment and Unemployment Rate 2004*, Santa Fe, New Mexico (available at www.dol.state.nm.us/data.htm).

NMDOL (New Mexico Department of Labor), 2006a, "Table A - Civilian Labor Force, Employment, Unemployment and Unemployment Rate 2005," Economic Research and Analysis Bureau, Albuquerque, New Mexico, February 28.

NMDOL (New Mexico Department of Labor), 2006b, "Table D - Quarterly Census of Employment Annual Averages 2001-2005," Economic Research and Analysis Bureau, Albuquerque, New Mexico, February 28.

NMDOT (New Mexico Department of Transportation), 2001, *New Mexico Traffic Crash Information 1999*, New Mexico State Highway and Transportation Department, Transportation Programs Division, Traffic Safety Bureau, Santa Fe, New Mexico, March.

NMDOT (New Mexico Department of Transportation), 2002, *New Mexico Traffic Crash Information 2000*, New Mexico State Highway and Transportation Department, Transportation Programs Division, Traffic Safety Bureau, Santa Fe, New Mexico, March.

NMDOT (New Mexico Department of Transportation), 2003, *New Mexico Traffic Crash Information 2001*, New Mexico State Highway and Transportation Department, Transportation Programs Division, Traffic Safety Bureau, Santa Fe, New Mexico, January.

NMDOT (New Mexico Department of Transportation), 2004, *New Mexico Traffic Crash Information 2002*, New Mexico State Highway and Transportation Department, Transportation Programs Division, Traffic Safety Bureau, Santa Fe, New Mexico, February.

NMDOT (New Mexico Department of Transportation), 2005a, *New Mexico Traffic Crash Information 2003*, New Mexico State Highway and Transportation Department, Transportation Programs Division, Traffic Safety Bureau, Santa Fe, New Mexico, March.

NMDOT (New Mexico Department of Transportation), 2005b, *All Aboard America Ridership Data for October 24-28, 2005*, Santa Fe, New Mexico, e-mail from G. White, November 2.

NMDOT (New Mexico Department of Transportation), 2006, *New Mexico Traffic Crash Information 2004*, New Mexico State Highway and Transportation Department, Transportation Programs Division, Traffic Safety Bureau, Santa Fe, New Mexico, March.

NMDOT (New Mexico Department of Transportation), 2007, *NMDOT Projects, Road Construction Projects* (accessed January 18, 2008, http://nmshtd.state.nm.us/ mainpage.asp?Page=11531).

NMED (New Mexico Environmental Department), 2004a, *2004-2006 State of New Mexico Integrated Clean Water Act §303(d) §305(b) Report*, Appendix B: 303(d)/305(b) Integrated List for Assessed Surface Waters, Surface Water Quality Bureau, Santa Fe, New Mexico (available at www.nmenv.state.nm.us/wqcc/303d-305b/2004/AppendixB/index.html).

NMED (New Mexico Environment Department), 2004b, Operating Permit No: P100, Air Quality Bureau, Santa Fe, New Mexico, April.

NMED (New Mexico Environment Department), 2005, Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act §74-4-10 and the New Mexico Solid Waste Act §74-9-36(D), March 1.

NMED (New Mexico Environment Department), 2006a, Operating Permit No. P100M1, Air Quality Bureau, Santa Fe, New Mexico, June 15.

NMED (New Mexico Environment Department), 2006b, *2006 New Mexico Solid Waste Annual Report*, Solid Waste Bureau, Santa Fe, New Mexico, July.

NMED (New Mexico Environment Department), 2007a, News Release: "Environment Department Completes Construction of Groundwater Remediation System for Superfund Site in Espanola", Santa Fe, New Mexico, May 1.

NMED (New Mexico Environment Department), 2007b, Factsheet Statement of Basis: Selection of a Remedy for Corrective Action at Material Disposal Area H, SWMU-004, at Technical Area 54, Los Alamos National Laboratory, Los Alamos New Mexico, EPA ID No. NM08990010515, Santa Fe, New Mexico, November 5.

NMNHP (New Mexico Natural Heritage Program), 2004, *NMNHP Tracking List* (available at http://nmnhp,unm,edu/tracking/tracking_results,php?output=html), November 30.

NMPED (New Mexico Public Education Department), 2006, Total Student Enrollment By District School Year 2005-2006, Data Collection and Reporting Bureau, January 12.

NMSF (New Mexico State Forestry), 2004, *Endangered Plant Protection, Agency Status of New Mexico Rare Plants* (available at www.emnrd.state.nm.us/forestry/olpages/endanger.cfm), December 3.

NNSA (National Nuclear Security Administration), 2001, *Environmental Assessment for Construction and Operation of a New Office Building and Related Structures within TA-3 at Los Alamos National Laboratory, Los Alamos, New Mexico*, NNSA/EA-1375, Los Alamos Area Office, Los Alamos, New Mexico, July 26.

NNSA (National Nuclear Security Administration), 2003, *Type B Accident Investigation of the August 5, 2003 Plutonium-238 Multiple Uptake Event at the Plutonium Facility, Los Alamos National Laboratory, New Mexico*, Washington, DC, December.

NNSA (National Nuclear Security Administration), 2004a, *NEPA Compliance Review for Proposed Modifications to the Security Perimeter Project at Los Alamos National Laboratory*, Los Alamos, New Mexico, March 9.

NNSA (National Nuclear Security Administration), 2004b, *Update on Multi-Sector General Storm Water Permit NMED Order and FFCA/AO Requirements*, PowerPoint Presentation by NNSA, Los Alamos Site Office, Los Alamos, New Mexico, March 16.

NNSA (National Nuclear Security Administration), 2004c, *Transitioning from Regulating Storm Water Discharges from SWMUs Under the MSGP to an Individual Permit at LANL through a FFCA*, Presentation by S. Veenis, CAB Briefing, November 17.

NNSA (National Nuclear Security Administration), 2005a, *NEPA Compliance Review Addendum for Proposed Modifications to the Security Perimeter Project at Los Alamos National Laboratory*, Los Alamos New Mexico, April 12.

NNSA (National Nuclear Security Administration), 2005b, *NEPA Compliance Review – DOE/EA 1409 for Modifications to the Proposed Project Analyzed in the Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico*, Los Alamos Site Office, Los Alamos, New Mexico, August 10.

NNSA (National Nuclear Security Administration), 2006a, Letter from L. Brooks, National Nuclear Security Administration, to A. Makhijani, Institute for Energy and Environmental Research, Response to “Accounting Discrepancy of Plutonium at LANL”, February 28.

NNSA (National Nuclear Security Administration), 2006b, *Complex 2030, An Infrastructure Planning Scenario for a Nuclear Weapons Complex Able to Meet the Threats of the 21st Century*, DOE/NA-0013, Office of Defense Programs, Washington, DC, October.

NNSA (National Nuclear Security Administration), 2006c, Fact Sheet, “Myth vs. Fact: The Truth about Plutonium Aging” (accessed August 7, 2007, www.nnsa.doe.gov/docs/factsheets/2006/NA-06-FS-08A.pdf), Washington, DC, December.

NNSA (National Nuclear Security Administration), 2007a, *Report on the Plan for Transformation of the National Nuclear Security Administration Nuclear Weapons Complex*, Office of Transformation, Washington, DC, January 31.

NNSA (National Nuclear Security Administration), 2007b, Chemistry and Metallurgy Research Building Replacement Project, Senate Report (109-274), Washington, DC, May.

NNSA (National Nuclear Security Administration), 2007c, Memorandum to R. McQuinn, Nuclear and High Hazards Operations, from D. Winchell, Los Alamos Site Office, Response to Justification for Continued Operations Related to Seismic Hazards Assessment, Los Alamos, New Mexico, July 31.

NPS (National Park Service), 2005a, *Geology of Bandelier National Monument*, U.S. Department of the Interior, Water Resources Division (available at www2.nature.nps.gov/geology/parks/band.htm), January.

NPS (National Park Service), 2005b, *Fire Management Plan for Bandelier National Monument*, National Park Service.

NRCS (Natural Resources Conservation Service), 2004, Natural Resources Reporter. Natural Resources Conservation Service, U.S. Department of Agriculture, Albuquerque, New Mexico, Winter 2004.

Nylander, C. L., K. A. Bitner, G. Cole, E. H. Keating, S. Kinkead, P. Longmire, B. Robinson, D. B. Rogers, and D. Vaniman, 2003, *Groundwater Annual Status Report For Fiscal Year 2002*, LA-UR-03-0244, GPP-03-011, Los Alamos National Laboratory, Los Alamos, New Mexico.

Pfeil, J., A. Leavitt, M. Wilks, S. Azevedo, L. Hemenway, K. Glesener, and J. Barker, 2001, *Mines, Mills and Quarries in New Mexico 2001*, Mining and Minerals Division, New Mexico Energy, Minerals and Natural Resources Division, and New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, New Mexico.

Phillips, J. S., D. B. Clauss, and D. F. Blower, 1994, *Determination of Influence Factors and Accident Rates for the Armored Tractor/Safe Secure Trailer*, SAND93-0111, Sandia National Laboratories, Albuquerque, New Mexico, April.

Pino, R., 2006, *Interview Record – Future Actions for Cumulative Impacts*, Mora County, Planning and Zoning, Personal communication with Courtney Brandenburg, Science Applications International Corporation, January 18.

PNM, 2005, Public Invited to Comment on PNM Electric Transmission Line Routes (accessed at www.pnm.com/news/2005/0204_sfe.html), February 4.

PNM Resources, 2006, *2005 Sustainability Report*, Albuquerque, New Mexico.

Presbyterian, 2006, Española Hospital Page (accessed at www.phs.org/facilities/espanola/index.shtml), March 10.

PSCNM (Public Service Company of New Mexico), 2006, *Renewable Energy Portfolio Procurement Plan for 2007*, Filed Pursuant to 17.9.572 NMAC, Albuquerque, New Mexico, August 16.

RAC (Risk Assessment Corporation), 2002, *Analysis of Exposure and Risks to the Public from Radionuclides and Chemicals Released by the Cerro Grande Fire at Los Alamos,* Summary Report, New Mexico Environment Department, RAC Report No. 5-NMED-2002-FINAL, June.

Reclamation (U.S. Bureau of Reclamation), 2004, *City of Albuquerque Drinking Water Project Final Environmental Impact Statement,* Bureau of Reclamation, U.S. Department of the Interior, and City of Albuquerque. Albuquerque, New Mexico. March.

Robinson, B. A., D. E. Broxton, and D. T. Vaniman, 2004, *Observations and Modeling of Deep Perched Water Beneath the Pajarito Plateau*, Vadose Zone Journal, Vol. 4, p. 637-652.

Saricks, C., and M. M. Tompkins, 1999, *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150, Center for Transportation Research, Argonne National Laboratory, Argonne, Illinois, April.

Scales, M., 2006, *Interview Record – Future Actions for Cumulative Impacts,* Sandoval County, Planning and Zoning, Personal communication with Courtney Brandenburg, Science Applications International Corporation, January 9.

Schaull, D. A., D. Ortiz, M. R. Alexander, and R. P. Romero, 2004, *Surface Water Data at Los Alamos National Laboratory, 2003 Water Year,* LA-14131-PR, Los Alamos National Laboratory, Los Alamos, New Mexico, March.

Sherwood, S., J. Biggs, and L. Hansen, 2004, *Summary of Animal-Vehicle Collisions in Los Alamos County, 1990-2004*, RRES-Ecology Group, Los Alamos National Laboratory, Los Alamos, New Mexico, October.

SNL (Sandia National Laboratories), 2006, *Annual Site Environmental Report for Sandia National Laboratories, New Mexico*, Calendar Year 2005, SAND2006-4506P, Albuquerque, New Mexico, September.

Snodgrass, R., 2006, "Chromium source traced," in *Lamonitor.com* (accessed January 11, 2006, www.lamonitor.com/articles/2006/01/08/headline_news/news02.prt).

St. Vincent (St. Vincent Regional Medical Center), 2006, About Us Page (accessed at www.stvin.org), March 10.

Stephens (Daniel B. Stephens & Associates, Inc.), 2006, *Long-Range Water Supply Plan, Los Alamos County*, Albuquerque, New Mexico, August.

Stephens and Associates, 2005, *Borrow Source Survey for Evapotranspiration Covers at Los Alamos National Laboratory (Draft),* Prepared for Shaw Environmental, Inc., Los Alamos, New Mexico, January 18.

Tafoya, A., 2006, *Interview Record – Future Actions for Cumulative Impacts,* San Miguel County, Planning and Zoning, Personal communication with Courtney Brandenburg, Science Applications International Corporation, January 18.

TransCore, 2001, *Long Range Major Transportation Investment Study*, North Central Region, Final Report, No. 2300047, Albuquerque, New Mexico, July.

Trujillo, T., 2006, *Interview Record – Future Actions for Cumulative Impacts,* Taos County, Planning, Personal communication with C. Brandenburg, Science Applications International Corporation, January 9.

USFS (U.S. Forest Service), 2005a, *Record of Decision for Invasive Plant Control Project Carson and Santa Fe National Forests in Colfax, Los Alamos, Mora, Rio Arriba, San Miguel, Santa Fe, Sandoval, and Taos Counties, New Mexico*, Forest Service, U.S. Department of Agriculture, September.

USFS (U.S. Forest Service), 2005b, Santa Fe National Forest, Projects & Plans (accessed on February 15, 2006, www.fs.fed.us/r3/sfe/projects/projects/index.html), November 30.

USFS (U.S. Forest Service), 2006, "Schedule of Proposed Action (SOPA), 01/01/2006 to 03/31/2006, Santa Fe National Forest," Forest Service, U.S. Department of Agriculture, (accessed February 15, 2006, www.fs.fed.us/r3/sfe/projects/projects/index.html).

USFWS (U.S. Fish and Wildlife Service), 2002, *Birds of Conservation Concern, 2002*, (Table 42, USFWS Region 2 (Southwest Region) BCC 2002 List), Division of Migratory Bird Management, Arlington, Virginia (available at http://migratorybirds.fws.gov/reports/BCC2002.pdf), December.

USFWS (U.S. Fish and Wildlife Service), 2004a, *The Endangered Species Program* (available at http://endangered.fws.gov), December 1.

USFWS (U.S. Fish and Wildlife Service), 2004b, *Proposed and Candidate Species as of 12/02/2004* (available at http://ecos.fws.gov/tess_public/TESSWebpageNonlisted?listings=0&type=both), December 2.

Valles Caldera Trust, 2005, *Valles Caldera National Preserve,* Los Alamos, New Mexico (available at www.vallescaldera.gov/index.aspx), October 18.

WAPA (Western Area Power Administration), 2006, *Infrastructure Maintenance and Upgrades* (accessed at www.wapa.gov/transmission/infrastructure.htm), February 15.

Webb, D., and K. Carpenter, 2001, *The Cerro Grande Fire, Los Alamos New Mexico,* LA-UR-01-1630, Los Alamos National Laboratory, Los Alamos, New Mexico, March 26.

Yuan, Y. C., S. Y. Chen, B. M. Biwer, and D. J. LePoire, 1995, *RISKIND - A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel*, ANL/EAD-1, Argonne National Laboratory, Argonne, Illinois, November.

CHAPTER 8
GLOSSARY

8.0 GLOSSARY

absorbed dose—For ionizing radiation, the energy imparted to matter by ionizing radiation per unit mass of the irradiated material (such as biological tissue). The units of absorbed dose are the rad and the gray. (See rad and gray.)

accident sequence—With regard to nuclear facilities, an initiating event followed by system failures or operator errors, which can result in significant core damage, confinement system failure, and/or radionuclide releases.

actinide—Any member of the group of elements with atomic numbers from 89 (actinium) to 103 (lawrencium) including uranium and plutonium. All members of this group are radioactive.

activation products—Nuclei, usually radioactive, formed by the bombardment and absorption in material with neutrons, protons, or other nuclear particles.

administrative control level—A dose level that is established well below the regulatory limit to administratively control and help reduce individual and collective radiation doses. Facility management should establish an annual facility administrative control level that should, to the extent feasible, be more restrictive than the more general administrative control level.

air pollutant—Generally, an airborne substance that could, in high enough concentrations, harm living things or cause damage to materials. From a regulatory perspective, an air pollutant is a substance for which emissions or atmospheric concentrations are regulated, or for which maximum guideline levels have been established because of potential harmful effects on human health and welfare.

air quality control region—Geographic subdivisions of the United States, designed to deal with pollution on a regional or local level. Some regions span more than one state.

alluvium—Sediment deposited by flowing water, as in a riverbed, flood plain, or delta.

alpha activity—The emission of alpha particles by radioactive materials.

alpha particle—A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It is identical to a helium nucleus and has a mass number of 4 and an electrostatic charge of +2. It has low penetrating power and a short range (a few centimeters in air). (See alpha radiation.)

alpha radiation—A strongly ionizing, but weakly penetrating, form of radiation consisting of positively charged alpha particles emitted spontaneously from the nuclei of certain elements during radioactive decay. Alpha radiation is the least penetrating of the three common types of ionizing radiation (alpha, beta, and gamma). Even the most energetic alpha particle generally fails to penetrate the dead layers of cells covering the skin and can be easily stopped by a sheet of paper. Alpha radiation is most hazardous when an alpha-emitting source resides inside an organism. (See alpha particle.)

ambient—Surrounding.

ambient air—The surrounding atmosphere as it exists around people, plants, and structures.

ambient air quality standards—The level of pollutants in the air prescribed by regulations that may not be exceeded during a specified time in a defined area. Air quality standards are used to provide a measure of the health-related and visual characteristics of the air.

analytical chemistry—The branch of chemistry that deals with the separation, identification, and determination of the components of a sample.

aquatic—Living or growing in, on, or near water.

aquifer—An underground geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to wells or springs.

archaeological sites (resources)—Any location where humans have altered the terrain or discarded artifacts during either prehistoric or historic times.

Area of Concern (AOC)—Any area that may have had a release of a hazardous waste or hazardous constituent, which is not a Solid Waste Management Unit.

artifact—An object produced or shaped by human workmanship of archaeological or historical interest.

as low as is reasonably achievable (ALARA)—An approach to radiation protection to manage and control worker and public exposures (both individual and collective) and releases of radioactive material to the environment to as far below applicable limits as social, technical, economic, practical, and public policy considerations permit. ALARA is not a dose limit but a process for minimizing doses to as far below limits as is practicable.

atmospheric dispersion—The process of air pollutants being dispersed in the atmosphere. This occurs by the wind that carries the pollutants away from their source, by turbulent air motion that results from solar heating of the Earth's surface, and air movement over rough terrain and surfaces.

Atomic Energy Act—A law originally enacted in 1946 and replaced in 1954 that placed nuclear production and control of nuclear materials within a civilian agency, originally the Atomic Energy Commission. The functions of the Atomic Energy Commission were replaced by the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy.

Atomic Energy Commission—A five-member commission, established by the Atomic Energy Act of 1946, to supervise nuclear weapons design, development, manufacturing, maintenance, modification, and dismantlement. In 1974, the Atomic Energy Commission was abolished, and all functions were transferred to the Nuclear Regulatory Commission and the Administrator of the Energy Research and Development Administration. The Energy Research and Development Administration was later terminated, and functions vested by law in the Administrator were transferred to the Secretary of Energy.

atomic number—The number of positively charged protons in the nucleus of an atom or the number of electrons on an electrically neutral atom.

attainment area—An area that the U.S. Environmental Protection Agency has designated as being in compliance with one or more of the National Ambient Air Quality Standards for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants but not for others. (See National Ambient Air Quality Standards, nonattainment area, and particulate matter.)

attractiveness level—A categorization of nuclear material types and compositions that reflects the relative ease of processing and handling required to convert that material to a nuclear explosive device.

backfill—The replacement of excavated earth or other material into an open trench, cavity, or other opening in the earth.

background radiation—Radiation from (1) cosmic sources, (2) naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and (3) global fallout as it exists in the environment (such as from the testing of nuclear explosive devices).

barrier—Any material or structure that prevents or substantially delays movement of pollutants or materials containing radionuclides toward the accessible environment.

basalt—The most common volcanic rock, dark gray to black in color, high in iron and magnesium and low in silica. It is typically found in lava flows.

baseline—The existing environmental conditions against which impacts of the Proposed Action and its alternatives can be compared. The environmental baseline is the site environmental conditions as they exist or are estimated to exist in the absence of the Proposed Action.

basin—Geologically, a circular or elliptical downwarp or depression in the Earth's surface that collects sediment. Younger sedimentary beds occur in the center of basins. Topographically, a depression into which water from the surrounding area drains.

becquerel—A unit of radioactivity equal to one disintegration per second. Thirty-seven billion becquerels is equal to 1 curie.

bedrock—The solid rock that lies beneath soil and other loose surface materials.

BEIR VII—Biological Effects of Ionizing Radiation; referring to the seventh in a series of committee reports from the National Research Council.

benthic—Plants and animals dwelling at the bottom of oceans, lakes, rivers, and other surface waters.

beryllium—An extremely light-weight element with the atomic number 4. It is metallic and is used in reactors as a neutron reflector.

best management practices—Structural, nonstructural, and managerial techniques, other than effluent limitations, to prevent or reduce pollution of surface water. They are the most effective and practical means to control pollutants that are compatible with the productive use of the resource to which they are applied. Best Management Practices are used in both urban and agricultural areas. Best Management Practices can include schedules of activities; prohibitions of practices; maintenance procedures; treatment requirements; operating procedures; and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

beta particle—A particle emitted in the radioactive decay of many radionuclides. A beta particle is identical to an electron. It has a short range in air and a small ability to penetrate other materials.

biomimetic—Imitating, copying, or learning from nature.

biota (biotic)—The plant and animal life of a region (pertaining to biota).

block—U.S. Bureau of the Census term describing small areas bounded on all sides by visible features or political boundaries; used in tabulation of census data.

boron-10—An isotope of the element boron that has a high capture cross section for neutrons. It is used in reactor absorber rods for reactor control.

borrow—Excavated material that has been taken from one area to be used as raw material or fill at another location.

bound—To use simplifying assumptions and analytical methods in analyzing potential impacts or risks such that the result provides an overestimate or upper limit that "bounds" the potential impacts or risks.

bounded—Producing the greatest consequences of any assessment of impacts associated with normal or abnormal operations.

Breccia—Rock composed of sharp-angled fragments embedded in a fine-grained matrix.

burial ground—In regard to radioactive waste, a place for burying unwanted radioactive materials in which the earth acts as a receptacle to prevent the escape of radiation and the dispersion of waste into the environment.

cancer—The name given to a group of diseases characterized by uncontrolled cellular growth, with cells having invasive characteristics such that the disease can transfer from one organ to another.

canister—A general term for a container, usually cylindrical, used in handling, storage, transportation, or disposal of waste.

capable fault—A fault that has exhibited one or more of the following characteristics: (1) movement at or near the ground surface at least once within the past 35,000 years, or movement of a recurring nature within the past 500,000 years; (2) macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault; (3) a structural relationship to a capable fault according to characteristic (1) or (2) above, such that movement on one could be reasonably expected to be accompanied by movement on the other.

carbon dioxide—A colorless, odorless gas that is a normal component of ambient air; it results from fossil fuel combustion, and is an expiration product.

carbon monoxide—A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

carcinogen—An agent that may cause cancer. Ionizing radiation is a physical carcinogen; there are also chemical and biological carcinogens, and biological carcinogens may be external (such as viruses) or internal (such as genetic defects).

cask—A heavily shielded container used to store or ship radioactive materials.

categories of special nuclear material (Categories I, II, III, and IV)—A designation determined by the quantity and type of special nuclear material or a designation of a special nuclear material location based on the type and form of the material and the amount of nuclear material present. A designation of the significance of special nuclear material based upon the material type, form of the material, and amount of material present in an item, grouping of items, or in a location

cation—A positively charged ion.

cavate—Consists of a room carved into a cliff face within the Bandelier Tuff geological formation. The category includes isolated cavates, multi-roomed contiguous cavates, and groups of adjacent cavates that together form a cluster or complex.

cell—See hot cell.

chain reaction—A reaction that initiates its own repetition. In nuclear fission, a chain reaction occurs when a neutron induces a nucleus to fission and the fissioning nucleus releases one or more neutrons which induce other nuclei to fission.

chemical wastes—Defined as hazardous waste (designated under the Resource Conservation and Recovery Act regulations); toxic waste (asbestos and polychlorinated biphenyls, designated under the Toxic Substances Control Act); and special waste (designated under the New Mexico Solid Waste Regulations and including industrial waste, infectious waste, and petroleum contaminated soils). In the past, LANL tracking efforts for chemical waste included construction and demolition debris and all other non-radioactive waste that managed through the Solid Chemical and Radioactive Waste Facilities. For waste projections in this SWEIS, construction and demolition debris are presented as a separate categories.

classified information—(1) Information that has been determined pursuant to Executive Order 12958, any successor order, or the Atomic Energy Act of 1954 (42 U.S.C. 2011) to require protection against unauthorized disclosure; (2) certain information requiring protection against unauthorized disclosure in the interest of national defense and security or foreign relations of the United States pursuant to Federal statute or Executive Order.

clay—The name for a family of finely crystalline sheet silicate minerals that commonly form as a product of rock weathering. Also, any particle smaller than or equal to about 0.002 millimeters (0.00008 inches) in diameter.

Clean Air Act—This Act mandates and provides for enforcement of regulations to control air pollution from various sources.

Clean Water Act of 1972, 1987—This Act regulates the discharge of pollutants from a point source into navigable waters of the United States in compliance with a National Pollutant Discharge Elimination System permit, and regulates discharges to or dredging of wetlands.

***Code of Federal Regulations* (CFR)—**All Federal regulations in effect are published in codified form in the CFR. References to the CFR usually take the form of XX CFR Part YY, where XX refers to Title (major division) and YY refers to Part (section).

collective dose—The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation. Collective dose is expressed in units of person-rem or person-sievert.

colluvium (colluvial)—A loose deposit of rock debris accumulated at the base of a cliff or slope.

committed dose equivalent—The dose equivalent to organs or tissues that will be received by an individual during the 50-year period following the intake of radioactive material. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rems or sieverts.

committed effective dose equivalent—The dose value obtained by—(1) multiplying the committed dose equivalents for the organs or tissues that are irradiated and the weighting factors applicable to those organs or tissues, and (2) summing all the resulting products. Committed effective dose equivalent is expressed in units of rem or sievert. (See committed dose equivalent and weighting factor.)

community (biotic)—All plants and animals occupying a specific area under relatively similar conditions.

community (environmental justice definition)—A group of people or a site within a spatial scope exposed to risks that potentially threaten health, ecology, or land values; or are exposed to industry that stimulates unwanted noise, smell, industrial traffic, particulate matter, or other nonaesthetic impacts.

Compliance Order on Consent (Consent Order)—An enforcement document signed by the New Mexico Environment Department, the U.S. Department of Energy, and the Regents of the University of California on March 1, 2005, which prescribes the requirements for corrective action at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the LANL Hazardous Waste Facility Permit.

conformity—Conformity is defined in the Clean Air Act as the action's compliance with an implementation plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards, and achieving expeditious attainment of such standards; and that such activities will not: (1) cause or contribute to any new violation of any standard in any area; (2) increase the frequency or severity of any existing violation of any standard in any area; or (3) delay timely attainment of any standard or any required interim emission reduction, or other milestones in any area.

contact-handled waste—Radioactive waste or waste packages whose external dose rate is low enough to permit contact handling by humans during normal waste management activities, (such as waste with a surface dose rate not greater than 200 millirem per hour). (See remote-handled waste.)

container—With regard to radioactive wastes, the metal envelope in the waste package that provides the primary containment function of the waste package.

contamination—The deposition of undesirable radioactive material on the surfaces of structures, areas, objects, or personnel.

control rod—A rod containing material such as boron that is used to control the power of a nuclear reactor. By absorbing excess neutrons, a control rod prevents the neutrons from causing further fissions that would increase power generation.

coolant—A substance, either gas or liquid, circulated through a nuclear reactor or processing plant to remove heat.

criteria pollutants—An air pollutant that is regulated by National Ambient Air Quality Standards. The U.S. Environmental Protection Agency must describe the characteristics and potential health and welfare effects that form the basis for setting, or revising, the standard for each regulated pollutant. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter, less than or equal to 10 micrometers (0.0004 inch) in diameter, and less than or equal to 2.5 micrometers (0.0001 inch) in diameter. New pollutants may be added to, or removed from, the list of criteria pollutants as more information becomes available. (See National Ambient Air Quality Standards.)

critical assembly—A critical assembly is a system of fissile material (uranium-233, uranium-235, plutonium-239, or plutonium-241) with or without a moderator in a specific proportion and shape. The critical assembly can be gradually built up by adding additional fissile material and/or moderator until this system achieves the dimensions necessary for a criticality condition. A continuous neutron source is placed at the center of this assembly to measure the fission rate of the critical assembly as it approaches and reaches criticality.

critical habitat—Habitat essential to the conservation of an endangered or threatened species that has been designated as critical by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the Endangered Species Act and its implementing regulations (50 CFR Part 424). The lists of Critical Habitats can be found in 50 CFR 17.95 (fish and wildlife), 50 CFR 17.96 (plants), and 50 CFR Part 226 (marine species). (See endangered species and threatened species.)

critical mass—The smallest mass of fissionable material that will support a self-sustaining nuclear chain reaction.

criticality—The condition in which a system is capable of sustaining a nuclear chain reaction.

cultural resources—Archaeological materials (artifacts) and sites that date to the prehistoric, historic, and ethnohistoric periods and that are currently located on the ground surface or buried beneath it; standing structures and/or their component parts that are over 50 years of age and are important because they represent a major historical theme or era, including the Manhattan Project and the Cold War era and structures that have an important technological, architectural, or local significance; cultural and natural places, select natural resources, and sacred objects that have importance for American Indians; American folklife traditions and arts; "historic properties" as defined in the National Historic Preservation Act; "archaeological resource" as defined in the Archaeological Resources Protection Act; and "cultural items" as defined in the Native American Graves Protection and Repatriation Act.

cumulative impacts—The impacts on the environment that result from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions, regardless of the agency or person who undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

curie—A unit of radioactivity equal to 37 billion disintegrations per second (37 billion becquerels); also a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

deactivation—The placement of a facility in a radiologically and industrially safe shutdown condition that is suitable for a long-term surveillance and maintenance phase prior to final decontamination and decommissioning.

decay (radioactive)—The decrease in the amount of any radioactive material with the passage of time due to spontaneous nuclear disintegration (the emission from atomic nuclei of charged particles, photons, or both).

decibel (dB)—A unit for expressing the relative intensity of sounds on a logarithmic scale where 0 is below human perception and 130 is above the threshold of pain to humans. For traffic and industrial noise measurements, the A-weighted decibel, a frequency-weighted noise unit, is widely used. The A-weighted decibel scale corresponds approximately to the frequency response of the human ear and thus correlates well with loudness.

decibel, A-weighted (dBA)—A unit of frequency-weighted sound pressure level, measured by the use of a metering characteristic and the “A” weighting specified by the American National Standards Institution (ANSI S1.4-1983 [R1594]) that accounts for the frequency response of the human ear.

decommissioning—Retirement of a facility, including any necessary decontamination and dismantlement.

decontamination—The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive or chemical contamination, from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

decontamination, decommissioning, and demolition (DD&D) – actions taken at the end of the useful life of a building or structure to reduce or remove substances that pose a substantial hazard to human health or the environment, retire it from service, and ultimately eliminate all or a portion of the structure.

degrees C (degrees Celsius)—A unit for measuring temperature using the centigrade scale in which the freezing point of water is 0 degrees and the boiling point is 100 degrees.

degrees F (degrees Fahrenheit)—A unit for measuring temperature using the Fahrenheit scale in which the freezing point of water is 32 degrees and the boiling point is 212 degrees.

depleted uranium—Uranium whose content of the fissile isotope uranium-235 is less than the 0.7 percent (by weight) found in natural uranium, so that it contains more uranium-238 than natural uranium. (See enriched uranium, highly enriched uranium, natural uranium, low-enriched uranium, and uranium.)

deposition—In geology, the laying down of potential rock-forming materials; sedimentation. In atmospheric transport, the settling on ground and building surfaces of atmospheric aerosols and particles ("dry deposition") or their removal from the air to the ground by precipitation ("wet deposition" or "rainout").

design basis—For nuclear facilities, information that identifies the specific functions to be performed by a structure, system, or component, and the specific values (or ranges of values) chosen for controlling parameters for reference bounds for design. These values may be: (1) restraints derived from generally accepted state-of-the-art practices for achieving functional goals; (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals; or (3) requirements derived from Federal safety objectives, principles, goals, or requirements.

dewatering—The removal of water. Saturated soils are "dewatered" to make construction of building foundations easier.

discharge—In surface water hydrology, the amount of water issuing from a spring or in a stream that passes a specific point in a given period of time.

disposition—The ultimate "fate" or end use of a surplus U.S. Department of Energy facility following the transfer of the facility to the Office of the Assistant Secretary for Environmental Management.

diversion—The unauthorized removal of nuclear material from its approved use or authorized location.

DOE Orders—Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dose (radiological)—A generic term meaning absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or committed equivalent dose, as defined elsewhere in this glossary. It is a measure of the energy imparted to matter by ionizing radiation. The unit of dose is the rem or rad.

dose equivalent—A measure of radiological dose that correlates with biological effect on a common scale for all types of ionizing radiation. Defined as a quantity equal to the absorbed dose in tissue multiplied by a quality factor (the biological effectiveness of a given type of radiation) and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert.

dose rate—The radiation dose delivered per unit of time (such as rem per year).

dosimeter—A small device (instrument) carried by a radiation worker that measures cumulative radiation dose (such as a film badge or ionization chamber).

drinking water standards—The level of constituents or characteristics in a drinking water supply specified in regulations under the Safe Drinking Water Act as the maximum permissible.

ecology—A branch of science dealing with the interrelationships of living organisms with one another and with their nonliving environment.

ecosystem—A community of organisms and their physical environment interacting as an ecological unit.

effective dose equivalent—The dose value obtained by multiplying the dose equivalents received by specified tissues or organs of the body by the appropriate weighting factors applicable to the tissues or organs irradiated, and then summing all of the resulting products. It includes the dose from radiation sources internal and external to the body. The effective dose equivalent is expressed in units of rems or sieverts. (See committed dose equivalent and committed effective dose equivalent.)

effluent—A waste stream flowing into the atmosphere, surface water, groundwater, or soil. Most frequently the term applies to wastes discharged to surface waters.

electron—An elementary particle with a mass of 9.107×10^{-28} gram (or 1/1,837 of a proton) and a negative charge. Electrons surround the positively charged nucleus and determine the chemical properties of the atom.

emission—A material discharged into the atmosphere from a source operation or activity.

emission standards—Legally enforceable limits on the quantities and/or kinds of air contaminants that can be emitted into the atmosphere.

endangered species—Plants or animals that are in danger of extinction through all or a significant portion of their ranges and that have been listed as endangered by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures outlined in the Endangered Species Act and its implementing regulations (50 CFR Part 424). The lists of endangered species can be found in 50 CFR 17.11 for wildlife, 50 CFR 17.12 for plants, and 50 CFR 222.23(a) for marine organisms. (See threatened species.)

enriched uranium—Uranium whose content of the fissile isotope uranium-235 is greater than the 0.7 percent (by weight) found in natural uranium. (See depleted uranium, uranium, natural uranium, low-enriched uranium, and highly enriched uranium.)

Environment, Safety, and Health Program—In the context of the U.S. Department of Energy (DOE), encompasses those requirements, activities, and functions in the conduct of all DOE and DOE-controlled operations that are concerned with impacts to the biosphere; compliance with environmental laws, regulations, and standards controlling air, water, and soil pollution; limiting the risks to the well-being of both operating personnel and the general public; and protecting property against accidental loss and damage. Typical activities and functions related to this program include, but are not limited to, environmental protection, occupational safety, fire protection, industrial hygiene, health physics, occupational medicine, process and facility safety, nuclear safety, emergency preparedness, quality assurance, and radioactive and hazardous waste management.

environmental impact statement (EIS)—The detailed written statement required by the National Environmental Policy Act (NEPA) section 102(2)(C) for a proposed major Federal action significantly affecting the quality of the human environment. A U.S. Department of Energy (DOE) EIS is prepared in accordance with applicable requirements of the Council on Environmental Quality National Environmental Policy Act regulations in 40 CFR Parts 1500 to 1508 and DOE NEPA regulations in 10 CFR Part 1021. The statement includes, among other information, discussions of the environmental impacts of the Proposed Action and all reasonable alternatives, adverse environmental effects that cannot be avoided should the proposal be implemented, the relationship between short-term uses of the human environment and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources.

environmental justice—The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Executive Order 12898 directs Federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations. (See minority population and low-income population.)

ephemeral stream—A stream that flows only after a period of heavy precipitation.

epidemiology—Study of the occurrence, causes, and distribution of disease or other health-related states and events in human populations, often as related to age, sex, occupation, ethnicity, and economic status, to identify and alleviate health problems and promote better health.

excavation—A cavity in the Earth's surface formed by cutting, digging, or scooping by excavating, such as with the use of heavy construction equipment.

exposure limit—The level of exposure to a hazardous chemical (set by law or a standard) at which or below which adverse human health effects are not expected to occur.

fault—A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred. A normal fault occurs when the hanging wall has been depressed in relation to the footwall. A reverse fault occurs when the hanging wall has been raised in relation to the footwall.

fissile materials—An isotope that readily fissions after absorbing a neutron of any energy, either fast or slow. Fissile materials are uranium-235, uranium-233, plutonium-239, and plutonium-241. Uranium-235 is the only naturally occurring fissile isotope. Although sometimes used as a synonym for fissionable material, this term has acquired a more restricted meaning, namely, any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

fission—The splitting of the nucleus of a heavy atom into two lighter nuclei. It is accompanied by the release of neutrons, gamma rays, and kinetic energy of fission products.

fission products—Nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the fission fragments' radioactive decay.

floodplain—The lowlands and relatively flat areas adjoining inland and coastal waters and the flood prone areas of offshore islands. Floodplains include, at a minimum, that area with at least a 1.0 percent chance of being inundated by a flood in any given year.

> The *base floodplain* is defined as the area that has a 1.0 percent or greater chance of being flooded in any given year. Such a flood is known as a 100-year flood.
>
> The *critical action floodplain* is defined as the area that has at least a 0.2 percent chance of being flooded in any given year. Such a flood is known as a 500-year flood. Any activity for which even a slight chance of flooding would be too great (such as storage of highly volatile, toxic, or water-reactive materials) should not occur in the critical action floodplain.
>
> The *probable maximum flood* is the hypothetical flood considered to be the most severe reasonably possible flood, based on the comprehensive hydrometeorological application of maximum precipitation and other hydrological factors favorable for maximum flood runoff (such as sequential storms and snowmelts). It is usually several times larger than the maximum recorded flood.

flux—Rate of flow through a unit area; in reactor operation, the apparent flow of neutrons in a defined energy range. (See neutron flux.)

formation—In geology, the primary unit of formal stratigraphic mapping or description. Most formations possess certain distinctive features.

fugitive emissions—(1) Emissions that do not pass through a stack, vent, chimney, or similar opening where they could be captured by a control device, or (2) any air pollutant emitted to the atmosphere other than from a stack. Sources of fugitive emissions include pumps; valves; flanges; seals; area sources such as ponds, lagoons, landfills, piles of stored material (such as coal); and road construction areas or other areas where earthwork is occurring.

gabions—Wire mesh boxes filled with rock used as a nonvegetative stabilization measure.

gamma radiation—High-energy, short wavelength, electromagnetic radiation emitted from the nucleus of an atom during radioactive decay. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded by dense materials, such as lead or depleted uranium. Gamma rays are similar to, but are usually more energetic than, x-rays.

genetic effects—Inheritable changes (chiefly mutations) produced by exposure to ionizing radiation or other chemical or physical agents of the parts of cells that control biological reproduction and inheritance.

genomics—The study of genes and their function.

geology—The science that deals with the Earth—the materials, processes, environments, and history of the planet, including rocks and their formation and structure.

glovebox—Large enclosure that separates workers from equipment used to process hazardous material, while allowing the workers to be in physical contact with the equipment; normally constructed of stainless steel, with large acrylic/lead glass windows. Workers have access to equipment through the use of heavy-duty, lead-impregnated rubber gloves, the cuffs of which are sealed in portholes in the glovebox windows.

graben—A usually elongated depression between geologic faults.

grading—Any stripping, cutting, filling, stockpiling, or combination thereof that modifies the land surface.

ground shine—The radiation dose received from an area on the ground where radioactivity has been deposited by a radioactive plume or cloud.

groundwater—Water below the ground surface in a zone of saturation.

habitat—The environment occupied by individuals of a particular species, population, or community.

half-life—The time in which one-half of the atoms of a particular radioactive isotope disintegrate to another nuclear form. Half-lives vary from millionths of a second to billions of years.

Hazard Index—The ratio of the potential exposure to a substance and the highest exposure level at which no adverse effects are expected. If the Hazard Index is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Index is greater than 1, then adverse health effects are possible.

hazardous air pollutants—Air pollutants not covered by ambient air quality standards but which may present a threat of adverse human health effects or adverse environmental effects. Those specifically listed in 40 CFR 61.01 are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, hazardous air pollutants are any of the 189 pollutants listed in or pursuant to the Clean Air Act, Section 112(b). Very generally, hazardous air pollutants are any air pollutants that may realistically be expected to pose a threat to human health or welfare.

hazardous chemical—Under 29 CFR Part 1910 Subpart Z, hazardous chemicals are defined as “any chemical which is a physical hazard or a health hazard.” Physical hazards include combustible liquids, compressed gases, explosives, flammables, organic peroxides, oxidizers, pyrophorics, and reactives. A health hazard is any chemical for which there is good evidence that acute or chronic health effects occur in exposed employees. Hazardous chemicals include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, agents that act on the hematopoietic system, and agents that damage the lungs, skin, eyes, or mucous membranes.

hazardous material—A material, including a hazardous substance, as defined by 49 CFR 171.8, that poses a risk to health, safety, and property when transported or handled.

hazardous waste—A category of waste regulated under the Resource Conservation and Recovery Act (RCRA). To be considered hazardous, a waste must be a solid waste under RCRA and must exhibit at least one of four characteristics described in 40 CFR 261.20-24 (ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the U.S. Environmental Protection Agency in 40 CFR 261.31-33.

hazards classification—The process of identifying the potential threat to human health of a chemical substance.

high-efficiency particulate air (HEPA) filter—An air filter capable of removing at least 99.97 percent of particles 0.3 micrometers (about 0.00001 inches) in diameter. High-efficiency particulate air filters include a pleated fibrous medium (typically fiberglass) capable of capturing very small particles.

high-level radioactive waste—High level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

highly enriched uranium—Uranium whose content of the fissile isotope uranium-235 has been increased through enrichment to 20 percent or more (by weight). (See uranium, natural uranium, enriched uranium, highly enriched uranium, and depleted uranium.)

historic artifact scatter/trash scatter—A concentration of items produced and deposited after AD 1593 (but most typically in the Los Alamos area deposited after about AD 1900).

historic resources—Archaeological sites, architectural structures, and objects produced after the advent of written history, dating to the time of the first European-American contact in an area.

historic structure—A building or other structure constructed after AD 1593 (but most typically in the Los Alamos area constructed after about AD 1900).

Holocene—An epoch of the Quaternary period that began at the end of the Pleistocene, or the "Ice Age," about 10,000 years ago and continuing to the present. It is named from the Greek words "holos" (entire) and "ceno" (new).

hot cell—A shielded facility that requires the use of remote manipulators for handling radioactive materials.

hydrology—The science dealing with the properties, distribution, and circulation of natural water systems.

hydrophobic soils—Non-permeable soil areas created as a result of very high temperatures often associated with wild fires).

Idaho National Laboratory (INL)—Formerly the Idaho National Engineering and Environmental Laboratory and the Argonne National Laboratory-West, INL is a U.S. Department of Energy (DOE) laboratory complex located in southeast Idaho about 25 miles west of Idaho Falls, that is managed and operated by a private consortium under contract to DOE.

incident-free risk—The radiological or chemical impacts resulting from emissions during normal operations and packages aboard vehicles in normal transport. This includes the radiation or hazardous chemical exposure of specific population groups and workers.

injection wells—A well that takes water from the surface into the ground, either through gravity or by mechanical means.

ion—An atom that has too many or too few electrons, causing it to be electrically charged.

ion exchange—A unit physiochemical process that removes anions and cations, including radionuclides, from liquid streams (usually water) for the purpose of purification or decontamination.

ion exchange resin—An organic polymer that functions as an acid or base. These resins are used to remove ionic material from a solution. Cation exchange resins are used to remove positively charged particles (cations), and anion exchange resins are used to remove negatively charged particles (anions).

ionizing radiation—Alpha particles, beta particles, gamma rays, high-speed electrons, high-speed protons, and other particles or electromagnetic radiation that can displace electrons from atoms or molecules, thereby producing ions.

irradiated—Exposure to ionizing radiation. The condition of reactor fuel elements and other materials in which atoms bombarded with nuclear particles have undergone nuclear changes.

isolates—A population of bacteria or other cells that has been isolated.

isotope—Any of two or more variations of an element in which the nuclei have the same number of protons (and thus the same atomic number), but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable; carbon-14 is radioactive).

joule—A metric unit of energy, work, or heat, equivalent to one watt-second, 0.737 foot-pound, or 0.239 calories.

landscape character—The arrangement of a particular landscape as formed by the variety and intensity of the landscape features (land, water, vegetation, and structures) and the four basic elements (form, line, color, and texture). These factors give an area a distinctive quality that distinguishes it from its immediate surroundings.

latent cancer fatalities (LCFs)—Deaths from cancer occurring some time after, and postulated to be due to, exposure to ionizing radiation or other carcinogens.

lithic scatter—The description of rocks on the basis of such characteristics as color, mineralogic composition, and grain size.

loam—Soil material that is composed of 7 percent to 27 percent clay particles, 28 percent to 50 percent silt particles, and less than 52 percent sand particles.

long-lived radionuclides—Radioactive isotopes with half-lives greater than 30 years.

long-term impact—In general, an impact that endures beyond the timeframe of the action or activity that causes the impact.

low-income population—Low-income populations, defined in terms of Bureau of the Census annual statistical poverty levels (Current Population Reports, Series P-60 on Income and Poverty), may consist of groups or individuals who live in geographic proximity to one another or who are geographically dispersed or transient (such as migrant workers or American Indians), where either group experiences common conditions of environmental exposure or effect. (See environmental justice and minority population.)

low-level radioactive waste—Waste that contains radioactivity but is not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material as defined by Section 11e (2) of the Atomic Energy Act of 1954, as amended. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level radioactive waste, provided the concentration of transuranic waste is less than 100 nanocuries per gram.

material access area—A type of security area that is authorized to contain a security Category I quantity of special nuclear material and which has specifically defined physical barriers, is located within a Protected Area, and is subject to specific access controls.

material characterization—The measurement of basic material properties, and the change in those properties as a function of temperature, pressure, or other factors.

material control and accountability—The part of safeguards that detects or deters theft or diversion of nuclear materials and provides assurance that all nuclear materials are accounted for appropriately.

material disposal area (MDA)—An area used any time between the beginning of Los Alamos National Laboratory operations in the early 1940s and the present for disposing of chemically, radioactively, or chemically and radioactively contaminated materials.

maximally exposed individual (MEI)—A hypothetical individual whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure routes (inhalation, ingestion, direct exposure).

maximally exposed individual (transportation analysis)—A hypothetical individual receiving radiation doses from transporting radioactive materials on the road. For the incident-free transport operation, the maximally exposed individual would be an individual stuck in traffic next to the shipment for 30 minutes. For accident conditions, the maximally exposed individual is assumed to be an individual located approximately 33 meters (100 feet) directly downwind from the accident.

maximum contaminant level—The designation for U.S. Environmental Protection Agency standards for drinking water quality under the Safe Drinking Water Act. The maximum contaminant level for a given substance is the maximum permissible concentration of that substance in water delivered by a public water system. The primary maximum contaminant levels (40 CFR Part 141) are intended to protect public health and are federally enforceable. They are based on health factors, but are also required by law to reflect the technological and economic feasibility of removing the contaminant from the water supply. Secondary maximum contaminant levels (40 CFR Part 143) are set by the U.S. Environmental Protection Agency to protect the public welfare. The secondary drinking water regulations control substances in drinking water that primarily affect aesthetic qualities (such as taste, odor, and color) relating to the public acceptance of water. These regulations are not federally enforceable, but are intended as guidelines for the states.

megawatt—A unit of power equal to 1 million watts. Megawatt thermal is commonly used to define heat produced, while megawatt-electric defines electricity produced.

metabolomics—The study of the small molecules, or metabolites, contained in a human cell, tissue or organ (including fluids) and involved in primary and intermediary metabolism.

MeV (million electron volts)—A unit used to quantify energy. In this SWEIS, it describes a particle's kinetic energy, which is an indicator of particle speed.

micron—One-millionth of 1 meter.

migration—The natural movement of a material through the air, soil, or groundwater; also, seasonal movement of animals from one area to another.

Migratory Bird Treaty Act—This Act states that it is unlawful to pursue, take, attempt to take, capture, possess, or kill any migratory bird, or any part, nest, or egg of any such bird other than permitted activities.

millirem—One-thousandth of 1 rem.

minority population—Minority populations exist where either: (a) the minority population of the affected area exceeds 50 percent, or (b) the minority population percentage of the affected area is meaningfully greater than in the general population or other appropriate unit of geographic analysis (such as a governing body's jurisdiction, a neighborhood, census tract, or other similar unit). "Minority" refers to individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. "Minority populations" include either a single minority group or the total of all minority persons in the affected area. They may consist of groups of individuals living in geographic proximity to one another or a geographically dispersed/transient set of individuals (such as migrant workers or American Indians), where either group experiences common conditions of environmental exposure or effect. (See environmental justice and low-income population.)

mitigate—Mitigation includes: (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; or (5) compensating for an impact by replacing or providing substitute resources or environments.

mixed waste—Waste that contains both nonradioactive hazardous waste and radioactive waste, as defined in this glossary.

National Ambient Air Quality Standards—Standards defining the highest allowable levels of certain pollutants in the ambient air (the outdoor air to which the public has access). Because the U.S. Environmental Protection Agency must establish the criteria for setting these standards, the regulated pollutants are called *criteria* pollutants. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter (less than or equal to 10 micrometers [0.0004 inches] in diameter and less than or equal to 2.5 micrometers [0.0001 inches] in diameter). Primary standards are established to protect public health; secondary standards are established to protect public welfare (such as visibility, crops, animals, buildings). (See criteria pollutant.)

National Emission Standards for Hazardous Air Pollutants—Emissions standards set by the U.S. Environmental Protection Agency for air pollutants which are not covered by National Ambient Air Quality Standards and which may, at sufficiently high levels, cause increased fatalities, irreversible health effects, or incapacitating illness. These standards are given in 40 CFR Parts 61 and 63. National Emission Standards for Hazardous Air Pollutants are given for many specific categories of sources (such as equipment leaks, industrial process cooling towers, dry cleaning facilities, petroleum refineries). (See hazardous air pollutants.)

National Environmental Policy Act (NEPA) of 1969—This Act is the basic national charter for protection of the environment. It establishes policy, sets goals (Section 101), and provides means (Section 102) for carrying out policy. Section 102(2) contains "action-forcing" provisions to ensure that Federal agencies follow the letter and spirit of the act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the National Environmental Policy Act requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the Proposed Action and other specified information.

National Historic Preservation Act—This Act provides that property resources with significant national historic value be placed on the National Register of Historic Places. It does not require any permits, but pursuant to Federal code, if a Proposed Action might impact a historic property resource, it mandates consultation with the proper agencies.

National Pollutant Discharge Elimination System—A provision of the Clean Water Act which prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the U.S. Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation. The National Pollutant Discharge Elimination System permit lists either permissible discharges, the level of cleanup technology required for wastewater, or both.

National Register of Historic Places—The official list of the Nation's cultural resources that are worthy of preservation. The National Park Service maintains the list under direction of the Secretary of the Interior. Buildings, structures, objects, sites, and districts are included in the National Register for their importance in American history, architecture, archaeology, culture, or engineering. Properties included on the National Register range from large-scale, monumentally proportioned buildings to smaller-scale, regionally distinctive buildings. The listed properties are not just of nationwide importance; most are significant primarily at the state or local level. Procedures for listing properties on the National Register are found in 36 CFR Part 60.

natural phenomena accidents—Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, etc.

natural uranium—Uranium with the naturally occurring distribution of uranium isotopes (approximately 0.7-weight percent uranium-235, and the remainder essentially uranium-238). (See uranium, depleted uranium, enriched uranium, highly enriched uranium, and low-enriched uranium.)

neptunium-237—A manmade element, with the atomic number 93. Pure neptunium is a silvery metal. The neptunium-237 isotope has a half-life of 2.14 million years. When neptunium-237 is bombarded by neutrons, it is transformed to neptunium-238, which in turn undergoes radioactive decay to become plutonium-238. When neptunium-237 undergoes radioactive decay, it emits alpha particles and gamma rays.

neutron—An uncharged elementary particle with a mass slightly greater than that of the proton. Neutrons are found in the nucleus of every atom heavier than hydrogen-1.

neutron flux—The product of neutron number density and velocity (energy), giving an apparent number of neutrons flowing through a unit area per unit time.

nitrogen—A natural element with the atomic number 7. It is diatomic in nature and is a colorless and odorless gas that constitutes about four-fifths of the volume of the atmosphere.

nitrogen oxides—Refers to the oxides of nitrogen, primarily nitrogen oxide and nitrogen dioxide. These are produced in the combustion of fossil fuels and can constitute an air pollution problem. Nitrogen dioxide emissions contribute to acid deposition and formation of atmospheric ozone.

noise—Undesirable sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities (hearing, sleep), damage hearing, or diminish the quality of the environment.

noise pollution—Any sound that is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying or undesirable.

nonattainment area—An area that the U.S. Environmental Protection Agency has designated as not meeting (not being in attainment of) one or more of the National Ambient Air Quality Standards for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants, but not for others. (See attainment area, National Ambient Air Quality Standards, and particulate matter.)

non-nuclear aboveground experimentation—Aboveground experimentation or testing in support of nuclear weapons programs that does not involve detonation of a nuclear explosive.

nonproliferation—Preventing the spread of nuclear weapons, nuclear weapon materials, and nuclear weapon technology.

normal operations—All normal (incident-free) conditions and those abnormal conditions that frequency estimation techniques indicate occur with a frequency greater than 0.1 events per year.

Notice of Intent (NOI)—Public announcement that an environmental impact statement will be prepared and considered. It describes the Proposed Action, possible alternatives, and scoping process, including whether, when, and where any scoping meetings will be held. The NOI is usually published in the *Federal Register* and local media. The scoping process includes holding at least one public meeting and requesting written comments on issues and environmental concerns that an environmental impact statement should address.

nuclear criticality—See criticality.

nuclear explosive—Any assembly containing fissionable and/or fusionable materials and main-charge high-explosive parts or propellants capable of producing a nuclear detonation.

nuclear facility—A facility that is subject to requirements intended to control potential nuclear hazards. Defined in U.S. Department of Energy directives as any nuclear reactor or any other facility whose operations involve radioactive materials in such form and quantity that a significant nuclear hazard potentially exists to the employees or the general public.

nuclear material—Composite term applied to—(1) special nuclear material; (2) source material such as uranium or thorium or ores containing uranium or thorium; and (3) byproduct material, which is any radioactive material that is made radioactive by exposure to the radiation incident to the process of producing or using special nuclear material.

nuclear reactor—A device that sustains a controlled nuclear fission chain reaction that releases energy in the form of heat.

Nuclear Regulatory Commission (NRC)—The Federal agency that regulates the civilian nuclear power industry in the United States.

nuclear weapon—The general name given to any weapon in which the explosion results from the energy released by reactions involving atomic nuclei, either fission, fusion, or both.

nuclear weapons complex—The sites supporting the research, development, design, manufacture, testing, assessment, certification, and maintenance of the Nation's nuclear weapons and the subsequent dismantlement of retired weapons.

nuclide—A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content.

Oak Ridge National Laboratory (ORNL)—A U.S. Department of Energy (DOE) laboratory complex located in eastern Tennessee about 25 miles west of Knoxville, that is managed and operated by a private consortium under contract to DOE.

Occupational Safety and Health Administration—The U.S. Federal Government agency that oversees and regulates workplace health and safety; created by the Occupational Safety and Health Act of 1970.

offsite—The term denotes a location, facility, or activity occurring outside the site boundary.

One- to three-room structure/fieldhouse—The remains of a small surface structure constructed of adobe, jacal, or masonry. This site typically consists of square to rectangular-shaped rock alignments, with individual units being no more than 3 m in length. The majority of these sites are identical to what many researchers term fieldhouses. Also included in the one- to three-room structure category is one example of a single unusually large rectangular structure, along with several smallish structures that are unusual due to the presence of upright stones or because of their location. Some of these "unusual" structures may represent shrines or other purposes not directly related to agriculture.

onsite—The term denotes a location or activity occurring within the boundary of a DOE complex site.

oralloy—Introduced in early Los Alamos documents to mean enriched uranium (Oak Ridge alloy); now uncommon except to signify highly enriched uranium.

outfall—The discharge point of a drain, sewer, or pipe as it empties into the environment.

ozone—The triatomic form of oxygen; in the stratosphere, ozone protects the Earth from the sun's ultraviolet rays, but in lower levels of the atmosphere, ozone is considered an air pollutant.

package—For radioactive materials, the packaging, together with its radioactive contents, as presented for transport (the packaging plus the radioactive contents equals the package).

packaging—With regard to hazardous or radionuclide materials, the assembly of components necessary to ensure compliance with Federal regulations. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle tie-down system and auxiliary equipment may be designated as part of the packaging.

paleontological resources—The physical remains, impressions, or traces of plants or animals from a former geologic age; may be sources of information on ancient environments and the evolutionary development of plants and animals.

particulate matter (PM)—Any finely divided solid or liquid material, other than uncombined (pure) water. A subscript denotes the upper limit of the diameter of particles included. Thus, PM_{10} includes only those particles equal to or less than 10 micrometers (0.0004 inches) in diameter; $PM_{2.5}$ includes only those particles equal to or less than 2.5 micrometers (0.0001 inches) in diameter.

perennial stream—A stream that flows throughout the year.

permeability—In geology, the ability of rock or soil to transmit a fluid.

person-rem—A unit of collective radiation dose applied to populations or groups of individuals; that is, a unit for expressing the dose when summed across all persons in a specified population or group. One person-rem equals 0.01 person-sieverts. (See collective dose.)

Perimeter Intrusion Detection and Assessment System (PIDAS)—A mutually supporting combination of barriers, clear zones, lighting, and electronic intrusion detection, assessment, and access control systems constituting the perimeter of the Protected Area and designed to detect, impede, control, or deny access to the Protected Area.

pit—The central core of a primary assembly in a nuclear weapon typically composed of plutonium-239 and/or highly-enriched uranium and other materials.

Plaza Pueblo—Contains one or more pueblo roomblocks that partially or completely enclose a plaza. Plaza pueblos typically are much larger (in both room numbers and site size) than single pueblo roomblock sites.

Pleistocene—The geologic time period of the earliest epoch of the Quaternary period, spanning between about 1.6 million years ago and the beginning of the Holocene epoch at 10,000 years ago. It is characterized by the succession of northern glaciations and also called the "Ice Age."

plume—The elongated volume of contaminated water or air originating at a pollutant source such as an outlet pipe or a smokestack. A plume eventually diffuses into a larger volume of less contaminated material as it is transported away from the source.

plutonium—A heavy, radioactive, metallic element with the atomic number 94. It is produced artificially by neutron bombardment of uranium. Plutonium has 15 isotopes with atomic masses ranging from 232 to 246 and half-lives from 20 minutes to 76 million years.

plutonium-238—An isotope with a half-life of 87.74 years used as the heat source for radioisotope power systems. When plutonium-238 undergoes radioactive decay, it emits alpha particles and gamma rays. Plutonium-238 may fission if exposed to neutrons. The likelihood of plutonium-238 undergoing fission is dependent upon many factors including the number and energy of neutrons, temperature, plutonium-238 purity and shape, and the presence and proximity of other elements.

plutonium-239—An isotope with a half-life of 24,110 years that is the primary radionuclide in weapons-grade plutonium. When plutonium-239 decays, it emits alpha particles. Plutonium-239 may fission if exposed to neutrons. The likelihood of plutonium-239 undergoing fission is dependent upon many factors including the number and energy of neutrons, temperature, plutonium-239 purity and shape, and the presence and proximity of other elements.

population dose—See collective dose.

potential release site (PRS)—A site suspected of releasing or having the potential to release contaminants (radioactive, chemical, or both) into the environment. PRS is a generic term that includes solid waste management units and areas of concern that are cited and defined in the Compliance Order on Consent (Consent Order).

pounds per square inch—A measure of pressure; atmospheric pressure is about 14.7 pounds per square inch.

prehistoric resources—The physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield otherwise inaccessible information about the past.

Prevention of Significant Deterioration—Regulations established to prevent significant deterioration of air quality in areas that already meet National Ambient Air Quality Standards. Specific details of Prevention of Significant Deterioration are found in 40 CFR 51.166. Among other provisions, cumulative increases in sulfur dioxide, nitrogen dioxide, and PM_{10} levels after specified baseline dates must not exceed specified maximum allowable amounts. These allowable increases, also known as increments, are especially stringent in areas designated as Class I areas (such as national parks, wilderness areas) where the preservation of clean air is particularly important. All areas not designated as Class I are currently designated as Class II. Maximum increments in pollutant levels are also given in 40 CFR 51.166 for Class III areas, if any such areas should be so designated by EPA. Class III increments are less stringent than those for Class I or Class II areas. (See National Ambient Air Quality Standards.)

prime farmland—Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oil-seed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, without intolerable soil erosion, as determined by the Secretary of Agriculture (Farmland Protection Act of 1981, 7 CFR Part 7, paragraph 658).

probabilistic risk assessment—A comprehensive, logical, and structured methodology that accounts for population dynamics and human activity patterns at various levels of sophistication, considering time-space distributions and sensitive subpopulations. The probabilistic method results in a more complete characterization of the exposure information available, which is defined by probability distribution functions. This approach offers the possibility of an associated quantitative measure of the uncertainty around the value of interest.

process—Any method or technique designed to change the physical or chemical character of the product.

protactinium—An element that is produced by the radioactive decay of neptunium-237. The pure metal has a bright metallic luster. The protactinium-233 isotope has a half-life of 27 days and emits beta particles and gamma rays during radioactive decay.

Protected Area—A type of security area defined by physical barriers (walls or fences), to which access is controlled, used for protection of security Category II special nuclear materials and classified matter and/or to provide a concentric security zone surrounding a Material Access Area (security Category I nuclear materials) or a Vital Area.

Proteomics—The analysis of the expression, localizations, functions, and interactions of the proteins expressed by the genetic material of an organism.

proton—An elementary nuclear particle with a positive charge equal in magnitude to the negative charge of the electron; it is a constituent of all atomic nuclei, and the atomic number of an element indicates the number of protons in the nucleus of each atom of that element.

Pueblo roomblock—The remains of a contiguous, multi-room habitation structure (four or more rooms with no enclosed plaza) constructed of adobe, jacal, or masonry. In several cases, somewhat amorphous mounds containing evidence of stone rubble but no distinct alignments were included in this category.

Quaternary—The second geologic time period of the Cenozoic era, dating from about 1.6 million years ago to the present. It contains two epochs: the Pleistocene and the Holocene. It is characterized by the first appearance of human beings on Earth.

rad—See radiation absorbed dose.

radiation (ionizing)—See ionizing radiation.

radiation absorbed dose (rad)—The basic unit of absorbed dose equal to the absorption of 0.01 joules per kilogram (100 ergs per gram) of absorbing material.

radioactive waste—In general, waste that is managed for its radioactive content. Waste material that contains source, special nuclear, or byproduct material is subject to regulation as radioactive waste under the Atomic Energy Act. Also, waste material that contains accelerator-produced radioactive material or a high concentration of naturally occurring radioactive material may be considered radioactive waste.

radioactivity—

Defined as a *process*: The spontaneous transformation of unstable atomic nuclei, usually accompanied by the emission of ionizing radiation.

Defined as a *property*: The property of unstable nuclei in certain atoms to spontaneously emit ionizing radiation during nuclear transformations.

radioisotope or radionuclide—An unstable isotope that undergoes spontaneous transformation, emitting radiation. (See isotope.)

radioisotope power system—Any one of a number of technologies used in spacecraft and in national security technologies that produces heat or electricity from the radioactive decay of suitable radioactive substances such as plutonium-238. They are typically used in applications such as to enable the operation of instruments and sensors where energy sources such as solar power are undesirable or impractical due to the remoteness or extreme conditions of the operating environment.

radioisotope thermoelectric generator (RTG)—An electrical generator that derives its electric power from heat produced by the decay of radioactive strontium-90, plutonium-238, or other suitable isotopes. The heat generated is directly converted into electricity, in a passive process, by an array of thermocouples.

radon—A gaseous, radioactive element with the atomic number 86, resulting from the radioactive decay of radium. Radon occurs naturally in the environment and can collect in unventilated enclosed areas, such as basements. Large concentrations of radon can cause lung cancer in humans.

RADTRAN—A computer code combining user-determined meteorological, demographic, transportation, packaging, and material factors with health physics data to calculate the expected radiological consequences and accident risk of transporting radioactive material.

reactor facility—Unless it is modified by words such as containment, vessel, or core, the term "reactor facility" includes the housing, equipment, and associated areas devoted to the operation and maintenance of one or more reactor cores. Any apparatus that is designed or used to sustain nuclear chain reactions in a controlled manner, including critical and pulsed assemblies and research, test, and power reactors, is defined as a reactor. All assemblies designed to perform subcritical experiments that could potentially reach criticality are also considered reactors.

Record of Decision (ROD)—A document prepared in accordance with the requirements of 40 CFR 1505.2 and 10 CFR 1021.315 that provides a concise public record of the U.S. Department of Energy's (DOE) decision on a Proposed Action for which an environmental impact statement was prepared. A ROD identifies the alternatives considered in reaching the decision; the environmentally preferable alternative; factors balanced by DOE in making the decision; and whether all practicable means to avoid or minimize environmental harm have been adopted, and, if not, the reason why they were not.

reference dose—The chronic-exposure dose (milligram or kilogram per day) for a given hazardous chemical at which or below which adverse human noncancer health effects are not expected to occur.

region of influence (ROI)—A site-specific geographic area in which the principal direct and indirect effects of actions are likely to occur.

rem (roentgen equivalent man)—A unit of dose equivalent. The dose equivalent in rem equals the absorbed dose in rad in tissue multiplied by the appropriate quality factor and possibly other modifying factors. Derived from "roentgen equivalent man," referring to the dosage of ionizing radiation that will cause the same biological effect as one roentgen of x-ray or gamma-ray exposure. One rem equals 0.01 sieverts. (See absorbed dose and dose equivalent.)

remediation—The process, or a phase in the process, of rendering radioactive, hazardous, or mixed waste environmentally safe, whether through processing, entombment, or other methods.

remote-handled waste—In general, refers to radioactive waste that must be handled at a distance to protect workers from unnecessary exposure (waste with a dose rate of 200 millirem per hour or more at the surface of the waste package). (See contact-handled waste.)

resin—See ion exchange resin.

Resource Conservation and Recovery Act (RCRA), as amended—A law that gives the U.S. Environmental Protection Agency the authority to control hazardous waste from "cradle to grave" (from the point of generation to the point of ultimate disposal), including its minimization, generation, transportation, treatment, storage, and disposal. The Resource Conservation and Recovery Act also sets forth a framework for the management of nonhazardous solid wastes. (See hazardous waste.)

riparian—Of, on, or relating to the banks of a natural course of water.

risk—The probability of a detrimental effect of exposure to a hazard. Risk is often expressed quantitatively as the probability of an adverse event occurring multiplied by the consequence of that event (in other words, the product of these two factors). However, separate presentation of probability and consequence is often more informative.

risk assessment (chemical or radiological)—The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific chemical or radiological materials.

rock shelter—An overhang, indentation, or alcove formed naturally in a rock face or large boulder, or alternatively, a partly enclosed area created by rock falls leaning against a rock face or large boulder, and which exhibits evidence of human use. Rock shelters generally are not of great depth, in contrast to caves.

roentgen—A unit of exposure to ionizing x- or gamma radiation equal to or producing one electrostatic unit of charge per cubic centimeter of air.

runoff—The portion of rainfall, melted snow, or irrigation water that flows across the ground surface, and eventually enters streams.

Safe Drinking Water Act—This Act protects the quality of public water supplies, water supply and distribution systems, and all sources of drinking water.

safeguards—An integrated system of physical protection, material accounting, and material control measures designed to deter, prevent, detect, and respond to unauthorized access, possession, use, or sabotage of nuclear materials.

Safety Analysis Report—A report that systematically identifies potential hazards within a nuclear facility, describes and analyzes the adequacy of measures to eliminate or control identified hazards, and analyzes potential accidents and their associated risks. Safety analysis reports are used to ensure that a nuclear facility can be constructed, operated, maintained, shut down, and decommissioned safely and in compliance with applicable laws and regulations. Safety analysis reports are required for U.S. Department of Energy nuclear facilities and as a part of applications for U.S. Nuclear Regulatory Commission licenses. The U.S. Nuclear Regulatory Commission regulations or DOE Orders and technical standards that apply to the facility type provide specific requirements for the content of safety analysis reports. (See nuclear facility.)

sand—Loose grains of rock or mineral sediment formed by weathering that range in size from 0.0625 to 2.0 millimeters (0.0025 to 0.08 inches) in diameter, and often consists of quartz particles.

sandstone—A sedimentary rock composed mostly of sand-size particles cemented usually by calcite, silica, or iron oxide.

sanitary waste—Wastes generated by normal housekeeping activities, liquid or solid (includes sludge), that are not hazardous or radioactive.

Savannah River Site (SRS)—A U.S. Department of Energy (DOE) industrial complex located in southwestern South Carolina about 20 miles southeast of Augusta, Georgia, that is managed and operated by a private consortium under contract to DOE.

scope—In a document prepared pursuant to the National Environmental Policy Act of 1969, the range of actions, alternatives, and impacts to be considered.

scoping—An early and open process, including public notice and involvement, for determining the scope of issues to be addressed in an environmental impact statement (EIS) and for identifying the significant issues related to a Proposed Action. The scoping period begins after publication in the *Federal Register* of a Notice of Intent to prepare an EIS. The public scoping process is that portion of the process where the public is invited to participate. The U.S. Department of Energy’s scoping procedures are found in 10 CFR 1021.311.

security—An integrated system of activities, systems, programs, facilities, and policies for the protection of Restricted Data and other classified information or matter, nuclear materials, nuclear weapons and nuclear weapons components, and/or U.S. Department of Energy or contractor facilities, property, and equipment.

sediment—Soil, sand, and minerals washed from land into water that deposit on the bottom of a water body.

seismic—Pertaining to any Earth vibration, especially an earthquake.

seismicity—The frequency and distribution of earthquakes.

select agent—A select agent is defined as an agent, virus, bacteria, fungi, rickettsiae or toxin listed in Appendix A of *Federal Register* 29327 (42 CFR Part 72) titled, *Additional Requirements for Facilities Transferring or Receiving Select Agents*. Select Agents also includes (a) genetically modified micro-organisms or (b) genetic elements that contain nucleic acid sequences associated with pathogenicity from organisms listed in Appendix A, (c) genetically modified micro-organisms listed in Appendix A, and (d) genetically modified micro-organisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in Appendix A, or their toxic subunits.

severe accident—An accident with a frequency rate of less than 10^{-6} per year that would have more severe consequences than a design-basis accident, in terms of damage to the facility, offsite consequences, or both. Also called a beyond-design-basis accident.

sewage—The total organic waste and wastewater generated by an industrial establishment or a community.

shielding—With regard to radiation, any material of obstruction (bulkheads, walls, or other construction) that absorbs radiation to protect personnel or equipment.

short-lived nuclides—Radioactive isotopes with half-lives no greater than about 30 years (such as cesium-137 and strontium-90).

short-term impact—In general, an impact that occurs during or for a short time after the action or activity that causes the impact.

silt—A sedimentary material consisting of fine mineral particles, intermediate in size between sand and clay. In general, soils categorized as silt show greater rates of erosion than soils categorized as sand.

soils—All unconsolidated materials above bedrock. Natural earthy materials on the Earth's surface, in places modified or even made by human activity, containing living matter, and supporting or capable of supporting plants out of doors.

solid waste management unit (SWMU)—Any discernible unit at which solid waste has been placed at any time, and from which the New Mexico Environment Department determines there may be a risk of a release of hazardous waste or hazardous waste constituents, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at the Facility (LANL) at which solid wastes have been routinely and systematically released; they do not include one-time spills. See 61 FR 19431 (May 1, 1996).

somatic effect—Any effect that may manifest in the body of the exposed individual over his or her lifetime.

source material—Depleted uranium, normal uranium, thorium, or any other nuclear material determined, pursuant to Section 61 of the Atomic Energy Act of 1954, as amended, to be source material, or ores containing one or more of the foregoing materials in such concentration as may be determined by regulation.

source term—The amount of a specific pollutant (chemicals, radionuclides) emitted or discharged to a particular environmental medium (air, water, earth) from a source or group of sources. It is usually expressed as a rate (amount per unit time).

spallation—A nuclear reaction in which the energy of the incident particle is so high that more than two or three particles are ejected from the target nucleus, and both its mass number and atomic number are changed.

special nuclear material(s)—A category of material subject to regulation under the Atomic Energy Act, consisting primarily of fissile materials. It is defined to mean plutonium, uranium-233, uranium enriched in the isotopes of uranium-233 or -235, and any other material that the Nuclear Regulatory Commission determines to be special nuclear material, but it does not include source material.

spectral characteristics—The natural property of a structure as it relates to the multidimensional temporal accelerations.

staging—The process of using several layers to achieve a combined effect greater than that of one layer.

stockpile—The inventory of active nuclear weapons for the strategic defense of the United States.

stockpile stewardship program—A program that ensures the operational readiness (safety and reliability) of the U.S. nuclear weapons stockpile by the appropriate balance of surveillance, experiments, and simulations.

straw wattles—Tubes of rice straw used for erosion control, sediment control and stormwater runoff control.

sulfur oxides—Common air pollutants (primarily sulfur dioxide), a heavy, pungent, colorless gas (formed in the combustion of fossil fuels, considered a major air pollutant) and sulfur trioxide. Sulfur dioxide is involved in the formation of acid rain. It can also irritate the upper respiratory tract and cause lung damage.

supernatant—The liquid that stands over a precipitated material.

surface water—All bodies of water on the surface of the Earth and open to the atmosphere, such as rivers, lakes, reservoirs, ponds, seas, and estuaries.

target—A tube, rod, or other form containing material that, on being irradiated in a nuclear reactor or an accelerator, would produce a desired end product.

technical area (TA)—Geographically distinct administrative units established for the control of LANL operations. There are currently 49 active TAs; 47 in the 41 square miles of the LANL site, one at Fenton Hill, west of the main site, and one comprising leased properties in town.

tectonic—Of or relating to motion in the Earth's crust and occurring on geologic faults.

Tertiary—The first geologic time period of the Cenozoic era (after the Mesozoic era and before the Quaternary period), spanning between about 66 million and 1.6 million years ago. During this period, mammals became the dominant life form on Earth.

threatened species—Any plants or animals that are likely to become endangered species within the foreseeable future throughout all or a significant portion of their ranges and which have been listed as threatened by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service following the procedures set out in the Endangered Species Act and its implementing regulations (50 CFR Part 424). (See endangered species.)

threshold limit values—The recommended highest concentrations of contaminants to which workers may be exposed according to the American Conference of Governmental Industrial Hygienists.

total effective dose equivalent—The sum of the effective dose equivalent from external exposures and the committed effective dose equivalent from internal exposures.

Toxic Substances Control Act of 1976—This Act authorizes the U.S. Environmental Protection Agency (EPA) to secure information on all new and existing chemical substances and to control any substances determined to cause an unreasonable risk to public health or the environment. This law requires that the health and environmental effects of all new chemicals be reviewed by the EPA before they are manufactured for commercial purposes.

transmutation—The transformation of one isotope into another isotope by changing its nuclear structure. It can occur naturally through radioactive decay, or the fission and neutron capture processes can be hastened by using nuclear reactors or particle accelerators. By converting long-lived hazards into materials that are, or soon will be, sable and harmless, the nuclear cycle is effectively complete.

transuranic—Refers to any element whose atomic number is higher than that of uranium (atomic number 92), including neptunium, plutonium, americium, and curium. All transuranic elements are produced artificially and are radioactive.

transuranic waste—Radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; of (3) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61 (DOE 435.1).

tuff—A fine-grained rock composed of ash or other material formed by volcanic explosion or aerial expulsion from a volcanic vent.

Type B packaging—A regulatory category of packaging for transportation of radioactive material. The U.S. Department of Transportation and U.S. Nuclear Regulatory Commission require Type B packaging for shipping highly radioactive material. Type B packages must be designed and demonstrated to retain their containment and shielding integrity under severe accident conditions, as well as under the normal conditions of transport. The current U.S. Nuclear Regulatory Commission testing criteria for Type B package designs (10 CFR Part 71) are intended to simulate severe accident conditions, including impact, puncture, fire, and immersion in water. The most widely recognized Type B packages are the massive casks used for transporting spent nuclear fuel. Large-capacity cranes and mechanical lifting equipment are usually needed to handle Type B packages.

Type B shipping cask—A U.S. Nuclear Regulatory Commission-certified cask with a protective covering that contains and shields radioactive materials, dissipates heat, prevents damage to the contents, and prevents criticality during normal shipment and accident conditions. It is used for transport of highly radioactive materials and is tested under severe, hypothetical accident conditions that demonstrate resistance to impact, puncture, fire, and submersion in water.

unconfomably—Refers to a break or gap in the geological time of deposited materials.

uranium—A radioactive, metallic element with the atomic number 92; one of the heaviest naturally occurring elements. Uranium has 14 known isotopes, of which uranium-238 is the most abundant in nature. Uranium-235 is commonly used as a fuel for nuclear fission. (See natural uranium, enriched uranium, highly enriched uranium, and depleted uranium.)

Vadose zone—The portion of Earth between the land surface and the water table.

vault (special nuclear material)—A penetration-resistant, windowless enclosure having an intrusion alarm system activated by opening the door and which also has—walls, floor, and ceiling substantially constructed of materials that afford forced-penetration resistance at least equivalent to that of 20-centimeter- (8-inch-) thick reinforced concrete; and a built-in combination-locked steel door, which for existing structures is at least 2.54-centimeters (1-inch) thick exclusive of bolt work and locking devices, and which for new structures meets standards set forth in Federal specifications and standards.

viewshed—The extent of an area that may be viewed from a particular location. Viewsheds are generally bounded by topographic features such as hills or mountains.

volatile organic compounds—A broad range of organic compounds, often halogenated, that vaporize at ambient or relatively low temperatures, such as benzene, chloroform, and methyl alcohol. With regard to air pollution, any organic compound that participates in atmospheric photochemical reaction, except for those designated by the U.S. Environmental Protection Agency Administrator as having negligible photochemical reactivity.

waste acceptance criteria—The requirements specifying the characteristics of waste and waste packaging acceptable to a disposal facility, and the documents and processes the generator needs to certify that the waste meets applicable requirements.

waste classification—Wastes are classified according to DOE Order 435.1, Radioactive Waste Management, and include high-level, transuranic, and low-level wastes.

Waste Isolation Pilot Plant (WIPP)—A U.S. Department of Energy facility designed and authorized to permanently dispose of defense-related transuranic waste in a mined underground facility in deep geologic salt beds. It is located in southeastern New Mexico, 42 kilometers (26 miles) east of the city of Carlsbad.

waste management—The planning, coordination, and direction of those functions related to generation, handling, treatment, storage, transportation, and disposal of waste, as well as associated surveillance and maintenance activities.

waste minimization and pollution prevention—An action that economically avoids or reduces the generation of waste and pollution by source reduction, reducing the toxicity of hazardous waste and pollution, improving energy use, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

water table—The boundary between the unsaturated zone and the deeper, saturated zone. The upper surface of an unconfined aquifer.

watt—A unit of power equal to 1 joule per second. (See joule.)

wetland—Wetlands are "... those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 328.3).

whole-body dose—In regard to radiation, dose resulting from the uniform exposure of all organs and tissues in a human body. (See effective dose equivalent.)

wind rose—A circular diagram showing, for a specific location, the percentage of the time the wind is from each compass direction. A wind rose for use in assessing consequences of airborne releases also shows the frequency of different wind speeds for each compass direction.

yield—The force in tons of TNT of a nuclear or thermonuclear explosion.

CHAPTER 9
INDEX

9. INDEX

E

F

G

H

I

J

L

M

N

O

P

R

S

T

U

V

W

X

Z

CHAPTER 10
LIST OF PREPARERS

10.0 LIST OF PREPARERS

ELIZABETH WITHERS, U.S. DEPARTMENT OF ENERGY, NATIONAL NUCLEAR SECURITY ADMINISTRATION (NEPA COMPLIANCE OFFICER, NNSA SERVICE CENTER)
EIS RESPONSIBILITIES: EIS DOCUMENT MANAGER, CHAPTER 1

Education: M.S., Life Sciences, Louisiana Tech University
B.S., Botany, Louisiana Tech University

Experience/Technical Specialty:
Twenty-four years. Environmental investigations and NEPA compliance.

KIRK OWENS, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PROJECT MANAGER

Education: B.S., Environmental Resource Management, The Pennsylvania State University

Experience/Technical Specialty:
Twenty-six years. Radioactive waste management, regulatory, and environmental compliance and assessment, radiological assessment.

STEPHEN R. ALCORN, TIME SOLUTIONS CORP.
EIS RESPONSIBILITIES: GROUNDWATER, GEOCHEMISTRY, EVAPOTRANSPIRATIVE COVERS

Education: Ph.D., Geology, University of Georgia
M.S., Geology, University of South Carolina
A.B., Geology, Lafayette College

Experience/Technical Specialty:
Twenty-seven years. Geology and geochemistry, transport behavior of radionuclides, geochemical and hydrological modeling and analysis, performance assessment, environmental compliance.

KAREN ANTIZZO, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PROJECT-SPECIFIC ANALYSES

Education: M.S., Technology/Environmental Management, University of Maryland
B.S., Education, Towson University

Experience/Technical Specialty:
Sixteen years. Infrastructure, radioactive waste management, regulatory review, public participation.

TERRI L. BINDER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: APPENDIX C, RADIOLOGICAL AIR EMISSIONS AND HUMAN HEALTH

Education: M.A., Organizational Learning and Instructional Technology
B.A., Mathematics

Experience/Technical Specialty:
Fifteen years. Radiological facility site-specific training, DOE compliance, computer programming.

KENNETH F. BRINSTER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: GROUNDWATER

Education: M.S., Geology, University of North Dakota
B.S., Biology and Education, Dickinson State University

Experience/Technical Specialty:
Twenty-eight years. Professional Geologist, Minnesota. Geology, hydrology, groundwater modeling, air permitting, solid and hazardous waste management, stormwater permitting, pollution prevention.

STEVEN P. CONNER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: GEOLOGY AND SOILS

Education: Ph.D., Geology, Texas A&M University
M.S., Geology, Texas A&M University
B.S. Geology, University of Delaware

Experience/Technical Specialty:
Seventeen years. Professional Geologist, South Carolina and Alabama. Environmental studies, risk assessment, earth resources and geologic characterization, contaminant fate and transport.

RICHARD D. CUNNINGHAM, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: APPENDIX J LEAD, PROJECT-SPECIFIC ANALYSES

Education: M.U.R.P., Urban and Regional Planning, University of Pittsburgh
Graduate Diploma in Social Science, Political Science, University of Stockholm
B.A., Political Science and History, Fairfield University

Experience/Technical Specialty:
Thirty-four years. NEPA, ES&H, environmental policy and regulations, facilities planning, land use, cultural resources, transportation.

M. J. DAVIS, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: WASTE MANAGEMENT

Education: J.D., Law, Georgetown University
B.S., Nuclear Engineering, University of Cincinnati

Experience/Technical Specialty:
Twenty-one years. Regulatory compliance and legal analysis, specializing in environmental protection.

ELLEN R. DIETRICH, SCIENCE APPLICATIONS INTERNATIONAL CORP.
EIS RESPONSIBILITIES: SUMMARY, WATER RESOURCES

Education: B.A., Anthropology, University of Illinois
Graduate school programs in Archaeology and Soil Science, The Pennsylvania State University

Experience/Technical Specialty:
Thirty years. Soil science, NEPA, soil and water resource planning and management.

JOHN DIMARZIO, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: CUMULATIVE IMPACTS

Education: M.S., Geology, George Washington University
B.S., Geology, University of Maryland

Experience/Technical Specialty:
Twenty-three years. NEPA compliance, geology, water resources, waste management, and cumulative impacts.

JOHN EICHNER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: CHAPTER 5 MANAGER, SOCIOECONOMICS

Education: B.S., Accounting, Syracuse University
B.S., Finance, Syracuse University

Experience/Technical Specialty:
Twenty-six years. Project management, impact analysis, socioeconomics, cost-benefit analyses.

SUSAN ENGELKE, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: APPENDIX G, PROJECT-SPECIFIC ANALYSES

Education: B.S., Environmental Science/Geology, University of California at Sacramento

Experience/Technical Specialty:
Four years. Environmental analyst on NEPA/CEQA documents.

SANDRA B. ENYEART, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: APPENDIX G LEAD, CUMULATIVE IMPACTS, PROJECT-SPECIFIC ANALYSES

Education: B.S., Civil Engineering, Georgia Institute of Technology
B.F.A., Art, Idaho State University

Experience/Technical Specialty:
Thirty-one years. Professional Engineer (Civil Engineer), Idaho. NEPA analysis, cumulative impacts, safety analyses, environmental monitoring, water resources management and impact analysis.

BETH FARRELL HALE, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PUBLIC AFFAIRS LEAD, EMERGENCY MANAGEMENT

Education: B.A., Liberal Arts, University of New Mexico

Experience/Technical Specialty:
Seventeen years. Public affairs, public involvement, and risk communication.
Fifteen years. Emergency management.

DEBBIE J. FINFROCK, TIME SOLUTIONS CORP.
EIS RESPONSIBILITIES: WATER RESOURCES

Education: M.S., Civil Engineering (Environmental Emphasis), University of New Mexico
B.S., Mechanical Engineering, University of Kentucky

Experience/Technical Specialty:
Twenty-four years. Professional Engineer, New Mexico. Waste management and pollution prevention, water resources management, landfill closure design and modeling.

KEVIN T. FOLK, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: INFRASTRUCTURE, PROJECT-SPECIFIC ANALYSES

Education: M.S., Environmental Biology, Hood College
B.A., Geoenvironmental Studies, Shippensburg University

Experience/Technical Specialty:
Seventeen years. Water resources management, utility infrastructure analysis, NPDES permitting and regulatory analysis, earth resources and geologic hazards assessment.

STEVE GEIGER, URS CORPORATION

EIS RESPONSIBILITIES: SCIENCE COMPLEX AND WAREHOUSE FACILITY PROJECT-SPECIFIC ANALYSES (WASTE AND WATER RESOURCES)

Education: Ph.D., Environmental/Agricultural Engineering, The Colorado State University
B.S., M.S. Civil Engineering, The University of New Mexico

Experience/Technical Specialty:

Sixteen years. Professional Engineer, New Mexico. Civil engineering, hydrology, and environmental engineering design, risk management, remediation, compliance, project management.

MILTON E. GORDEN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

EIS RESPONSIBILITIES: APPENDIX H CO-LEAD, PROJECT-SPECIFIC ANALYSES

Education: B.S., Nuclear Engineering, North Carolina State University

Experience/Technical Specialty:

Sixteen years. Engineer-in-training (Georgia). Waste management, transportation, human health impacts, socioeconomics, environmental remediation technologies.

TENA A. GRABEN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

EIS RESPONSIBILITIES: MATERIAL DISPOSAL AREAS CHARACTERIZATION AND HAZARD ASSESSMENT

Education: B.S., Professional Biology, University of North Alabama

Experience/Technical Specialty:

Twenty years. Applied health physics, occupational and environmental radiological hazards assessment and dose modeling, regulatory compliance, emergency management.

KATIE A. GRASTY, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

EIS RESPONSIBILITIES: GENERAL SUPPORT

Education: M.E.M., Conservation Science and Policy, Duke University
B.S., Geography, Radford University

Experience/Technical Specialty:

Two years. Environmental law and compliance, ecosystem and natural resource science.

CHADI D. GROOME, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: DEPUTY PROJECT MANAGER, CHAPTER 3 MANAGER

Education: M.S., Environmental Engineering Sciences, University of Florida
B.S., Zoology, Clemson University

Experience/Technical Specialty:
Twenty-six years. Environmental and nuclear regulatory compliance, permitting, and licensing, NPDES permitting, radioactive and hazardous waste management.

CATHY G. HAUPT, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: CHAPTER 6 MANAGER

Education: M.S., Science Education (Biology), Clarion University
B.S., Secondary Education (Geography/Environmental Science), Clarion State College

Experience/Technical Specialty:
Twenty-five years. Regulatory compliance, technical research, quality control.

ROBERT G. HOFFMAN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: APPENDIX H CO-LEAD, PROJECT-SPECIFIC ANALYSES

Education: B.S., Environmental Resource Management, The Pennsylvania State University

Experience/Technical Specialty:
Twenty years. NEPA compliance, regulatory review, land use planning.

ROBERT W. HULL, LOS ALAMOS TECHNICAL ASSOCIATES, INCORPORATED
EIS RESPONSIBILITIES: ENVIRONMENTAL REMIDIATION DATA AND ACCIDENT ANALYSIS

Education: M.S., Civil Engineering (focus Environmental Engineering), Stanford University
M.S., Geochemistry and Environmental Geology, Florida State University
B.S., Geology, Florida State University

Experience/Technical Specialty:
Thirty-five years. Environmental impacts assessments, environmental baseline surveys, human health risk assessment, environmental remediation.

JAMES D. JAMISON, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: HUMAN HEALTH IMPACTS, SPECIAL PATHWAYS ASSESSMENTS

Education: B.A., Physics, Doane College

Experience/Technical Specialty:
Thirty-six years. Certified Health Physicist. Occupational and environmental radiation safety, accident analysis, assessment of impacts from release of radioactive materials and toxic chemicals.

CHARLES M. JOHNSON, JR., SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: MATERIAL DISPOSAL AREAS CHARACTERIZATION AND HAZARD ASSESSMENT

Education: M.S., Chemistry, Western Carolina University
B.S., Geology, Western Carolina University

Experience/Technical Specialty:
Twenty-two years. Radiochemistry, radiochemical data analysis, validation, and interpretation, site characterization.

CANDI L. JONES, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: BIOLOGICAL SCIENCES

Education: B.S., Cell and Molecular Biology, Minor, Chemistry, University of Montana

Experience/Technical Specialty:
Nine years. Biochemistry, biological warfare and biological warfare agents, risk assessments, biological containment, threat analysis.

ROY KARIMI, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PROJECT ENGINEER, TRANSPORTATION AND RISK ASSESSMENT

Education: Sc.D., Nuclear Engineering, Massachusetts Institute of Technology
N.E., Nuclear Engineering, Massachusetts Institute of Technology
M.S., Nuclear Engineering, Massachusetts Institute of Technology
B.Sc., Chemical Engineering, Abadan Institute of Technology

Experience/Technical Specialty:
Twenty-nine years. Nuclear power plant safety, risk and reliability analysis, design analysis, criticality analysis, accident analysis, consequence analysis, spent fuel dry storage safety analysis, probabilistic risk assessments.

JULIE KUTZ, URS CORPORATION
EIS RESPONSIBILITIES: SCIENCE COMPLEX AND WAREHOUSE FACILITY PROJECT-SPECIFIC ANALYSES (BIOLOGICAL RESOURCES, FLOODPLAINS AND WETLANDS, VISUAL RESOURCES, AND SOCIOECONOMICS)

Education: B.S., Biology, University of New Mexico

Experience/Technical Specialty:
Six years. Environmental and natural resources.

DALE LYONS, URS CORPORATION

EIS RESPONSIBILITIES: SCIENCE COMPLEX AND WAREHOUSE FACILITY PROJECT-SPECIFIC ANALYSES (SOILS, HUMAN HEALTH, TRANSPORTATION, AND GENERAL ENVIRONMENTAL RESOURCE CONSIDERATIONS)

Education: M.S., Soil Chemistry and Land Rehabilitation, The Montana State University
B.S., Soils and Environmental Science, The Montana State University

Experience/Technical Specialty:
Fourteen years. Environmental consulting, scientific research, and project management.

JASPER G. MALTESE, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

EIS RESPONSIBILITIES: ACCIDENT ANALYSIS, RADIOLOGICAL AND CHEMICAL IMPACTS

Education: M.S., Operations Research, George Washington University
B.S., Mathematics, Fairleigh Dickinson University

Experience/Technical Specialty:
Forty-two years. NEPA assessments, accident analyses, safety analysis report reviews, facility safety audits, system reliability analyses.

GREGORY F. MARTIN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

EIS RESPONSIBILITIES: HUMAN HEALTH IMPACTS, SPECIAL PATHWAYS ASSESSMENTS

Education: M.S., Radiological Physics, San Diego State University
B.S., Physics, San Diego State University

Experience/Technical Specialty:
Twenty-four years. Hazards assessment, accident analysis, environmental transport of hazardous materials, and assessment of human impacts.

PAUL MINK, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

EIS RESPONSIBILITIES: MATERIAL DISPOSAL AREAS CHARACTERIZATION AND HAZARD ASSESSMENT

Education: M.S., Nuclear (Radiological) Engineering (coursework completed, thesis in progress), University of Tennessee
B.S., Industrial Engineering, University of Tennessee

Experience/Technical Specialty:
Thirteen years. Health physics, evaluation of survey data and radiological engineering analysis.

STEVEN M. MIRSKY, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: HUMAN HEALTH LEAD, APPENDIX D LEAD, ACCIDENT ANALYSIS

Education: M.S., Nuclear Engineering, The Pennsylvania State University
B.S., Mechanical Engineering, Cooper Union

Experience/Technical Special:
Thirty years. Professional Engineer (Mechanical) Maryland. Safety analysis, nuclear powerplant design, operations, foreign nuclear powerplant system analysis, accident analysis, thermal hydraulics, shielding and dose assessment, spent nuclear fuel dry storage safety analysis.

STEVEN E. MIXON, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: TECHNICAL EDITOR

Education: B.S., Communications, University of Tennessee

Experience/Technical Specialty:
Eighteen years. Program analyst, technical writer and editor, speechwriter, publications specialist.

SHEA NELSON, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: GENERAL SUPPORT, QUALITY ASSURANCE

Education: M.E., Environmental Engineering, University of Maryland
B.A., Environmental Science, University of Virginia

Experience/Technical Specialty:
Six years. Regulatory compliance, environmental remediation, technical writing, quality assurance/quality control.

ARIS PAPADOPOULOS, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: WORKER AND PUBLIC HEALTH AND SAFETY

Education: M.S., Nuclear Engineering, University of Utah
B.S., Physics, Hamline University

Experience/Technical Specialty:
Thirty-seven years. NEPA compliance, nuclear facilities regulatory compliance, radiological risk analysis, health physics, radioactive waste management.

WILDA E. PORTNER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PUBLIC INVOLVEMENT, TECHNICAL EDITOR

Education: A.A., Business Administration, Frederick Community College

Experience/Technical Specialty:
Sixteen years. Public information, Tribal relations, technical writing and editing.

JEFFREY J. RIKHOFF, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: DEPUTY PROJECT MANAGER, CHAPTER 2, ENVIRONMENTAL JUSTICE

Education: M.R.P., Regional/Environmental Planning, University of Pennsylvania
M.S., International Economic Development and Appropriate Technology, University of Pennsylvania
B.A., English, DePauw University

Experience/Technical Specialty:
Nineteen years. NEPA compliance, regulatory compliance and permitting, socioeconomics, environmental justice, comprehensive land-use and development planning, cultural resources.

JOSEPH F. ROBBINS, U.S. DEPARTMENT OF ENERGY, NATIONAL NUCLEAR SECURITY ADMINISTRATION (NEPA COMPLIANCE OFFICER, ALBUQUERQUE SERVICE CENTER)
EIS RESPONSIBILITIES: DOCUMENT REVIEW

Education: B.S., Biology, University of Maine
Graduate Studies, University of Massachusetts and Utah State University

Experience/Technical Specialty:
Thirty-one years. Environmental investigations, NEPA compliance.

NESETARI A. ROBINSON, SCIENCE APPLICATION INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: ENVIRONMENTAL DATA ANALYSES

Education: B.S., Chemical Engineer, University of Maryland Baltimore County

Experience/Technical Specialty:
Nine months. Engineer-in-training (Maryland). Technical writer and compiling data into graphs and charts.

GARY W. ROLES, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: MATERIAL DISPOSAL AREA REMEDIATION, CANYON CLEANUPS, AND OTHER COMPLIANCE ORDER ACTIONS LEAD

Education: M.S., Nuclear Engineering, University of Arizona
B.S., Mechanical Engineering, Arizona State University

Experience/Technical Speciality:
Twenty-eight years. Radioactive waste management; regulatory and compliance analysis.

THOMAS L. RUCKER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: MATERIAL DISPOSAL AREAS CHARACTERIZATION AND HAZARD ASSESSMENT

Education: Ph.D., Analytical Chemistry, Health Physics Minor, University of Tennessee
M.S., Environmental Chemistry, University of Tennessee
B.S., Chemistry, David Lipscomb University

Experience/Technical Specialty:
Thirty-three years. Analytical chemistry, radiochemistry, radiological monitoring, dose and risk assessment, and environmental and waste characterization.

PETER C. SANFORD, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PROJECT-SPECIFIC ANALYSES, DD&D AND CONSTRUCTION PARAMETER ESTIMATES

Education: M.S., Metallurgical Engineering, Colorado School of Mines
B.S.E., Chemical Engineering/Material Science, University of Connecticut

Experience/Technical Specialty:
Twenty-six years. Project management, actinide recovery and processing, health physics, decontamination and decommissioning, waste management, and environmental compliance.

JAMES R. SCHINNER, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: CHAPTER 4 MANAGER, LAND, VISUAL, ECOLOGICAL, AND CULTURAL RESOURCES

Education: Ph.D., Wildlife Management, Michigan State University
M.S., Zoology, University of Cincinnati
B.S., Zoology, University of Cincinnati

Experience/Technical Specialty:
Thirty-three years. Ecological field assessments, NEPA documentation, regulatory reviews.

JENNIFER C. SMITH, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: PAST PERFORMANCE AND DESCRIPTION OF ALTERNATIVES

Education: M.S., Natural Resources and Environment, University of Michigan
B.A., Environmental Studies, University of Vermont

Experience/Technical Specialty:
Two years. Environmental education and public awareness, risk communication.

MARY ALICE SPIVEY, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: LAWS AND REGULATIONS

Education: B.S., Environmental Science, Florida Institute of Technology

Experience/Technical Specialty:
Twenty-three years. Regulatory analysis and compliance, waste management, NEPA compliance.

ELLEN TAYLOR, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: CHAPTER 5, PROJECT-SPECIFIC ANALYSES

Education: Ph.D., Biology, University of Pennsylvania
B.A., Zoology, University of Vermont

Experience/Technical Specialty:
Twenty-four years. Environmental compliance and NEPA assessments.

ALAN L. TOBLIN, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: ACCIDENT ANALYSIS, RADIOLOGICAL AND CHEMICAL IMPACTS

Education: M.S., Chemical Engineering, University of Maryland
B.E., Chemical Engineering, Cooper Union

Experience/Technical Specialty:
Thirty-five years. Contaminant transport through air, groundwater, and surface water, accident risk analysis.

TOBY WALTERS, URS CORPORATION
EIS RESPONSIBILITIES: SCIENCE COMPLEX AND WAREHOUSE FACILITY PROJECT-SPECIFIC ANALYSES (GEOLOGIC AND ENVIRONMENTAL RESOURCES)

Education: M.S., Water Resources Management, The University of New Mexico
B.S., Geology, The University of New Mexico

Experience/Technical Specialty:
Twenty-six years. Environmental consulting and project management.

ROBERT H. WERTH, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
EIS RESPONSIBILITIES: NOISE ANALYSIS, AIR QUALITY MODELING

Education: B.A., Physics, Gordon College

Experience/Technical Specialty:
Thirty years. Acoustics and air quality analysis, regulatory reviews, and NEPA documentation.

JACK YOUNG, URS CORPORATION

EIS RESPONSIBILITIES: SCIENCE COMPLEX AND WAREHOUSE FACILITY PROJECT-SPECIFIC ANALYSES (ARCHAEOLOGICAL DATA ANALYSIS)

Education: M.A., Archaeological Survey and Cultural Resource Planning, Durham
B.A., History, The University of New Mexico

Experience/Technical Specialty:

Nine years. Cultural resource management and planning throughout the greater Southwestern USA and Britain; New Mexico State Land Use Permit for Archaeology 2005 NM-05-187; 2005 Laboratory of Anthropology curation agreement and ARMS user agreement.

CHAPTER 11
DISTRIBUTION LIST

11. DISTRIBUTION LIST

The U.S. Department of Energy (DOE) provided copies of the *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS) to Federal, state, and local elected and appointed officials; Native American representatives; public interest groups; and other organizations and individuals listed in this chapter. Approximately 400 copies of the Final SWEIS and 400 copies of the Final SWEIS Summary were distributed. Copies will be provided to others on request.

United States Congress

U.S. House of Representatives

Steve Pearce, R-New Mexico
Tom Udall, D-New Mexico
Heather A. Wilson, R-New Mexico

U.S. House of Representatives Committees

David Obey, Committee on Appropriations
Jerry Lewis, Committee on Appropriations
Peter J. Visclosky, Committee on Appropriations
Subcommittee on Energy and Water Development, and Related Agencies
David L. Hobson, Committee on Appropriations
Subcommittee on Energy and Water Development, and Related Agencies
John D. Dingell, Committee on Energy and Commerce
Joe Barton, Committee on Energy and Commerce
Rick Boucher, Committee on Energy and Commerce
Subcommittee on Energy and Air Quality
Fred Upton, Committee on Energy and Commerce
Subcommittee on Energy and Air Quality
Albert R. Wynn, Committee on Energy and Commerce
Subcommittee on Environment and Hazardous Materials
John B. Shadegg, Committee on Energy and Commerce
Subcommittee on Environment and Hazardous Materials
Bart Gordon, Committee on Science and Technology
Ralph M. Hall, Committee on Science and Technology
Nick Lampson, Committee on Science and Technology
Subcommittee on Energy and Environment
Bob Inglis, Committee on Science and Technology
Subcommittee on Energy and Environment

U.S. Senate

Jeff Bingaman, D-New Mexico
Pete V. Domenici, R-New Mexico

U.S. Senate Committees

Robert C. Byrd, Committee on Appropriations
Thad Cochran, Committee on Appropriations
Byron L. Dorgan, Committee on Appropriations
 Subcommittee on Energy and Water Development
Pete V. Domenici, Committee on Appropriations
 Subcommittee on Energy and Water Development
Barbara Mikulski, Committee on Appropriations
 Subcommittee on Commerce, Justice, Science, and Related Agencies
Richard Shelby, Committee on Appropriations
 Subcommittee on Commerce, Justice, Science, and Related Agencies
Daniel K. Inouye, Committee on Commerce, Science and Transportation
Ted Stevens, Committee on Commerce, Science and Transportation
John Ensign, Committee on Commerce, Science and Transportation
 Subcommittee on Science, Technology and Innovation
John F. Kerry, Committee on Commerce, Science and Transportation
 Subcommittee on Science, Technology and Innovation
Jeff Bingaman, Committee on Energy and Natural Resources
Pete V. Domenici, Committee on Energy and Natural Resources
Bryon L. Dorgan, Committee on Energy and Natural Resources, Subcommittee on Energy
Lisa Murkowski, Committee on Energy and Natural Resources, Subcommittee on Energy
Barbara Boxer, Committee on Environment and Public Works
James M. Inhofe, Committee on Environment and Public Works
Thomas R. Carper, Committee on Environment and Public Works
 Subcommittee on Clean Air and Nuclear Safety
George V. Voinovich, Committee on Environment and Public Works
 Subcommittee on Clean Air and Nuclear Safety

Federal Agencies

Advisory Council on Historic Preservation
Bandelier National Monument
Defense Nuclear Facilities Safety Board
Santa Fe National Forest
U.S. Department of the Interior
U.S. Environmental Protection Agency
U.S. Nuclear Regulatory Commission
U.S. Fish and Wildlife Service

Local Government

New Mexico

Mayors
- Martin J. Chavez, Albuquerque
- Joseph Maestas, Española
- David Coss, Santa Fe

City Officials
- Danielle Duran, City of Espanola, City Councilor
- Miguel Chavez, City of Santa Fe, City Councilor

County Officials

Los Alamos County
- Max Baker, County Administrator
- Anthony Mortillaro, Assistant County Administrator
- Rick Bohn, Director, Community Development
- Regina Wheeler, Los Alamos County Landfill, Manager, Solid Waste Division

Rio Arriba County
- Lorenzo Valdez, County Manager

Taos County

Acequia Abajo de El Valle, Mark Schiller, Commissioner

NEPA State Point of Contact

Ron Curry, New Mexico

State Government

New Mexico Governor
- Bill Richardson

New Mexico Senators
- Lynda M. Lovejoy
- Richard C. Martinez
- John Pinto
- James G. Taylor

New Mexico Representatives
- Richard J. Berry
- Rhonda S. King
- Ben Lujan
- Patricia A. Lundstrom
- Alfred A. Park
- Debbie A. Rodella
- Henry Saavedra
- Nick L. Salazar
- Jeannette O. Wallace

New Mexico Environment Department
- Bill Bartels
- James Bearzi
- Ron Curry
- William Moats
- John Parker
- Dennis Pepe
- Steve Yanicak

Citizen Advisory Boards

J. D. Campbell, Northern New Mexico Citizens' Advisory Board
Menice Santistevan, Northern New Mexico Citizens' Advisory Board
Christina Houston, Northern New Mexico Citizens' Advisory Board

Native American Representatives

New Mexico

Joe Garcia, Chairman, All Indian Pueblo Council
Greg Ortiz, Vice Chairman, All Indian Pueblo Council
James Roger Madalena, Director, Five Sandoval Indian Pueblos
Executive Director, Eight Northern Indian Pueblos Council
Levi Pesata, President, Jicarilla Apache Nation
Ty Vicenti, Vice President, Jicarilla Apache Nation
Carleton Naiche-Palmer, President, Mescalero Apache Tribe
Jackie D. Blaylock, Sr., Vice President, Mescalero Apache Tribe
Holly Houghten, Tribal Historic Preservation Officer, Mescalero Apache Tribe
Robert Gruenig, National Tribal Environmental Council
Ben Shelly, Vice President, Navajo Nation
Lawrence Morgan, Speaker of the House, Navajo Nation Council
Joe Shirley, Jr., President, Navajo Nation
Herman Shorty, Director, Commission on Emergency Management, Navajo Nation
Hope MacDonald Lone Tree, Public Safety Committee, 21st Navajo Nation Council
Chandler Sanchez, Governor, Pueblo of Acoma
Mark Thompson, 1st Lieutenant Governor, Pueblo of Acoma
Stanley Paytiamo, EPA Office, Pueblo of Acoma
Ron Charlie, 2nd Lieutenant Governor, Pueblo of Acoma
Mike Pecos, Lieutenant Governor, Pueblo of Cochiti
Ernest Suina, Governor, Pueblo of Cochiti
Robert Benavides, Governor, Pueblo of Isleta
Frank Lujan, 2nd Lieutenant Governor, Pueblo of Isleta
Max Zuni, 1st Lieutenant Governor, Pueblo of Isleta
Paul Chinana, Governor, Pueblo of Jemez
Joshua Madalena, 1st Lieutenant Governor, Pueblo of Jemez
Delbert Tafoya, 2nd Lieutenant Governor, Pueblo of Jemez
John Antonio, Sr., Governor, Pueblo of Laguna
Pete Kasero, 2nd Lieutenant Governor, Pueblo of Laguna
Richard Luarkie, 1st Lieutenant Governor, Pueblo of Laguna
Arnold Garcia, Lieutenant Governor, Pueblo of Nambe
Ernest Mirabal, Governor, Pueblo of Nambe
Johnny Abeyta, 1st Lieutenant Governor, Ohkay Owingeh
Larry Phillips, Jr., 2nd Lieutenant Governor, Ohkay Owingeh
Earl Salazar, Governor, Ohkay Owingeh
Julia Geffroy, Associate Director, Environment Department, Pueblo of Picuris
Richard Mermejo, Lieutenant Governor, Pueblo of Picuris
Craig Quanchello, Governor, Pueblo of Picuris
Linda Diaz, Lieutenant Governor, Pueblo of Pojoaque
George Rivera, Governor, Pueblo of Pojoaque
Robert Montoya, Governor, Pueblo of Sandia
Ryan Paisano, Lieutenant Governor, Pueblo of Sandia
Fred Armijo, Lieutenant Governor, Pueblo of Santa Ana

Ulysses Leon, Governor, Pueblo of Santa Ana
J. Michael Chavarria, Governor, Pueblo of Santa Clara
Stanley Tafoya, Lieutenant Governor, Pueblo of Santa Clara
Bernie L. Chavez, Lieutenant Governor, Pueblo of San Felipe
Ronald L. Tenorio, Governor, Pueblo of San Felipe
Leon Roybal, Governor, Pueblo of San Ildefonso
Paul Rainbird, 1st Lieutenant Governor, Pueblo of San Ildefonso
Terrence Garcia, 2nd Lieutenant Governor, Pueblo of San Ildefonso
Neil Weber, Director, Environmental and Cultural Preservation, Pueblo of San Ildefonso
David F. Garcia, Lieutenant Governor, Pueblo Santo Domingo
Sisto Quintana, Governor, Pueblo Santo Domingo
Tom Lujan, Sr., Lieutenant Governor, Pueblo of Taos
Paul T. Martinez, Governor, Pueblo of Taos
Anthony Dorame, Lieutenant Governor, Pueblo of Tesuque
Robert Mora, Governor, Pueblo of Tesuque
Fred Medina, Lieutenant Governor, Pueblo of Zia
Ivan Pino, Governor, Pueblo of Zia
Norman Cooeyate, Governor, Pueblo of Zuni
Dancy Simplicio, Lieutenant Governor, Pueblo of Zuni

Public Interest Groups

Dorelen Bunting, Albuquerque Center for Peace and Justice
Judith Kidd, Albuquerque Center for Peace and Justice
Susan Gordon, Alliance for Nuclear Accountability
Alfred Meyer, Alliance for Nuclear Accountability
Laura Harris, Americans for Indian Opportunity
Brian Shields, Amigos Bravos
J. Berde, Carson Forest Watch
Maureen Houlihan, Catholic Charities of Gallup, Catholic Indian Center
Sue Dayton, Citizen Action New Mexico
David McCoy, Citizen Action New Mexico
Janet Greenwald, Citizens for Alternatives to Radioactive Dumping
Bradley Schiro, Citizens Against Radioactive Waste
Kamara O'Connor, Coalition to Demilitarize Education
Susan Dayton, Citizen Action New Mexico
Joni Arends, Concerned Citizens for Nuclear Safety
Sadaf Cameron, Concerned Citizens for Nuclear Safety
Kalliroi Matsakis, Concerned Citizens for Nuclear Safety
Sheri Kotowski, Embudo Valley Environmental Monitoring Group
Tom Carpenter, Government Accountability Project
Jim Riccio, Greenpeace International
Lois Chalmers, Institute for Energy and Environmental Research
Arjun Makhijani, Institute for Energy and Environmental Research
Peter Malmgren, Los Alamos Oral History Project
Robert Long, Los Alamos Study Group
Greg Mello, Los Alamos Study Group
Blake Trask, Los Alamos Study Group
Robert Holden, National Congress of American Indians
Jacqueline Johnson, National Congress of American Indians
Libby Fayad, National Parks Conservation Association
Thomas Cochran, Natural Resources Defense Council
Denise Gonzales, New Mexico Community Foundation

Doug Melklejohn, New Mexico Environmental Law Center
Jay Coghlan, Nuclear Watch of New Mexico
Scott Kovac, Nuclear Watch of New Mexico
Geoff Petrie, Nuclear Watch of New Mexico
John Witham, Nuclear Watch of New Mexico
Ilse Bleck, Pajarito Group of the Sierra Club
Peggy Prince, Peace Action New Mexico
Virginia Miller, People for Peace
Will Callaway, Physicians for Social Responsibility
LeRoy Moore, Rocky Mountain Peace and Justice Center
Juan Montes, Rural Alliance for Military Accountability
Alice Roos, Sanctuary Foundation
Bernard Foy, Sangre de Cristo Audubon Society
Tom Taylor, Sangre de Cristo Audubon Society
Patricia McCormick, Sisters of Loretto
Penelope McMullen, Sisters of Loretto
Sharon Palma, Sisters of Loretto
Sylvia Sedillo, Sisters of Loretto
Jeremy Maxand, Snake River Alliance
Michael Guerrero, Southwest Organizing Project
William Paul Robinson, Southwest Research and Information Center
Don Hancock, Southwest Research and Information Center
Clifton Bain, Taos Rio Arriba County Green Party
Kathy Sanchez, TEWA Women United
Jay Gilbert Sanchez, Tribal Environmental Watch Alliance
Alden Meyer, Union of Concerned Scientists
TE Origer, Veterans for Peace
Matthew Bishop, Western Environmental Law Center

Public Reading Rooms and Libraries

A complete copy of the Final SWEIS along with the reference materials may be reviewed at any of the Public Reading Rooms and Libraries listed below.

Freedom of Information Reading Room
U.S. Department of Energy
1000 Independence Avenue, SW, 1E-90
Washington, DC 20585-0001
(202) 586-5955

Los Alamos National Laboratory
Research Library
TA-3-207
Los Alamos, NM 87545
(505) 667-0216

Mesa Public Library
2400 Central Avenue
Los Alamos, NM 87544
(505) 662-8240

New Mexico State Library
1209 Camino Carlos Rey
Santa Fe, NM 87507
(505) 476-9700

Santa Fe Main Library
145 Washington Avenue
Santa Fe, NM 87501
(505) 955-6780

Santa Fe Public Library
Oliver La Farge Branch
1730 Llano Street
Santa Fe, NM 87501
(505) 955-4862

Española Public Library
313 N. Paseo de Oñate
Española, NM 87532
(505) 747-6087

Government Information Department
Zimmerman Library
University of New Mexico
Albuquerque, NM 87131-1466
(505) 277-5441

Individuals

Jessica Aberly
Marylin Abesir
John Acker
Rodney Adams
Cecelia Albert
Bob Aly
Robert Anderson, PhD
Ann Anthony
Ivan Archuleta
Jodie Arellano
Navrose D. Armaria
Richard Arthure
Linda Aspenwind
Sage Asplund
Mr. Avdas
Elaine Baker
MJ Baker
Darrell Baldwin
Caron Balkany, Esq.
Josephine Ball
Donald Baltz
Susan Bardes
Steven Barela
Chloe Barrett
Floy Barrett
S. Cabrini Bartolo
Michael and Julie Bechko
Kathryn Becker
Leslie Behn
Richard Belanger
Jeffrey Birnbaum
A Bittson
Tiska Blankenship
Hans Bleiker
Jim Bock
Beatrice Boles
Lorrie Bonds Lopez
Bonnie Bonneau
Jan Boyer
Keri Boynt
Mark Bremer
Marcia Brenden
Jeanne Bridge
Ellen Brodsky
Mary Bronsteter
James Brosnan
Christina Hope Brown
Don Brown
Joan Brown
Karen Browne
Phyllis Browne, PhD
Norm Budow
Mark Bundy
Amy Bunting
Patrick Burns
Beverly Busching
Martha Bushnell PhD
Cleo Byers
Beverley Sheena Cameron
Marilyn Campbell
Alice Campion
Elizabeth Carson
Teresa Chavez
Ann Chew
William Christison
Joseph Ciddio

Doug Clark
Phil Clark
Grace Clearson
Evelyn Cole
Phylis Collier
Lori Colt
Barbara Conroy
Wendy Courtemanche
Theresa Coyle
Joan Coyote
Daniel Craig, DOM
Gary Cronin
Jesse Cross
Peggy Cross
Priscilla Cross
Virginia Cross
Tim Curry
Hilary Cushing-Murray
Aaron Czerny
Phil and Kathy Dahl-Bredine
Glory Dassi
Andrew Davis
Rev. John Dear, SJ
Steve Dees
Janet Degan
Maria Demmin
Michele Desgroseilliers
Laurie Dickerson Moreau
Mark Dilg
Trish Doherty
Jody Donaldson
Kevin Doyle
Nora Drosin
Carolyn Dukeminier
Jackie Dulle
Clarissa Duran
Ann Eberlein
George Emery
M Jane Engel
Daniel Erdman
Jay Ertel
Oliver Esch
Gary and Dianne Eschman
Rosamund Evans
Erich Evered
Bernard and Melinda Ewell
Sky Fabin
Stevie Famulari
Toni Feder
Bernadette & Sierra Fernandez
Barbara Ferry
Raymond Finck
Dee and Doris Finney
Jim and Mary Finney
Mary Flaherty
John Fleck
Bobbie Fleming
Nancy Florsheim
Ann Fonfa
Felicity Fonsera
Patricia Forman
Antoinette Fox
Lisa Fox
Paulette Frankl
Ellen Franklin, PhD
Harvey Frauenglass
Jack Frenkel
Carla Friedman
David Fuehne
Aurelia Fule
Graciela Garcia
Jade Garcia
Myra Garcia
Percyne Gardner
Heather Gaudet
John Geddie
Georgiana Geerds
Jim and Jean Genasci
David Genth
Jane German
Daniel Gibson
Travis Gibson
Gregg Giesler
Carl Gilbert
Pamela Gilchrist
Joe and Janice Gildea
Beth Ann Gillian
Katie Gillis
Sylvia Ginder
Diane and Arthur Gledhill
Michael Gold
Barbara Gonzales
Sally Goodknight
Emily Graeser
Kim Granzow
Mary Grathwol
Glen Graves
Connie Green
Jeanne Green
Patricia Green
Janet Greenwald
Nona Lee Gregg
Ellen Gregor
Patricia Griffin
Linda Griffth
Ed Grothus
Saul and Jennet Grover
Irene Grygorowicz
Jane Hanna
Berta Hanna
Patricia Hannigan
Linda Hardman
Jonathan Hare
Faith Harmony
Bob Harris
Wendell Harris
Selma Harwell
Hallie Hayden
Ann Hendrie
Diane Hiel
Jack High
Elizabeth Hinds
Dorothy Hoard
Marie Hoare
Gabriel Hoare, SL
Linda Hobbs
Marilyn Hoff
Sue Holmes
David Holmstron
Kevin Holsapple
Laura Holt
Dee Homans
Helenty Homans
Cynthia Homire
Sharon Horne
Robert Hull
Madeleine Hurd
Mimi Hurd
Virginia Ikeda
Dorothy Jensen
Norma Jette
Jose Jimenez
Ed Johnson
Karin Johnson
Richard Johnson
Thomas Johnson
Marjorie Jones
Velva Jones
Myron Kaczmarsky
Kathryn Keith, MD
C Keller
Jean Kelley
Susan Kemper Bryant
Diane and Mike Kenny
Amy Kepfer

Richard Khanlian
Joy Kincaid
Nancy King
Donal Kinney
Kim Kirkpatrick
Karen Kleeman
Terry Klein
Linda Klosky
Andrew Koehler
Terrence Kopet
Eleanor and John Krebs
Erich Kuerschner
Hildegard Kurz
Paul LaBeaume
Dennis and Eleanor Lacoss
Alice Ladas
Paula Lake
Leslie LaKind, DDS
Shaphan Laos
Rick Lass
Lisa Law
Patricia Leahan
Beatrice Lewis
Edwina Lieb
Mark Lind
Debra Link
Lucy Lippard
Susannah Lippman
Becky Lo Dolce
Ashana Lobody
Ross Lockridge
Joan Logghe
Timothy Long
Sabine Lucas
Jane Lumsden
Jan Lustig
Ronald Lynn
Sue Shen Lyons
Donald and Judith Machen
Anne MacNaughton
Carol Macomber
Sue Malec
Peter Malmgren
Richard & Elizabeth Malmgren
Patricia Manion SL PhD
John Marin
Jon Marin
Christina Maris
Albert Marshall
Betsy and Robert Martinez
Cheryl Martinez

Susan Martinez
Alison and Tony Martinez
Tyla Matteson
Rachel McCarthy
Doug McClellen
Anne McConnell
Beverly McCrary
Rita McElmury
Amy McFall
Joan McGrane
Keith McHenry
Kristin McNamara
Chris Mechels
Dorothy Mendelson
Arlene Mestas
Edgar and Catherine Meyer
Sarah Meyer
Leslie Michaels
Carol Miller
Iria Miller
Larry Miller
Matt Miller
Michael Miller
Rima Miller
Tonya Miller
Sharon Millstein
Ian Mion
Betsy Mitchell
Ignacio Montano
Carlos Mora
Luis Morales
Laurie Dickerson Moreau
Ann Morgan, PhD
Amanda Murchison
Frank Murchison
David Murnion
Vincent Murphy
Ann Murray
Ethel Nachlinger
Marian Naranjo
Linda Naranjo-Huebl
Margaret Nes
David and Renze Nesbit
Shel Neymark
Jean Nichols
Corina Nolting
Sandra O'Kelly
Kathleen O'Malley
Michael and Jodi Odland
Fancesca Oldeni-Neff
James Oliver
Cheryl Olson

Alan Osborne
Mark Oswald
Dennis and Eileen Overman
Miguel Pacheco
Jane Padberg
Jeanne Pahls
Claudia Parker
Kathleen Parker
Joseph Parko
Ruth Parrish
David and Therese Patton
Bobbie Paul
Jeannie Pearle
Robert Pearson
Charles Pergler
Mia Perotta
Valerie Peterson
Suzanne Phillips
Giselle Piburn
Mary Pickett
Dave Pierce
Steve Piersol
James Pigg
Gaye and Henry Pollitt
Dan and Barbara Pollock
Robin Poole
Marjorie Popp
Donivan Porterfield
Jean Porteus
Ira and Doris Pottenger
Peter Prandoni
Rebecca Procter
Sasha Pyle
Donna Quasthoff
Giuseppe Quinn
Michael Quintana Jr
Adam Rankin
Elizabeth Raby
Thomas Ray
Adam Read
Deborah Reade
Steven Reneau
Mauna Richardson
Nausika Richardson
Elizabeth Riedel
Sophia Ritchie
Gayanne Robinson
Carmen Rodriguez
Earl Rohleder
Robert Romeo
Carmella Romero
Ryan and Amanda Rose

Stanley Rosen
Tamara Roske
Jasmine Roske-Jones
Richard Rowe
Katherine Roxlau
Bud Ryan
Meena Sachdeva
Miriam Sagan
Gregory Sagemiller
Mr. and Mrs. Sant
William Santelmann Jr
Emile Sawyer
Sharon Scarlett
Peter Scherm
R Schmidt
Mellis Schmidt, PhD
Don Schrader
Michael Scofield
Alice Sealey
Paula Seaton
Anne Sensenig
Robert Seton
Marion Seymour
Lexie Shabel
Lorenna Shalev
Colleen Shanahan
Thomas and Rebecca Shankland
Sandra Shaw
Michael Shorr
Robert Siebert
Alan Siegel
Raymond and Wendy Singer
Lisa Sipp
Deborah Smith-Davis
Roger Snodgrass
Shannyn Sollitt
Helen South
Paul Sowanick
Thea Spaeth
Steven Spencer, MD
Jeff Spicer
Zane Spiegel
Elana Sue St Pierre
David Stephenson
Dwight Stephenson
Roy Stephenson
Jasmine Stewart
Steve and Barbara Stoddard
Adam Stone
Ron Strauch
Sonia Stromberg
John Stroud
Martin Suazo, Sr.
Cathie Sullivan
Martina Sullivan
Marie Sutton
Simone Withers Swan
Cathy Swedlund
Roxanne Swentzell
Brooke Tatum
Patricia Ellen Taylor
Simon Teolis
Carroll Thomas
Judy Thompson
Laura Thompson
David Thomson
Alicia Tietje
Elizabeth Timken
Christopher Timm, PE
Bob Tirk
Jeff Tollefson
Andrew Tongate
Beth Tori
Aileen Torres-Hughes
Patrick Travers
Jeanne Treadway
Kathryn Tretter
Calvin Tribby
Barbara Turner
Janet Urian
Ernest Valdez
Marcia Valdez
Jonathan Ventura
Susan Verkamp
Mimi Voegelin
Sue Vorenburg
Eleanore Voutselas
David Wagoner
Robin Gay Wakeland
Jennifer Walters
Sally Warnick
Marion Wasserman
LuAnn Watkins
Deanna and Mark Watson
Kimberly Webber
Max Weber
Robert Weber
John Martin West
Rev. Dr. Judi West
Patricia Whalen
Paul White
Linda Wiener
Michel Wiggs-West
Chrysa Wikstrom
Amy Williams
Holly Ann Williams
Marjorie Williams
Dean Williamson
Natasha Williamson
Marilyn Winter-Tamkin
Scott Wiseman
Richard and Evelyn Witt
Hollis Wood
Ray Wood
Keith Wuertz
George Yankura
Landon Young
Richard Yunker
Jay Zeiger
Cecile Zeigler
Nina Zelenunsky
Tiffin Zellers
Bonnie Zirkel
Alice Zorthian

DOE/EIS-0380
May 2008

Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

Volume 2
Appendices A through M

U.S. Department of Energy

National Nuclear Security Administration

Los Alamos Site Office

Availability of the Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico

To submit general questions regarding this EIS, or to request a copy, please contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

Printed with soy ink on recycled paper

COVER SHEET

Responsible Agency: U.S. Department of Energy (DOE)
National Nuclear Security Administration (NNSA)

Title: *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS) (DOE/EIS-0380)

Location: Los Alamos, New Mexico

For additional information or for copies of the SWEIS, contact:

Elizabeth Withers, EIS Document Manager
NNSA Service Center - Albuquerque
National Nuclear Security Administration
U.S. Department of Energy
P. O. Box 5400
KAFB East, SC-1
Albuquerque, NM 87185-5400
Telephone: 505-845-4984

For general information on the DOE National Environmental Policy Act (NEPA) process, contact:

Carol M. Borgstrom, Director
Office of NEPA Policy and Compliance
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Telephone: 202-586-4600, or leave a message at 1-800-472-2756

This document is available on the DOE NEPA website (www.eh.doe.gov/nepa) and the NNSA Los Alamos Site Office website (www.doeal.gov/laso/NEPASWEIS.aspx) for viewing and downloading.

***Abstract*:** NNSA proposes to continue operating Los Alamos National Laboratory (LANL), which is located in Los Alamos County in north-central New Mexico. NNSA has identified and assessed three alternatives for continued operation of LANL: (1) No Action, (2) Reduced Operations, and (3) Expanded Operations. Under the No Action Alternative, NNSA would continue the historical mission support activities conducted at LANL at currently approved operational levels. Under the Reduced Operations Alternative, NNSA would eliminate some activities and limit the operations of other activities. Under the Expanded Operations Alternative, NNSA would operate LANL at the highest levels of activity currently foreseeable, including full implementation of mission assignments. Expanded Operations is NNSA's Preferred Alternative. NNSA intends to implement actions necessary to comply with the March 2005 Compliance Order on Consent (Consent Order) to address the investigation and remediation of environmental contamination at LANL, regardless of decisions it makes on other actions analyzed in the SWEIS. Under all of the alternatives, the affected environment is primarily within 50 miles (80 kilometers) of LANL. Analyses indicate little difference in the environmental impacts of the alternatives on many resource areas. The primary discriminators are public risk due to radiation exposure, collective worker risk due to radiation exposure, socioeconomic effects due to LANL employment changes, electrical power and water demand, waste management, and transportation. A classified appendix assesses the potential impacts of terrorist acts.

Public Comments: In preparing the Final SWEIS, NNSA considered comments received during the scoping period (January 19 to February 17, 2005) and during the public comment period on the Draft SWEIS (July 7 to September 20, 2006). Public hearings on the Draft SWEIS were held in Los Alamos, Española, and Santa Fe, New Mexico. Comments on the Draft SWEIS were requested during a period of 75 days following publication of the U.S. Environmental Protection Agency's (EPA's) Notice of Availability in the *Federal Register*. All comments, including any late comments, were considered during preparation of the Final SWEIS.

The Final SWEIS contains revisions and new information based in part on comments received on the Draft SWEIS. Vertical change bars in the margins indicate the locations of these revisions and new information. Volume 3 contains the comments received during the public comment period on the Draft SWEIS and NNSA's responses to the comments. NNSA will use the analysis presented in this Final SWEIS, as well as other information, in preparing the Record(s) of Decision (RODs) regarding the level of continued operations at LANL. NNSA will issue ROD(s) no sooner than 30 days after the EPA publishes a Notice of Availability of this Final SWEIS in the *Federal Register*.

TABLE OF CONTENTS
VOLUME 2

TABLE OF CONTENTS
VOLUME 2

VOLUME 1 – CHAPTERS 1 THROUGH 11
VOLUME 2 BOOK 1 – APPENDICES A THROUGH H
VOLUME 2 BOOK 2 – APPENDICES I THROUGH M
VOLUME 3 BOOK 1 – COMMENT RESPONSE DOCUMENT
SECTIONS 1, 2, AND 3 (PAGES 3-1 THROUGH 3-561)
VOLUME 3 BOOK 2 – COMMENT RESPONSE DOCUMENT
SECTION 3 (PAGES 3-562 THROUGH 3-1089) AND SECTION 4

Appendix D
Evaluation of Human Health Impacts from Facility Accidents

Appendix E
Current Understanding of the Groundwater Regime at Los Alamos National Laboratory

Appendix F
Environmental Sample Data

Appendix G
Impacts Analyses of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities

Appendix H
Impacts Analyses of Closure and Remediation Actions

Appendix I
Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions

Appendix J
Impacts Analyses of Projects Associated with New Infrastructure or Levels of Operation

LIST OF FIGURES

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K

LIST OF TABLES

Appendix B

Appendix C

Appendix D

Appendix E

Appendix F

Appendix G

Appendix H

Appendix I

Appendix J

Appendix K

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ALARA	as low as reasonably achievable
AOC	area of concern
BEIR	Biological Effects of Ionizing Radiation
CAP-88	Clean Air Act Assessment Package – 1988
CASA	Critical Assembly Storage Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CH	contact-handled
CME	corrective measure evaluation
CMR	Chemistry and Metallurgy Research (Building)
CMRR	Chemistry and Metallurgy Research Building Replacement Project
CO	carbon monoxide
CO_2	carbon dioxide
CSU	container storage unit
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
dB	decibel
dBA	decibel A-weighted
D&D	decontamination and decommissioning
DD&D	decontamination, decommissioning, and demolition
DIF	Definitive Identification Facility
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DVRS	Decontamination and Volume Reduction System
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FY	fiscal year
GIS	geographical information system
HDPE	high-density polyethylene
HE	high explosive
HEPA	high-efficiency particulate air (filter)
HSWA	Hazardous and Solid Waste Amendments
HTO	tritiated water
ISCORS	Interagency Steering Committee on Radiation Standards
ISCST3	Industrial Source Complex Air Quality Dispersion Model

LANL	Los Alamos National Laboratory
LANL SWEIS	*Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*
LANSCE	Los Alamos Neutron Science Center
LSA	low specific activity (waste)
LASL	Los Alamos Scientific Laboratory (now LANL)
LCF	latent cancer fatality
LEED	Leadership in Energy and Environmental Design
LLNL	Lawrence Livermore National Laboratory
LLW	low-level radioactive waste
LOC	level-of-concern
MAR	material at risk
MDA	material disposal area
MEI	maximally exposed individual
MET	meteorological
MLLW	mixed low-level radioactive waste
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NO_x	nitrogen oxide
NOEL	No Observed Effect Level
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
PC	performance category
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
petaflops	one quadrillion floating point operations per second
PHERMEX	Pulsed High Energy Radiographic Machine Emitting X Rays
PIDAS	Perimeter Intrusion Detection and Assessment System
ppm	parts per million
PM_n	particulate matter less than or equal to *n* microns in aerodynamic diameter
PRS	potential release site
PSVE	passive soil vapor extraction
PuO_2	plutonium dioxide
rad	radiation absorbed dose

RANT	Radioassay and Nondestructive Testing Facility
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RFI	RCRA facility investigation
RH	remote-handled
RLWTF	Radioactive Liquid Waste Treatment Facility
ROD	Record of Decision
SA	supplement analysis
SAL	Screening Action Level
SHEBA	Solution High-Energy Burst Assembly
SLEV/Q	screening level emission value by the estimated emission rate
SNM	special nuclear material
SO_x	sulfur oxide
SRS	Savannah River Site
SST	safe secure transport
SVE	soil vapor extraction
SWEIS	Site-Wide Environmental Impact Statement
SWMU	solid waste management unit
TA	technical area
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
TEELs	Temporary Emergency Exposure Limits
teraflops	one trillion floating point operations per second
TNT	trinitrotoluene
TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	transuranic
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
TWCF	Transuranic Waste Consolidation Facility
U-233	uranium-233
UCL	upper confidence limit
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VOC	volatile organic compound
WCRR	Waste Characterization, Reduction, and Repackaging Facility
WIPP	Waste Isolation Pilot Plant
Y-12	Y-12 Complex in Oak Ridge
°C	degrees Celsius
°F	degrees Fahrenheit
µg/g	micrograms per gram
mg/m^3	milligrams per cubic meter

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	0.16667	Tons/acre	Tons/acre	0.5999	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,025.6	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.78533	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003046	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	μ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

APPENDIX A
FEDERAL REGISTER NOTICES

DEPARTMENT OF ENERGY

Record of Decision: Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory in the State of New Mexico

AGENCY: Department of Energy.

ACTION: Record of decision.

SUMMARY: The Department of Energy (DOE) is issuing this Record of Decision on the continued operation of the Los Alamos National Laboratory (LANL) in the State of New Mexico. This Record of Decision is based on the information and analysis contained in the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, DOE/EIS–0238 (including the classified supplement), and other factors, including the mission responsibilities of the Department, and comments received on the final Site-Wide Environmental Impact Statement. DOE has decided to implement the Preferred Alternative, which, with certain limitations, is the Expanded Operations Alternative. This alternative would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels, and to fully implement the mission elements assigned to LANL.

FOR FURTHER INFORMATION CONTACT: For further information on the Site-Wide Environmental Impact Statement or to receive a copy of the Site-Wide Environmental Impact Statement or other information related to this Record of Decision, contact: Corey Cruz, Document Manager, U.S. Department of Energy, Albuquerque Operations Office, P.O. Box 5400, Albuquerque, NM 87185, (505) 845–4282.

For information on the DOE National Environmental Policy Act (NEPA) process, contact: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, (202) 586–4600, or leave a message at (800) 472–2756.

SUPPLEMENTARY INFORMATION:

Background

DOE prepared this Record of Decision pursuant to the regulations of the Council on Environmental Quality for implementing NEPA (40 CFR Parts 1500–1508) and DOE's NEPA Implementing Procedures (10 CFR Part 1021). This Record of Decision is based, in part, on DOE's Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, (DOE/EIS–0238). LANL is located in north-central New Mexico, 60 miles (96 kilometers) north-northeast of Albuquerque, 25 miles (40 kilometers) northwest of Santa Fe, and 20 miles (32 kilometers) southwest of Española. LANL occupies an area of approximately 27,832 acres (11,272 hectares), or approximately 43 square miles (111 square kilometers), of which 86 percent lies within Los Alamos County and 14 percent within Santa Fe County. The Fenton Hill site (Technical Area [TA]–57), a remote site 20 miles (32 kilometers) west of LANL, occupies 15 acres (6 hectares) in Sandoval County on land leased from the U.S. Forest Service. LANL is divided into 49 separate Technical Areas. LANL is a multi-disciplinary, multipurpose national laboratory engaged in theoretical and experimental research and development. DOE has assigned elements of each of its four principal missions (National Security, Energy Resources, Environmental Quality, and Science) to LANL, and has established and maintains several capabilities in support of these mission elements, including applications of science and technology to the nuclear weapons program. These capabilities also support applications for other Federal agencies and other organizations in accordance with national priorities and policies.

DOE is currently engaged in other NEPA reviews that include LANL as an alternate location for the action under consideration. These other NEPA reviews include programmatic and project Environmental Impact Statements for Waste Management and Surplus Plutonium Disposition. Since these other Environmental Impact Statements identify potential new or expanded activities for LANL, the impacts of these activities are described under the Preferred Alternative in the Site-Wide Environmental Impact Statement. The nature of the decisions in this Record of Decision with regard to the Waste Management programmatic and project proposals is simply to reserve infrastructure at LANL pending completion of these programmatic and project reviews and the corresponding decision document. With regard to the Surplus Plutonium Disposition program, the nature of the decision in this Record of Decision is to maintain the competency and capability to fabricate the Lead Assemblies as evaluated in the Surplus Plutonium Disposition Environmental Impact Statement (SPD EIS). However, the availability and capacity of facilities to perform such work may be limited because of competing priorities from the weapons program. DOE's resolution of any such competing priorities will be reflected in the Record of Decision for the SPD EIS.

DOE was directed by Congress (Pub. L. 105–119) to convey or transfer parcels of DOE land in the vicinity of LANL to the Incorporated County of Los Alamos, New Mexico, and the Secretary of the Interior, in trust for the San Ildefonso Pueblo. Such parcels, or tracts of land, must not be required to meet the national security mission of LANL and must also meet other criteria established by the Act. DOE has issued a Draft Environmental Impact Statement to examine the potential environmental impacts associated with the conveyance or transfer of 10 specific parcels. EPA published a Notice of Availability for the Draft Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico, in the Federal Register on February 26, 1999.

The Site-Wide Environmental Impact Statement considers the environmental impacts of ongoing and proposed activities at LANL. DOE expects that it will continue to suggest new programs, projects, and facilities for LANL (or consider LANL as an alternative site for such facilities or activities). These new proposals will be analyzed in programmatic or project-specific NEPA reviews, as they become ripe for decision. Subsequent NEPA reviews will make reference to, and be tiered from, the Site-wide Environmental Impact Statement; and subsequent DOE decisions on these proposals may amend this Record of Decision.

Alternatives Considered

DOE analyzed four broad alternative levels of operation at the Los Alamos National Laboratory. The four alternatives are as follows:

Alternative 1—No Action

The No Action Alternative reflects the levels of operation at LANL that are currently planned. This includes operations that provide for continued support of DOE's four primary missions, but would not include an increase in the existing pit manufacturing capacity (beyond the current capacity of 14 pits per year) nor expansion of the low-level waste disposal facility at Technical Area–54 (the remaining space in the existing Area G footprint would be used, but some low-level waste would be shipped off-site for disposal). This alternative includes the maintenance of existing capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects throughout LANL that have previous NEPA reviews.

Alternative 2—Expanded Operations (DOE's Preferred Alternative Except for Pit Manufacturing)

The Expanded Operations Alternative would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels, and to fully implement the mission elements assigned to LANL. This includes the impacts of the full implementation of pit manufacturing up to a capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts). This alternative includes the expansion of the low-level waste disposal site at Technical Area–54, including receipt of off-site wastes. In addition, this alternative includes the continued maintenance of existing and expanded capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects at Technical Area–53 (i.e., the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility).

Alternative 3—Reduced Operations

The Reduced Operations Alternative reflects the minimum levels of operation at LANL considered necessary to maintain the capabilities to support DOE missions over the near-term (through the year 2007). While the capabilities are maintained under this alternative, this may not constitute full support of the mission elements currently assigned to LANL. This alternative reflects pit manufacturing at a level below the existing capacity (at 6 to 12 pits per year) and reflects shipment of much of the low-level waste generated at LANL for off-site disposal (on-site disposal would be limited to those waste types for which LANL has a unique capability at Area G). This alternative includes the maintenance of existing capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects throughout LANL that have previous NEPA reviews; some of the projects previously reviewed under NEPA would be reduced in scope or eliminated (e.g., the Low-Energy Demonstration Accelerator would only be operated at the lower end of its energy range).

Alternative 4—''Greener''

The ''Greener'' Alternative reflects increased levels of operation at LANL in support of nonproliferation, basic science, and materials recovery/stabilization mission elements, and reduced levels of operation in support of defense and nuclear weapons mission elements. All LANL capabilities are maintained for the short term under this alternative; however, this may not constitute full support of the nuclear weapons mission elements currently assigned to LANL. This alternative reflects pit manufacturing at a level below the existing capacity (at 6 to 12 pits per year) and reflects shipment of much of the low-level waste generated at LANL for off-site disposal (on-site disposal would be limited to those waste types for which LANL has a unique capability at Area G). This alternative includes the maintenance of existing capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects at Technical Area–53 (i.e., the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility.) The name and general description for this alternative were provided by interested public stakeholders as a result of the scoping process.

Preferred Alternative

In the draft Site-Wide Environmental Impact Statement, the Preferred Alternative was the Expanded Operations Alternative. In the final Site-Wide Environmental Impact Statement, the Expanded Operations Alternative is the Preferred Alternative with one modification, which involves the level at which pit manufacturing would be implemented at LANL. Under the Expanded Operations Alternative, DOE would expand operations at LANL, as the need arises, to increase the level of existing operations to the highest reasonably foreseeable levels. This expansion of operations would apply broadly to the essential science and technology activities across LANL, and would apply to the level of activity for those operations (e.g., increased throughput or increased numbers of experiments). The Expanded Operations alternative includes expansion to fully implement pit manufacturing up to the capacity of 50 pits per year under single-shift operations (80 pits per year using multiple shifts) assigned to LANL in the Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement.

However, as a result of delays in the implementation of the Capability Maintenance and Improvement Project and recent additional controls and operational constraints applied to work conducted in the Chemistry and Metallurgy Research (CMR) Building, DOE has determined, as a matter of policy, to postpone any decision to expand pit manufacturing beyond a level of a nominal 20 pits per year in the near future (through the year 2007), and to study further methods for implementing the 50 pits per year production capacity. The revised Preferred Alternative reflects implementing pit manufacturing at the 20-pit-per-year level. This postponement does not modify the long-term goal announced in the Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement of 50 pits per year (up to 80 pits per year using multiple shifts).

The Preferred Alternative includes the expansion of the low-level waste disposal site at Technical Area–54. The Preferred Alternative also includes the continued maintenance of existing and expanded capabilities, continued support/infrastructure activities, and implementation of several facility construction or modification projects at Technical Area–53 (i.e., the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility).

Environmentally Preferable Alternative

The Council on Environmental Quality, in its ''Forty Most Asked Questions Concerning CEQ's NEPA Regulations'' (46 FR 18026, 2/23/81), with regard to 40 CFR 1505.2, defined the ''environmentally preferable alternative'' as the alternative ''that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources.''

After considering impacts to each resource area by alternative, DOE has identified Alternative 3, Reduced Operations, as the environmentally preferable alternative. Alternative 3 was identified as having the fewest direct impacts to the physical environment and to worker and public health and safety because all operations would be at the lowest levels. However, the analyses indicate that there would be very little difference in the environmental impacts among the alternatives analyzed. The major discriminators among alternatives are collective worker risks due to radiation exposure, socioeconomic effects due to LANL employment changes, and electrical power demand. Therefore, Reduced Operations would have the fewest impacts and Expanded Operations would have the most.

Environmental Impacts of Alternatives

DOE weighed environmental impacts as one factor in its decision making. DOE analyzed the potential impacts that might occur to land resources; geology, geological conditions, and soils; water resources, air quality; ecological and biological resources, human health, environmental justice, cultural resources; and socioeconomic, infrastructure, and waste management for the four alternatives. DOE considered the impacts that might occur from use of special nuclear materials, facility accidents, and the transportation of radioactive and other materials associated with LANL operations. DOE considered the impacts of projects and activities associated with each alternative, the irreversible or irretrievable commitments of resources, and the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity.

The highest resource impacts under any of the alternatives will be to the electrical power infrastructure. Peak electrical demand under the Reduced Operations Alternative exceeds supply during the winter months and may result in periodic brownouts. Peak electrical demand under the No Action, Expanded Operations, and Greener Alternatives exceeds the power supply in both winter and summer, when this may result in periodic brownouts. (Power supply to the Los Alamos area has been a concern for a number of years, and DOE continues to work with other users in the area and power suppliers to increase supply and reduce use.)

Nonradioactive hazardous air pollutants would not be expected to degrade air quality or affect human health under any of the alternatives. The differences in activities among the alternatives do not result in large differences in chemical usage. The activities at LANL are such that large amounts of chemicals are not typically used in any industrial process at LANL (compared to what may be used in commercial manufacturing facilities); but research and development activities involving many users dispersed throughout the site are the norm. Air emissions are, therefore, not expected to change by a magnitude that would, for example, trigger more stringent regulatory requirements or warrant continuous monitoring. Radioactive air emissions change slightly, but are within a narrow range due to the controls placed on these types of emissions and the need to assure compliance with regulatory standards. The collective population radiation doses from these emissions range from about 11 person-rem per year to 33 person-rem per year across the alternatives, and the radiation dose to the maximally exposed individual ranges from 1.9 millirem per year to 5.4 millirem per year across the alternatives. These doses were considered in the human health impact analysis.

The total radiological doses from normal operations over the next 10 years to the public under any of the alternatives are relatively small and are not expected to result in any excess latent cancer fatalities (LCFs) to members of the public. Additionally, exposure to chemicals due to LANL operations under any of the alternatives is not expected to result in significant effects to either workers or the public. Exposure pathways associated with the traditional practices of communities in LANL area (special pathways) would not be expected to result in human health effects under any of the alternatives. The annual collective radiation dose to workers at LANL ranges from 170 person-rem per year to 833 person-rem per year across the alternatives. These dose levels would be expected to result in from 0.07 to 0.33 excess LCFs per year of operation, respectively, among the exposed workforce. These impacts, in terms of excess LCFs per year of operation, reflect the numbers of excess fatal cancers estimated to occur among the exposed members of the work force over their lifetimes per year of LANL operations. These impacts form an upper bound, and the actual consequences could be less, but probably would not be worse.

Worker exposures to physical safety hazards are expected to result in a range of 417 (Reduced Operations) to 507 (Expanded Operations) reportable cases each year; typically, such cases would result in minor or short-term effects to workers, but some of these incidents could result in long-term health effects or even death.

LANL employment (including the University of California employees and those of the two subcontractors with the largest employment among LANL subcontractors) ranges from 9,347 (Reduced Operations) to 11,351 (Expanded Operations) full-time equivalents across the alternatives, as compared to 9,375 LANL full-time equivalents in 1996. These changes in employment would result in changes in regional population, employment, personal income, and other socioeconomic measures. Under any of the alternatives, these secondary effects would change existing conditions in the region by less than 5 percent.

Water demand for LANL ranges from 602 million gallons (2,279 million liters) per year to 759 million gallons (2,873 million liters) per year across the alternatives; the total water demand (including LANL and the residences and other businesses and agencies in the area) is within the existing DOE Rights to Water, and would result in average drops of 10 to 15 feet (3.1 to 4.6 meters) in the water levels in DOE well fields over the next 10 years. Usage, therefore, will remain within a fairly tight range among the alternatives. The related aspect of wastewater discharges is also within a narrow range for that reason. Outfall flows range from 218 to 278 million gallons (825 to 1,052 million liters) per year across the alternatives, and these flows are not expected to result in substantial changes to existing surface or groundwater quantities. Outfall flows are not expected to result in substantial surface contaminant transport under any of the alternatives. However, since mechanisms for recharge to groundwater are highly uncertain, it is possible that discharges under any of the alternatives could result in contaminant transport in groundwater and off the site, particularly beneath Los Alamos Canyon and Sandia Canyon, which have increased outfall flows. The outfall flows associated with the Expanded Operations and Greener Alternatives reflect the largest potential for such contaminant transport, and the flows associated with the Reduced Operations Alternative have the least potential for such transport.

There is little difference in the impacts to geology, geological conditions, and soils across the alternatives. Wastewater discharge volumes with associated contaminants do change across the alternatives, but not to a degree noticeable in terms of impacts (such as causing soil erosion, for example). Under all of the alternatives, small quantities (as compared to existing conditions) of contaminants would be deposited in soils due to continued LANL operations, and the Environmental Restoration Project would continue to remove existing contaminants at sites to be remediated. Geological mapping and fault trenching studies at LANL are currently under way or recently completed to better define the rates of fault movements, specifically of the Pajarito Fault, and the location and possible southern termination of the Rendija Canyon Fault. Ongoing and recently completed seismic hazard studies indicate that slip rates (recurrence intervals for earthquakes) are within the parameters assumed in the 1995 seismic hazards study at LANL.

There is little difference in the impacts to land resources between the No Action, Reduced Operations, and the Greener Alternatives. Differences among the alternatives are primarily associated with operations in existing facilities, and very little new development is planned. Therefore, these impacts are essentially the same as currently experienced. The Expanded Operations Alternative has very similar land resources impacts to those of the other three alternatives, with the principal differences being attributable to the visual impacts of lighting along the proposed transportation corridor between the Plutonium Facility and the Chemistry and Metallurgy Research Building (this corridor will not be built under the Preferred Alternative) and the noise and vibration associated with increased frequency of high explosives testing (as compared to the other three alternatives).

No significant adverse impact to ecological and biological resources is projected under any of the alternatives. The separate analyses of impacts to air and water resources constitute some of the source information for analysis of impacts in this area; as can be seen from the above discussion, the variation across the alternatives is not of a sufficient magnitude to cause large differences in effects. The impacts of the Expanded Operations Alternative differ from those of the other alternatives in that there is some projected loss of habitat; however, this habitat loss is small (due to limited new construction) compared to available similar habitat in the immediate vicinity.

DOE expects no environmental justice impacts from the operation of LANL under any of the alternatives, i.e., projected impacts are not disproportionately high for minority or low-income populations in the area. DOE also analyzed human health impacts from exposure through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathways have the potential to be important to the environmental justice analysis because some of these pathways may be more important or viable for the traditional or cultural practices of minority populations in the area. However, human health impacts associated with these special pathways also will not present disproportionately high and adverse impacts to minority or low-income populations.

Under all of the Site-Wide Environmental Impact Statement alternatives, there is a negligible to low potential for impacts to archaeological and historic resources due to shrapnel and vibration caused by explosives testing and contamination from emissions. Potential impacts will vary in intensity in accordance with the frequency of explosives tests and the operational levels that generate emissions (e.g., Reduced Operations would reflect the lowest potential, and Expanded Operations would reflect the highest potential). Recent assessments of prehistoric resources indicate a low potential compared to the effects of natural conditions (wind, rain, etc.). In addition to these potential impacts, the Expanded Operations Alternative includes the expansion of the low-level waste disposal site at Technical Area-54, which contains several National Register of Historic Places sites; if any significant cultural resources will be adversely effected by the undertaking, DOE will consult with the New Mexico State Historic Preservation Office and other consulting parties to resolve the adverse effect.

The potential impacts to specific traditional cultural properties would depend on their number, characteristics, and location. Such resources could be adversely affected by changes in water quality and quantity, erosion, shrapnel from explosives testing, noise and vibration from explosives testing, and contamination from ongoing operations. Such impacts would vary in intensity in accordance with the frequency of explosive tests and the operational levels that generate emissions. The current practice of consultation would continue to be used to provide opportunities to avoid or minimize adverse impacts to any traditional cultural properties located at LANL.

LANL chemical waste generation ranges from 3,173 to 3,582 tons (2,878,000 to 3,249,300 kilograms) per year across the alternatives. LANL low-level waste generation, including low-level mixed waste, ranges from 338,210 to 456,530 cubic feet (9,581 to 12,837 cubic meters) per year across the alternatives. LANL transuranic (TRU) waste generation, including mixed TRU waste, ranges from 6,710 to 19,270 cubic feet (190 to 547 cubic meters) across the alternatives. Disposal of these wastes at on-site or off-site locations is projected to constitute a relatively small portion of the existing capacity for disposal sites; disposal of all LANL low-level waste on the site would require expansion of the low-level waste disposal capacity beyond the existing footprint of Technical Area-54 Area G under all alternatives (although this is only included in the analysis of the Expanded Operations Alternative).

Radioactively contaminated space in LANL facilities would increase by about 63,000 square feet (5,853 square meters) under the No Action, Reduced Operations, and Greener Alternatives (due primarily to actions previously reviewed under NEPA but not fully implemented at the time the existing contaminated space estimate was established [May 1996]). The Expanded Operations Alternative would increase contaminated space in LANL facilities by about 73,000 square feet (6,782 square meters). The creation of new contaminated space causes a clean-up burden in the future, including the generation of radioactive waste for treatment and disposal; the actual impacts of such clean-up actions are highly uncertain because they are dependent on the actual characteristics of the facilities, the technologies available, and the applicable requirements at the time of the cleanup.

Incident-free transportation associated with LANL activities over the next 10 years would be conservatively expected to cause radiation doses that would result in about one excess latent cancer fatality to a member of the public and two excess latent cancer fatalities to members of LANL workforce over their lifetimes under each of the Site-Wide Environmental Impact Statement alternatives. There is little variation in impacts because effects are small, and the increased transport of radioactive materials is not enough to make a significant change in those small effects.

Transportation accidents without an associated cargo release over the next 10 years of LANL operations are conservatively projected to result in from 33 to 76 injuries and 3 to 8 fatalities (including workers and the public) across the alternatives. The bounding off-site and on-site transportation accidents over the next 10 years involving a release of cargo would not be expected to result in any injuries or fatalities to members of the public for any of the alternatives. Accidents were analyzed by type of material, and the maximum quantities were selected for analysis. These parameters do not change across the alternatives. Total risk also does not change appreciably across the alternatives because the frequency of shipments does not vary enough to substantially influence the result.

The accident analyses (other than transportation and worker physical safety incidents/accidents) considered a variety of initiators (including natural and manmade phenomena), the range of activities at LANL, and the range of radioactive and other hazardous materials at LANL. Transportation accidents and the relatively frequent worker physical safety incidents/accidents were considered separately. The accidents discussed below are those that bound the accident risks at LANL (other than transportation and physical safety incidents/accidents).

The operational accident analysis included four scenarios that would result in multiple source releases of hazardous materials: three due to a site-wide earthquake and one due to a wildfire, resulting in three different degrees of consequences and one wildfire scenario. These four scenarios dominate the radiological risk due to accidents at LANL because they involve radiological releases at multiple facilities and are considered credible (that is, they would be expected to occur more often than once in a million years), with the wildfire considered likely.

Another earthquake-initiated accident, labeled RAD–12, is facility-specific (to Building Technical Area–16–411) and is dominated by the site-wide earthquake accidents due to its very low frequency (about 1.5×10^{-6} per year). It is noteworthy that the consequences of such earthquakes are dependent on the frequency of the earthquake event, the facility design, and the amount of material that could be released due to the earthquake; such features do not change across the alternatives, so the impacts of these accidents are the same for all four alternatives. The risks were estimated conservatively in terms of both the frequency of the events and the consequences of such events. (In particular, it is noteworthy that the analysis assumes that any building that would sustain structural or systems damage in an earthquake scenario does so in a manner that creates a path for release of material outside of the building.) The total risk of an accident is the product of the accident frequency and the consequences to the total population within 50 miles (80 kilometers). This risk ranges from 0.046 (SITE–01, i.e., seismic event) and 0.034 (SITE–04, i.e., wildfire event) excess latent cancer fatalities per year of operation, to extremely small numbers for most of the radiological accidents. The risk for release of chemicals, such as chlorine, is calculated similarly as the product of the frequency and numbers of people exposed to greater than the selected guideline concentration, Emergency Response Planning Guideline (ERPG)–2. (ERPG–2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without irreversible or serious health effects or symptoms that could impair their abilities to take protective action). Under all alternatives, the risks for chemical releases range from 6.4 (SITE–01) people exposed per year of operation to extremely small numbers for some chemical releases. In general, such earthquakes would be expected to cause fatalities due to falling structures or equipment; this also would be true for LANL facilities. Thus, worker fatalities due to the direct effects of the earthquakes would be expected. Worker injuries or fatalities due to the release of radioactive or other hazardous materials would be expected to be small or modest increments to the injuries and fatalities due to the direct effects of the earthquakes.

Comments on the Final Site-Wide Environmental Impact Statement

DOE distributed approximately 500 copies of the final Site-Wide Environmental Impact Statement to Congressional members and committees, the State of New Mexico, various American Indian Tribal governments and organizations, local governments, other Federal agencies, and the general public. Comments were received from the U.S. Department of the Interior (DOI) and Chestnut Law Offices, representing San Ildefonso Pueblo. The U.S. Environmental Protection Agency (EPA) did not provide comments on the final Site-Wide Environmental Impact Statement stating in the **Federal Register** (64 FR 18901) that ''Review of the FEIS was not deemed necessary. No formal comment letter was sent to the preparing agency.''

DOI identified two areas of concern with the final Site-Wide Environmental Impact Statement. The first concern is that the Site-Wide Environmental Impact Statement does not adequately assess the direct, indirect, and cumulative effects of programs and activities associated with the continued operation of LANL either on or off the site. DOI maintains that the existing impacts from the environmental baseline should be quantified and not restricted to the evaluation of only two site-specific projects. DOI further states that while programs and activities that are proposed or under way may help to reduce adverse impacts, these programs and activities were not adequately evaluated in the Site-Wide Environmental Impact Statement.

Chapter 4 (Volume I) of the Site-Wide Environmental Impact Statement presents the environmental setting and existing conditions associated with LANL operations. The information presented in Chapter 4 forms a baseline for use in evaluating the environmental impacts of the four Site-Wide alternatives. For all alternatives, assessment of significance was accomplished both quantitatively where data and analysis were available, and qualitatively. The assessment of the potential effects, both positive and adverse, of the Expanded Operations, Reduced Operations, Greener, and No Action Alternatives was based on the degree of change from baseline conditions and was presented in Chapter 5 (Volume I) of the Site-Wide Environmental Impact Statement. DOE integrated many programs and activities, including the Natural Resources Management Plan (see Mitigation Measures), that would reduce adverse impacts in its analysis of environmental impacts.

DOI's second concern is threatened and endangered species protection at LANL. DOI does not concur with DOE's determination that implementation of the Expanded Operation Alternative may affect but would not likely adversely affect four listed species at LANL. The DOI believes that measures necessary to reduce impacts to threatened and endangered species that are identified through the consultation process should be incorporated into the Site-Wide Environmental Impact Statement as required measures.

On April 29, 1999, subsequent to DOI's submittal of comments on the final Site-Wide Environmental Impact Statement, DOE initiated formal section 7 consultation between the DOI and DOE for DOE's proposal to expand existing operations at LANL. DOE sees this consultation process as an opportunity to further the stewardship of listed species provided by the recently implemented Threatened and Endangered Species Management Plan for LANL. Based on communications with the U.S. Fish and Wildlife Service, DOE anticipates that the Service will issue a Biological Opinion in the near future. Upon its receipt DOE will continue to coordinate with the Service the integration into the operation of LANL of any needed measures recommended in the Biological Opinion that will contribute to the welfare of listed species. DOE believes that this process should proceed on a separate, parallel track from that of the Site-Wide Environmental Impact Statement process.

The Chestnut Law Offices, representing San Ildefonso Pueblo, identified three issues of concern with the final Site-Wide Environmental Impact Statement. First, Chestnut Law Offices states that the environmental justice analysis is flawed because it divides San Ildefonso Pueblo into several different segments thereby not indicating any adverse impacts to the Pueblo. Chestnut Law Offices states that most environmental risk is at the perimeter of the laboratory directly affecting San Ildefonso Pueblo, and that the Site-Wide Environmental Impact Statement determines there is no greater impact on the Pueblo than on other disadvantaged communities. Chestnut Law Offices states that this approach in environmental justice analysis does not comply with Federal law and is inadequate.

DOE prepared the environmental justice analysis in accordance with guidance from the Council on Environmental Quality and Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The segments referred to in the comments were used to identify and highlight the locations of low-income and/or minority populations for the impact analyses. Using this tool, the San Ildefonso Pueblo was identified as housing minority and/or low-income populations for consideration in the Environmental Justice analysis. DOE has not identified any disproportionately high and adverse human health or environmental impacts on minority or low-income populations under any of the alternatives analyzed in the Site-Wide Environmental Impact Statement. To the extent that there is a potential for adverse impacts, DOE analysis has shown that most of the impact would affect all populations equally. In the cases of air emissions and on-site transportation, the residential populations nearest to LANL, which have a relatively low percentage of minority and low-income populations, would be affected to a greater extent than other populations within the 50-mile radius.

The impacts addressed in the environmental justice analysis in the Site-Wide Environmental Impact Statement include land resources, geology, soils, water resources, ecological resources, air quality, human health, waste management, socioeconomic, and transportation. This analysis includes the projected impacts due to contamination in the area from past LANL activities. As part of its human health impact analysis, DOE looked at potential exposure through special pathways, including ingestion of game animals, fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. For LANL, the special pathways influence the environmental justice analysis because some of these pathways are more important or viable to the traditional or cultural practices of minority populations in the area. Even considering these special pathways, DOE did not find disproportionately high and adverse health impacts to minority or low-income populations.

The Chestnut Law Offices' second concern is groundwater contamination due to LANL activities. The Chestnut Law Offices states that the final Site-Wide Environmental Impact Statement does not address the recent groundwater contamination but downplays it, and that this section of the Site-Wide Environmental Impact Statement should be re-evaluated.

DOE believes that drinking water quality in the Los Alamos area continues to meet all Federal and New Mexico chemical and radiological standards. In February 1999 DOE discovered, as part of implementing the Hydrogeologic Workplan (the multi-year effort to characterize the flow and extent of contamination of the main aquifer), high explosives contamination while drilling a well (R–25) in the western part of the Laboratory. Based on current knowledge, DOE believes it will take at least 50 years for these contaminants to reach the drinking water production wells approximately three and a half miles to the East of R–25. DOE has and will continue to sample the drinking water to ensure it is safe. Groundwater monitoring data from implementation of the Hydrogeologic Workplan is still under review and evaluation. As new information becomes available, the LANL Environmental Surveillance and Compliance Program will be revised to incorporate the additional data.

Chestnut Law Offices' third concern is that the Site-Wide Environmental Impact Statement does not consider the shutdown of the low-level waste disposal area, Area G, a reasonable alternative. The commentor states the alternatives in the Site-Wide Environmental Impact Statement are based on the assumption that LANL will be a regional low-level waste disposal site. The commentor believes the Site-Wide Environmental Impact Statement does not analyze the possibility that another site may be chosen as the regional low-level waste disposal site, thereby providing the opportunity for the waste to be removed from Area G. The commentor states this is a serious flaw since it does not anticipate a clearly reasonable alternative in light of existing planning documents.

The shutdown of the low-level waste disposal area, Area G, was not considered a reasonable alternative for analysis in the Site-Wide Environmental Impact Statement because Area G has a unique capability for the disposal of certain wastes generated by LANL. Such wastes include classified wastes and other wastes that would be difficult to transport to other sites. The Expanded Operations Alternative was the only alternative that analyzed the impacts of LANL being chosen as a regional low-level waste disposal site.

Under the Waste Management Programmatic Environmental Impact Statement, which evaluated locations for treatment and disposal of low-level radioactive waste and mixed low-level radioactive waste, these wastes would be treated on the site at LANL and disposed of at a regional site to be determined after consultation with stakeholders. One of the potential regional disposal sites for low-level waste is LANL. Therefore, in the Expanded Operations Alternative, the Site-Wide Environmental Impact

Statement addressed treatment and disposal of LANL-generated low-level waste, as well as disposal of off-site generated low-level waste. The Expanded Operations Alternative analyzes the environmental impacts and the footprint needed at Area G to allow for the implementation of this alternative.

If LANL is not selected as a regional disposal site, some low-level waste could be sent off-site for disposal, as reflected in the No Action, Reduced, and Greener Alternatives. The current low-level waste capacity available at Area G is limited. If LANL were selected as a regional disposal site, the expansion of Area G would occur at the fastest rate. If LANL continues to dispose of its own wastes, the expansion would still occur, but at a slower rate. Currently LANL generates some low-level waste that, primarily because of its size and shape, does not meet the acceptance criteria for disposal at other DOE sites, such as the Nevada Test Site. However, the decision as to the ultimate treatment and disposal of low-level waste and mixed low-level waste will be made in a Record of Decision for the Waste Management Programmatic Environmental Impact Statement.

It should also be noted that the EPA, State of New Mexico, and representatives of the Pueblos (four Accord Pueblos) near LANL were invited to review and comment on the Classified Supplement for the Draft Site-Wide Environmental Impact Statement (EPA declined the invitation). Comments from that review were received shortly after the final Site-Wide Environmental Impact Statement was issued. This final Classified Supplement and all comments provided were considered in reaching the decisions in this Record of Decision.

Other Decision Factors

As noted in the final Site-Wide Environmental Impact Statement, LANL houses unique facilities and expertise that have been developed over the past 50 years. These have served several National Security and other national needs in the past. It is expected that, for the foreseeable future, the U.S. will maintain a nuclear weapons stockpile and require ''cutting edge'' science and manufacturing capabilities to address issues of national importance for the maintenance of that stockpile and for other purposes, including assuring the safety and reliability of that stockpile. The unique facilities and expertise at LANL are needed to assist in finding solutions to these issues. As noted in the final Site-Wide Environmental Impact Statement, LANL's role in supporting DOE's missions has expanded as the DOE nuclear weapons complex has been downsized over the last decade. Additionally, it is expected that there will be continued emphasis on applying the unique capabilities at LANL to support DOE's basic science mission and to apply technologies developed in DOE laboratories to improve the U.S. technological position and competitiveness. These factors were also considered (in addition to the human health and environmental impact information discussed above) in reaching this Record of Decision.

Decisions

DOE has decided to continue to operate LANL for the foreseeable future and to expand the scope and level of its operations at LANL. DOE is implementing the Preferred Alternative, that is Alternative 2, Expanded Operations, but with pit production limited to a capacity that can be accommodated within the limited space currently set aside for this activity in the plutonium facility (estimated at nominally 20 pits per year). This alternative reflects a broad expansion of science and technology research, and applications of this research to a variety of issues of national importance; this alternative also includes the continued maintenance of existing and expanded capabilities, and continued support/infrastructure activities. The following discussion describes the major actions to be taken, with an emphasis on those areas that have had the most extensive programmatic or public interest.

It should be noted that the decisions in this Record of Decision will be reflected in DOE budget requests and management practices. However, the actual implementation of these decisions is dependent on DOE funding levels and allocations of DOE budget across competing priorities.

Pit Production and Other Plutonium Operations

DOE remains committed to meeting pit production requirements to support the enduring nuclear weapons stockpile. As part of its implementation of the Preferred Alternative, DOE will establish, over time, a pit production capability at LANL with a capacity of nominally 20 pits per year; this decision reflects an intent to establish a pit production capability at LANL within the existing floor space set aside for this operation (about 11,400 ft^2 [1060 m^2]). This will eliminate the need to transfer several Technical Area-55 plutonium operations (to ''make room'' for pit production activities in Technical Area-55) either to the CMR Building, or to newly constructed nuclear space, as contemplated in the Site-Wide Environmental Impact Statement. Thus, the Preferred Alternative for Pit Production can be implemented without an expansion of the plutonium operations floor space at LANL. The exact production capacity of this floor space is not known with certainty (pending process optimization studies), but has been characterized as nominally 20 pits per year. This level provides adequate capacity to meet the near-term pit production requirements to maintain the enduring stockpile (about 20 pits per year), as expressed in the Record of Decision for the Stockpile Stewardship and Management Programmatic Environmental Impact Statement. While this does not change the 50-pit-per-year mission assignment made in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement Record of Decision, it does suspend full implementation of that decision until an undetermined time in the future.

Implementation of the pit production mission at LANL will be phased. The first pit for delivery to the U.S. nuclear weapons stockpile will be made in 2001. It is expected that, through equipment installation in existing facilities, the limited production capacity of nominally 20 pits per year will be achieved in 2007. At these levels of production, there is no need to move plutonium operations from the Plutonium Facility, Technical Area-55, to the CMR Building, and there is no need to construct a corridor between Technical Area-55 and Technical Area-3. Thus, DOE has decided not to move these operations or construct the road at this time.

Chemistry and Metallurgy Research Building—As the Site-Wide Environmental Impact Statement was being prepared, DOE was working on two sets of information associated with CMR operations: (1) Establishment of a modern authorization basis for these operations (referred to as the CMR Basis for Interim Operations, or BIO); and, (2) studies of the seismicity of the Technical Area-55 and Technical Area-3 areas. Both sets of information are included in the impact analyses in the Site-Wide Environmental Impact Statement (where details were not known, the analyses in the Site-Wide Environmental Impact Statement were, in fact, bounding of the details determined through these efforts). Through this effort, it became apparent that the subprojects included in the CMR Upgrades Construction Project should be reprioritized and oriented to provide for the continued safe operation of the CMR Building through about 2010. The single most substantive change in this project was to replace the proposed seismic upgrades with a combination of material containerization, a reduction in the amount of Material at Risk (or MAR, which is the amount of in-process material that would be subject to release if there were a catastrophic accident), and a substantial reduction in the amount of combustible material allowed in the CMR Building. With these controls in place, the worst-case plausible accidents involving the CMR Building would have minimal effects on public health (effects would be within applicable guidelines intended to protect human health).

The 1996 Stockpile Stewardship and Management Programmatic Environmental Impact Statement analyzed the environmental impacts of locating a pit manufacturing capability at either LANL or the Savannah River Site. In December 1996, DOE issued a Record of Decision reestablishing the pit manufacturing mission at LANL. In August 1998, the U.S. District Court for the District of Columbia, while ruling in DOE's favor in litigation challenging the adequacy of the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, directed DOE to take another look at certain new studies regarding seismic hazards at LANL, and to provide a factual report and technical analysis of the plausibility of a building-wide fire at LANL's plutonium facility (PF–4 at Technical Area-55). The Court directed that DOE prepare a Supplement Analysis, pursuant to DOE's NEPA regulations (10 CFR 1021.314(c)), to help determine whether a supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement should be issued to address these studies. These seismic studies have been released to the public and are examined in more detail in the draft Supplement Analysis released for public review and comment on July 1, 1999. On September 2, 1999, DOE issued a final Supplement Analysis and determined that none of the issues analyzed in the Supplement Analysis represents substantial changes to the actions considered in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, nor do those issues provide significant new information relevant to the environmental concerns discussed in that Programmatic Environmental Impact Statement. Therefore no supplement to that Programmatic Environmental Statement is required.

Secondaries

While LANL was considered as a production site for secondaries (components of a nuclear weapon that contains elements needed to initiate the fusion reaction in a thermonuclear reaction) in the Stockpile Stewardship and Management Programmatic Environmental Impact Statement, this mission was assigned to the Y–12 plant at Oak Ridge, Tennessee. However, DOE expects LANL to maintain an understanding of secondary production technologies, as well as the characteristics of War Reserve secondaries in the stockpile.

Tritium

LANL will continue to support both research and development and production activities involving tritium (neutron tube target loading for nuclear weapons stockpile components). These will include development of new reservoirs and reservoir fill operations, surveillance and performance testing on tritium components, tritium recovery and purification technologies, and production operations associated with neutron generator production for the stockpile. The expansion of these activities results in: (1) tritium throughputs on an annual basis increase by a factor of up to 2.5; and (2) the on-site inventory of tritium increases by a factor of 10.

High Explosives Processing and Testing

Operations in this area will increase such that annual explosives throughput will increase to about 82,700 pounds, and the annual mock explosives throughput will increase to about 2,910. These quantities include continued research, development, and fabrication of high-power detonators, including support of up to 40 major product lines per year in support of the Stockpile Stewardship and Management program. In addition, the number of hydrodynamic tests will increase to about 100 per year; the annual amount of depleted uranium will increase to about 6,900 pounds.

Accelerator Operations

DOE will implement several facility construction or modification projects at Technical Area–53: the Long-Pulse Spallation Source, the 5-Megawatt Target/Blanket Experimental Area, the Dynamic Experiment Laboratory, and the Isotope Production Facility.

Expansion of Technical Area–54/Area G Low-Level Waste Disposal Area

As part of the implementation of the Preferred Alternative, DOE will continue the on-site disposal of LANL generated low-level waste using the existing footprint at Area G low-level waste disposal area and will expand disposal capacity into Zones 4 and 6 at Area G (this expansion would cover up to 72 acres [29 hectares]). DOE will develop both Zones 4 and 6 in a step-wise fashion, expanding these areas as demand requires.

Mitigation Measures

The Site-Wide Environmental Impact Statement included a discussion of existing programs and plans and controls built into the operations at LANL, including operating within applicable regulations, DOE Orders, contractual requirements and approved policies and procedures. The following discussion outlines the mitigation measures that DOE will undertake to reduce the impacts of continuing to operate LANL at the levels outlined in this Record of Decision.

Electrical Power

The Site-Wide Environmental Impact Statement recognizes the need for an increase in electrical power supply and reliability under the Preferred Alternative as well as other alternatives analyzed. The impact analyses emphasize the severity of these issues and consequences if they are not resolved, e.g., brownouts. Solutions to power supply issues are essential to mitigate the effects of power demand under all alternatives. An operating plan for improved load monitoring, equipment upgrades, and optimization of some available power sources was discussed. Additional measures under consideration by DOE include: (1) Limiting operation of large users of electricity to periods of low demand, and contractual mechanisms to bring additional electric power to the region and some form of on-site cogeneration as an incremental resource. DOE and other users of electrical power in the area have been working with suppliers to resolve these foreseeable power and reliability issues. One solution under consideration for improved reliability is the provision of a third power line from the existing Public Service Company of New Mexico Norton substation to the existing LANL substations. This solution could include a new LANL substation. In any case, DOE is committed to manage electric power demands to prevent periods of brownouts by adjusting to the limitations of available power until a solution for a long-term increase in power is in place. DOE is also committed to approve and begin implementing a Utility Procurement Plan by November 1999.

Water Supply and Demand

Prior to September 8, 1998, DOE supplied all potable water for LANL, Bandelier National Monument, and Los Alamos County, including the towns of Los Alamos and White Rock. This water was derived from DOE's groundwater right to withdraw 5,541.3 acre-feet or about 1,806 million gallons of water per year from the main aquifer. On this date, DOE leased these rights to the County of Los Alamos. This lease also included DOE's contracted annual right obtained in 1976 to 1,200 acre-feet of San Juan-Chama Transmountain Diversion Project water. This lease agreement is effective for three years, at which point DOE expects to convey 70 percent of the water right to the County of Los Alamos and lease the remaining 30 percent to them. The San Juan-Chama rights will be transferred in their entirety to the County. On several occasions since 1986 through 1998, LANL operations have exceeded 30 percent of the total DOE annual water right. The agreement between DOE and the County does not preclude provision of additional waters in excess of the 30 percent agreement, if available. However, the agreement also states that should the County be unable to provide water to its customers, the County shall be entitled to reduce water services to DOE in an amount equal to the water rights deficit.

DOE is committed to managing water demand to prevent exceedances of DOE water rights. LANL will develop and implement by June 2000 procedures to assure that all new projects will implement water conservation design and techniques. LANL will also develop water conservation goals and begin implementing them by October 2001.

Waste Management

DOE is committed to the proper management and minimization of all wastes. LANL will integrate waste minimization into Integrated Safety Management by October 2000. By June 2000 LANL will develop and implement procedures to assure that all new projects will implement waste minimization for TRU and mixed TRU waste streams. In addition LANL will reduce by December 2005 waste from routine operations by 80% using 1993 as a baseline for hazardous, low-level radioactive, and mixed low-level radioactive wastes. Also, LANL will recycle 40% of sanitary waste from routine operations by December 2005.

LANL will also purchase EPA-designated items with recycled content according to the conditions of Executive Order 12873. A LANL Implementing Requirement for waste minimization activities is currently in draft.

Wildfire

The final Site-Wide Environmental Impact Statement included an accident scenario from a wildfire that was initiated on land adjacent to LANL and spread to the LANL site. The analysis concluded that a major fire is not only credible but also likely. The current and future risks of wildfires at LANL can only be mitigated through purposeful environmental intervention and active land management. LANL will develop by December 1999 a preliminary program plan for comprehensive wildfire mitigation, including construction and maintenance of strategic fire roads and fire breaks, creation of defensible space surrounding key facilities, and active forest management to reduce fuel loadings. LANL will prepare and begin implementation of a long-term strategy for wildfire mitigation actions before the start of the 2000 fire season.

Cultural Resources

DOE is committed through ongoing consultation processes with affected Native American tribes to ensure protection of cultural resources and sites of cultural, historic, or religious importance to the tribes. With input from the tribes participating in the Los Alamos Pueblos Project (LAPP), DOE will develop a strategy to increase the understanding of traditional cultural properties at LANL, to determine strategies for the long-term management of identified traditional cultural properties and sacred sites and to determine appropriate mitigation measures for specific traditional cultural properties. The strategies could include the development of access agreements to traditional cultural properties and sacred sites. In the past, attempts to identify specific traditional cultural properties at LANL have encountered concerns from traditional groups because of the potential for increased risk to these resources if they are individually identified; thus, DOE will explore the potential benefits and risks of such a study, and options to such a study, with the LAPP tribes. This approach is intended to ensure appropriate respect and consideration regarding cultural concerns, while attempting to provide the information and ability to mitigate or avoid potential impacts to traditional cultural properties (which are currently not specifically known, to a large extent). The goal of the consultation and coordination would be an agreement with the relevant Native American tribes for the management of these resources.

DOE will complete an Integrated Cultural Resource Management Plan (ICRMP) by April 2002. The ICRMP will detail how LANL will manage, preserve, and protect cultural resources within the scope of Federal and State laws, regulations, Executive Orders, standards, as well as to the extent practicable, follow Tribal criteria and guidelines. The ICRMP will provide a basis for a unified approach to address the multiplicity of cultural resources located on LANL lands. The plan will serve to streamline many of the administrative steps required by Federal and State laws and regulations. The scope of activities for the ICRMP would include development of the plan, completion of surveys of archeological resources and historic buildings, and implementation of long-term monitoring.

Natural Resources

DOE will develop and begin implementation of an integrated Natural Resources Management Plan (NRMP) by October 2002, which will integrate the principles of ecosystem management into the critical missions of LANL to conserve ecosystem processes and biodiversity. The NRMP will support DOE's policy to manage all of its land and facilities as valuable national resources. This stewardship will integrate LANL's mission and operations with its biological, water, soil, and air resources in a comprehensive plan that will guide land and facility use decisions. The plan will consider the site's larger regional context and be developed in consultation with regional land managing agencies and owners (particularly Bandelier National Monument, Santa Fe National Forest, and Native American Pueblos), State agencies, and the U.S. Fish and Wildlife Service. This cooperative effort will ensure a consistent, integrated, and structured approach to regional natural resource management.

The NRMP is viewed as a sequenced planning document that will include specific tasks and studies as part of the process of development. It will include new initiatives as well as integrating ongoing programs, plans, and activities at LANL, some of which may be reassessed to ensure their contribution to the goals and objectives of integrated ecosystem management.

Mitigation Action Plan

In accordance with 10 CFR 1021.331, DOE is preparing a Mitigation Action Plan that will identify specific actions needed to implement these mitigation measures and provide schedules for completion. These mitigation measures represent all practicable means to avoid or minimize harm from the alternative selected.

Conclusion

DOE has considered environmental impacts, stakeholder concerns, and National policy in its decisions regarding the management and use of LANL. The analysis contained in the Site-Wide Environmental Impact Statement is both programmatic and site specific in detail. It is programmatic from the broad multi-use facility management perspective and site specific in the detailed project and program activity analysis. The impacts identified in the Site-Wide Environmental Impact Statement were based on conservative estimates and assumptions. In this regard, the analyses bound the impacts of the alternatives evaluated in the Site-Wide Environmental Impact Statement. The Expanded Operations Alternative was defined to include activities to implement the programmatic decisions made or that may be made as a result of other DOE Environmental Impact Statements (some of which are currently in progress). This Site-Wide Environmental Impact Statement and the analyses it contains can be used to support these future programmatic or project decisions.

In accordance with the provisions of NEPA, its implementing procedures and regulations, and DOE's NEPA regulations, I have considered the information contained within the Site-Wide Environmental Impact Statement, including the classified supplement and public comments received in response to the final Site-Wide Environmental Impact Statement. Being fully apprised of the environmental consequences of the alternatives and other decision factors described above, I have decided to continue and expand the use of LANL and its resources as described. This will enhance DOE's ability to meet its primary National security mission responsibility and create an environment that fosters technological innovation in both the public and private sectors.

Issued at Washington, DC, September 13, 1999.

Thomas F. Gioconda,

Brigadier General, USAF, Acting Assistant Secretary for Defense Programs.

[FR Doc. 99–24456 Filed 9–17–99; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Notice of Intent to Prepare a Supplemental Environmental Impact Statement to the Final Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory

AGENCY: U.S. Department of Energy, National Nuclear Security Administration.

ACTION: Notice of Intent.

SUMMARY: Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 *et seq.*), the Council on Environmental Quality's (CEQ) and the U.S. Department of Energy's (DOE) regulations implementing NEPA (40 CFR parts 1500–1508 and 10 CFR part 1021, respectively), the National Nuclear Security Administration (NNSA), an agency within the DOE, announces its intent to prepare a supplemental site-wide environmental statement (S–SWEIS) to update the analyses presented in the Final Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory (SWEIS) (DOE/EIS–0238; January 1999). The purpose of this notice is to invite individuals, organizations, and government agencies and entities to participate in developing the scope of the S–SWEIS.

In its September 1999 Record of Decision (ROD) based on the SWEIS, DOE announced its decision to implement the Expanded Operations Alternative analyzed in the SWEIS, with modifications to weapons related production work (the Preferred Alternative), at Los Alamos National Laboratory (LANL). That decision is being implemented at LANL. Pursuant to 40 CFR 1502.20, the S–SWEIS will rely on and expand on the analysis in the original SWEIS. The No Action Alternative for the S–SWEIS is the continued implementation of the SWEIS ROD, together with other actions described and analyzed in subsequent NEPA reviews. The Proposed Action in the S–SWEIS will include changes since the SWEIS 1999 ROD.

DATES: NNSA invites comments on the scope of this S-SWEIS through February 27, 2005. NNSA will hold a public scoping meeting in Pojoaque, New Mexico, at the Pablo Roybal Elementary School on January 19, 2005, from 6 to 8 pm. Scoping comments received after February 27, 2005, will be considered to the extent practicable.

ADDRESSES: To submit comments on the scope of the S-SWEIS, questions about the document or scoping meeting, or requests to be placed on the document distribution list, please write or call: Ms. Elizabeth Withers (e-mail address: *lanl_sweis@doeal.gov;* mailing address: NNSA Los Alamos Site Office, NEPA Compliance Officer, 528 35th Street, Los Alamos, New Mexico, 87544; (toll free) telephone 1–877–491–4957; or Facsimile 505–667–9998).

FOR FURTHER INFORMATION CONTACT: For general information about the DOE NEPA process, please contact: Ms. Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585, 202–586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION: LANL is located in north-central New Mexico, 60 miles north-northeast of Albuquerque, 25 miles northwest of Santa Fe, and 20 miles southwest of Española in Los Alamos and Santa Fe Counties. It is located between the Jemez Mountains to the west and the Sangre de Cristo Mountains and Rio Grande to the east. LANL occupies about 40 square miles (104 square kilometers) and is operated for NNSA under contract, by the University of California. (The contract for LANL's management and operation is undergoing a competitive bid process; however, the selection of the LANL management and operations contractor in the future will not affect the nature of the NNSA and DOE work performed at LANL.)

LANL is a multidisciplinary, multipurpose institution primarily engaged in theoretical and experimental research and development. LANL has been assigned science, research and development, and production mission support activities that are critical to the accomplishment of the national security objectives (as reflected in the ROD for the September 1996 Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management (DOE/EIS–0236)). Specific LANL assignments will continue for the foreseeable future include production of War-Reserve products, assessment and certification of the stockpile, surveillance of the War-Reserve components and weapon systems, ensuring safe and secure storage of strategic materials, and management of excess plutonium inventories. LANL's main role in the fulfillment of DOE mission objectives includes a wide range of scientific and technological capabilities that support nuclear materials handling, processing and fabrication; stockpile management; materials and manufacturing technologies; nonproliferation programs; and waste management activities.

The Final LANL SWEIS, issued in January 1999, considered the operation of LANL at various levels for about a 10-year period of time. Alternatives considered in that document were: No Action Alternative, the Expanded Operations Alternative, the Reduced Operations Alternative, and the Greener Alternative. In addition to providing an overview of the LANL site and its activities and operations, the SWEIS identified 15 LANL "Key Facilities" for the purposes of NEPA analysis. "Key

[1] Protection from public disclosure involving this kind of specific information is based upon 18 CFR 4.32(b)(3)(ii) of the Commission's regulations implementing the Federal Power Act.

Facilities'' are those facilities that house operations with the potential to cause significant environmental impacts; are of most interest or concern to the public based on scoping comments; or are facilities that would be the most subject to change due to potential programmatic decisions. The operations of these ''Key Facilities'' were described in the SWEIS and, together with other non-key facility functions, formed the basis of the description of LANL facilities and operations analyzed for their potential impacts. The Preferred Alternative was the Expanded Operations Alternative with certain reductions in weapons-related manufacturing capabilities. This alternative was chosen for implementation in the ROD issued in September 1999.

In mid-2004, NNSA undertook the preparation of a Supplement Analysis for the SWEIS pursuant to DOE's regulatory requirement to evaluate site-wide NEPA documents at least every 5 years (10 CFR 1021.330) and determine whether the existing EIS remains adequate, to prepare a new site-wide EIS, or prepare a supplement to the existing EIS. During the development of this Supplement Analysis, NNSA decided to proceed immediately with a supplement to the existing SWIES in order to expedite the NEPA process and to save time and money. DOE NEPA regulations (10 CFR 1021.314) require the preparation of a Supplemental EIS if there are substantial changes to a proposal or significant new circumstances or information relevant to environmental concerns. Substantial changes to the level of LANL operations may result from proposed, modified or enhanced activities and operations within LANL facilities (discussed later in subsequent paragraphs of this Notice), and new circumstances and information with regard to effects from the Cerro Grande Fire (which burned a part of LANL), a reduction in the size of the LANL reservation due to recent land conveyance and transfers, and contaminant migration have come to light over the past five years that could be deemed significant under 10 CFR 1021.314.

Since the issuance of the Final SWEIS in 1999, DOE and NNSA have finalized several environmental impact statements, environmental assessments (EA), and a special environmental analysis dealing with LANL operations and actions taken immediately after the 2000 Cerro Grande Fire. The activities analyzed in these NEPA documents and developing changes to the LANL environmental setting led NNSA to conclude it would be prudent and efficient to begin updating the SWEIS now by preparing a supplemental SWEIS. NNSA will use the S–SWEIS to consider the potential impacts of proposed modifications to LANL activities, as well as the cumulative impacts associated with on-going activities at LANL, on the changed LANL environment.

The S–SWEIS will provide a review of the impacts resulting from implementing the SWEIS ROD over the past 5 years at LANL and compare these impacts to the impacts projected in the SWEIS analyses for that alternative to provide an understanding of the SWEIS's ability to identify potential impacts. The S–SWEIS analyses will focus primarily on aspects of the existing environment that could be impacted by newly proposed changes to LANL operations at certain facilities and by environmental cleanup actions that could occur over the next 5 to 6 years in response to a consent order from the State of New Mexico. The S–SWEIS Proposed Action will analyze projected impacts anticipated from operating LANL at the 1999 ROD level for at least the next 5 years, with some modified work now being proposed at certain facilities. NNSA is considering proposed operational changes within at least two new ''Key Facilities'' at LANL:

• The Nicholas C. Metropolis Center for Modeling and Simulation (formerly called the Strategic Computing Complex), and
• The Nonproliferation and International Security Center (NISC).

The construction and operation of the Nicholas C. Metropolis Center for Modeling and Simulation were analyzed in a December 1998 EA and a finding of no significant impact (FONSI) for that proposed action was issued based on the impact analyses for operating the computational facility up to a 50–TeraOp platform (a TeraOp is a trillion floating point operations per second). The Center has been constructed and is currently operating below the operations level analyzed in the 1998 EA; however, NNSA proposes to increase the facility's operational capacity up to 100 TeraOps before 2009 with corresponding increases to the facility's consumption of water and electrical power resources. This proposed increase in the operating platform from 50 TeraOps up to 100 TeraOps will be analyzed in the S–SWEIS.

The NISC's construction and operation were analyzed in a July 1999 EA and a FONSI was issued for that proposed action based on the impact analyses for consolidating activities and operating the facility as it was envisioned at that time. The facility is currently operating as evaluated in the 1999 EA; however, NNSA is now proposing to move certain operations from the Technical Area 18 (TA–18) Pajarito Site (another of LANL's ''Key Facilities,'' which is also discussed in the following paragraph) into the NISC. This would change the amount of nuclear material stored in the facility, with corresponding potential increases to worker exposures in the case of a site accident. The proposed changes to operations and material stored in NISC will be analyzed in the S–SWEIS.

NNSA will also eliminate one former LANL ''Key Facility'' identified in the 1999 SWEIS—the TA–18 Pajarito Site. In its 2002 EIS (the TA–18 Relocation Final EIS (DOE/EIS–319)) and ROD, the NNSA decided to relocate TA–18 security category I and II operations and associated nuclear material to the Nevada Test Site. Implementation of the relocation decision began in 2004 and will continue over the next 5 years. After relocation of operations and materials, this facility will no longer be a LANL ''Key Facility'' within the meaning of the SWEIS, and therefore will not be listed as such a facility. There are certain proposals related to the relocation of the TA–18 security category III and IV operations and the disposition of the TA–18 facilities that were not analyzed in the 2002 EIS; these proposed actions and their projected impacts will be evaluated in the S–SWEIS impact analyses.

Certain aspects of operational changes, construction and activities that have occurred or are being proposed for LANL over the next 5 years that were not analyzed in the 1999 SWEIS will also be considered and analyzed in the S–SWEIS. Changes that have been made to existing LANL operations that will also be considered further in the S–SWEIS include some permanent modifications to on-going operations that have recently been made as a result of decreases in specific work and projects performed at some LANL facilities, and changes to the locations of various types of materials at risk (MAR) at LANL facilities or off-site locations. Examples of newly proposed actions at LANL include the remediation of 10 major material disposal areas (MDAs) at LANL; the operation of a Biosafety Level-3 (BSL–3) Facility (this facility will become part of an existing ''Key Facility'' at LANL, the former Health Research Laboratory (HRL) now known as the Bioscience Facilities); the construction and operation of a new solid waste transfer station, an office and light laboratory complex, a consolidated warehouse and truck inspection station, and a new radiography facility; and recently proposed increases in the types and quantities of sealed sources accepted for waste management at LANL. Some of these newly proposed actions may be analyzed explicitly in the S–SWEIS in project specific analyses, while others may be analyzed in separate EAs to be prepared over the next several months, such as the new BSL–3 Facility EA. The potential impacts of the BSL–3 Facility will be included in the S–SWEIS evaluation of cumulative impacts, as will the impacts of all of the newly proposed actions. A comparison of the newly projected operational impacts will also be made to the projected impacts identified in the SWEIS.

The NEPA compliance process for the BSL–3 Facility at LANL has spanned several years. In early 2002, the NNSA issued an EA and FONSI for the construction and operation of the facility at LANL. Due to the need to consider new circumstances and information relevant to the actual construction of the BSL–3 Facility and its future operation, the NNSA withdrew the 2002 FONSI for operating this facility and determined that a new EA should be prepared that re-evaluates the proposed operations of the facility as it has been constructed. The new EA is currently being prepared and a draft EA will be issued for public review and comment in early 2005. The EA will be used by NNSA in making a decision about whether to issue a FONSI for operation of the BSL–3 Facility. If a FONSI cannot be issued, the analyses for the operation of the BSL–3 Facility will be included in the S–SWEIS Proposed Action.

In accordance with applicable DOE and CEQ NEPA regulations, the No Action Alternative will also be analyzed in the S–SWEIS. In this case, the No Action Alternative will be the continued implementation of the 1999 ROD at LANL over the next 5 years as this alternative was originally analyzed in the SWEIS, and will also include the implementation of other actions selected in DOE and NNSA RODs supported by separate NEPA reviews (specifically, actions analyzed since the issuance of the final SWEIS in the Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico (DOE/EIS–293), the Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at Los Alamos National Laboratory (DOE/EIS–319), the Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico (DOE/EIS–0350), and in about 20 various EAs and their associated FONSIs, as well as actions categorically excluded from the need for preparation of either an EA or an EIS). The Los Alamos Site Office has posted a list of EAs and their associated FONSIs that pertain to LANL operations dating from the completion of the 1999 SWEIS on their Web site at: *http://www.doeal.gov/LASO/nepa.* The full text of most of these EAs is also available through links provided at that Web site; copies of all of the documents may be obtained by contacting Ms. Withers at any of the addresses provided previously in this Notice.

Changes or new information have also surfaced regarding the environmental setting at LANL over the past 5 years that may affect future LANL operations, such as changes to LANL watersheds as the result of the Cerro Grande Fire, new information and changes resulting from thinning the forests around LANL, and the long-term effects from the regional drought. Additionally, there have been changes to both the number of LANL workers and to the surrounding population that have occurred or are being projected that are different from those on which the SWEIS socioeconomic and other impact analyses were based. To the extent that changes to or new information about the existing LANL environment may significantly affect natural and cultural resource areas originally considered in the 1999 SWEIS, projected impacts associated with implementing the Proposed Action over the next 5 years at LANL will be analyzed in the S–SWEIS.

Direct, indirect, and unavoidable impacts to the various natural and cultural resources present at LANL, together with irreversible and irretrievable commitments and mitigations, will also be analyzed in the S–SWEIS. Further, operational and site differences require a re-evaluation of LANL operational accident analyses and a new assessment and understanding of cumulative impacts of LANL operations will also be addressed.

Public Scoping Process: The scoping process is an opportunity for the public to assist the NNSA in determining the issues for impact analysis, and at least one public scoping meeting is held. The purpose of the scoping meeting is to provide attendees an opportunity to present oral and written comments, ask questions, and discuss concerns regarding the S–SWEIS with NNSA officials. Comments and recommendations can also be mailed to Elizabeth Withers at any of the identified addresses noted in the previous paragraphs of this Notice. The S–SWEIS meeting will use a format to facilitate dialogue between NNSA and the public and will be an opportunity for individuals to provide written or oral statements. NNSA welcomes specific comments or suggestions on the content of the document that could be considered. The potential scope of the S–SWEIS discussed in the previous portions of this Notice is tentative and is intended to facilitate public comment on the scope of this S–SWEIS. It is not intended to be all-inclusive, nor does it imply any predetermination of potential impacts. The S–SWEIS will describe the potential environmental impacts of the alternatives by using available data where possible and obtaining additional data where necessary. Copies of written comments and transcripts of oral comments provided to NNSA during the scoping period will be available at the following locations: Los Alamos Outreach Center, 1350 Central Avenue, Suite 101, Los Alamos, New Mexico, 87544; and the Zimmerman Library, University of New Mexico, Albuquerque, New Mexico 87131.

S–SWEIS Preparation Process: The S–SWEIS preparation process begins with the publication of this Notice of Intent in the **Federal Register**. After the close of the public scoping period, NNSA will begin developing the draft S–SWEIS. NNSA expects to issue the Draft S–SWEIS for public review in the fall of 2005. Public comments on the Draft S–SWEIS will be received during a comment period of at least 45 days following publication of the Notice of Availability. The Notice of Availability, also published in the **Federal Register**, along with notices placed in local newspapers, will provide dates and locations for public hearings on the Draft S–SWEIS and the deadline for comments on the draft document. Issuance of the Final S–SWEIS is scheduled for early 2006.

Issued in Washington, DC, this 29th day of December, 2004.

Everet H. Beckner,

Deputy Administrator for Defense Programs, National Nuclear Security Administration.

[FR Doc. 05–210 Filed 1–4–05; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Notice of Availability of the Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, NM

AGENCY: U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA).

ACTION: Notice of availability and public hearings.

SUMMARY: NNSA announces the availability of the Draft Site-wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (LANL Draft SWEIS) (DOE/EIS – 0380), and the dates and locations for the public hearings to receive comments on the Draft LANL SWEIS. The Draft LANL SWEIS was prepared in accordance with the Council on Environmental Quality's National Environmental Policy Act (NEPA) Implementing Regulations (40 CFR parts 1500–1508) and the DOE NEPA Implementing Procedures (10 CFR part 1021). The Draft LANL SWEIS analyzes the potential environmental impacts associated with continuing ongoing Los Alamos National Laboratory (LANL) operations and foreseeable new and modified operations and facilities. The Draft LANL SWEIS analyzes the No Action Alternative and two action alternatives: a Reduced Operations Alternative and an Expanded Operations Alternative. The No Action Alternative would continue currently assigned operations at LANL in support of DOE and NNSA missions. The Reduced Operation Alternative also includes most operations discussed under the No Action Alternative with reductions to certain LANL activities below the No Action Alternative level. The Expanded Operations Alternative includes operations discussed under the No Action Alternative plus new and expanded levels of operations in support of reasonably foreseeable future mission requirements.

DATES: The NNSA invites members of Congress, American Indian Tribal Governments, state and local governments, other Federal agencies, and the general public to provide comments on the Draft LANL SWEIS. The comment period extends from the publication of this Notice of Availability through September 5, 2006. Written comments must be received or postmarked by September 5, 2006. Comments postmarked after this date will be considered to the extent practicable. The NNSA will consider the comments in the preparation of the Final LANL SWEIS. Public hearings to present information and receive comments on the Draft LANL SWEIS will be held at three locations. This information will also be published in local New Mexico newspapers in advance of the hearings. Any necessary changes will be announced in the local media and on the web site noted in the **ADDRESSES** section of this notice. Oral and written comments will be accepted at the public hearings. The locations, dates, and times for these public hearings are as follows:

Tuesday, August 8, 2006, at 6:30 p.m. to 9:30 p.m., Fuller Lodge, Pajarito Room, 2132 Central Avenue, Los Alamos, NM.

Wednesday, August 9, 2006, at 6:30 p.m. to 9:30 p.m., Northern New Mexico Community College, Eagle Memorial Sportsplex, 921 Paseo de Onate, Española, NM.

Thursday, August 10, 2006, at 6:30 p.m. to 9:30 p.m., Santa Fe Community College, Main Building, Jemez Rooms, 6401 Richards Avenue, Santa Fe, NM.

The following Web site may be accessed for additional information: *http://www.doeal.gov/laso/nepa/sweis.htm* . For information or to record comments call 1–877–491–4957

ADDRESSES: Copies of the Draft LANL SWEIS are available for review at: The Los Alamos Outreach Center, 1619 Central Avenue, Los Alamos, New Mexico, 87544; the Office of the Northern New Mexico Citizens Advisory Board, 1660 Old Pecos Trail, Suite B, Santa Fe, New Mexico; and the Zimmerman Library, University of New Mexico, Albuquerque, New Mexico 87131. The Draft SWEIS will also be available on the Department of Energy Los Alamos Site Office's LASO NEPA website at: *http://www.doeal.gov/laso/nepa/sweis.htm.* Additionally, a copy of the Draft LANL SWEIS or its Summary may be obtained upon request by writing to: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Site Office, Attn: Ms. Elizabeth Withers, Office of Environmental Stewardship, 528 35th Street, Los Alamos, New Mexico, 87544; or by facsimile ((505) 667–5948); or by e-mail at: *LANL_SWEIS@doeal.gov.*

Specific information regarding the public hearings can also be obtained by the means described above. Comments concerning the Draft LANL SWEIS can be submitted to the NNSA Los Alamos Site Office by the means described above or by leaving a message on the LASO EIS Hotline at (toll free) 1 –877–491–4957. The Hotline will have instructions on how to record comments. Please mark all envelopes, faxes and e-mail: "Draft LANL SWEIS Comments".

FOR FURTHER INFORMATION CONTACT: For general information on NNSA NEPA process, please contact: Ms. Alice Williams, NA–56, NEPA Compliance Officer for Defense Programs, U.S. Department of Energy, National Nuclear Security Administration, 1000 Independence Avenue, SW., Washington, DC 20585, or telephone 202–586–6847, or Ms. Elizabeth Withers, NEPA Compliance Officer, U.S. Department of Energy, Los Alamos Site Office, 528 35th Street, Los Alamos, New Mexico, 87004, or telephone 505 – 845–4984. For general information about the DOE NEPA process, please contact: Ms. Carol Borgstrom, Director, Office of NEPA Policy and Compliance (EH–42), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–4600, or leave a message at 1–800–472–2756.

SUPPLEMENTARY INFORMATION: The primary purpose and need for continued operation of LANL is to provide support for DOE and NNSA core missions as directed by Congress and the President. NNSA's need to continue operating LANL is focused on their obligation to ensure a safe and reliable nuclear weapons stockpile. LANL is also needed to support other Federal agencies, including the Department of Homeland Security. The Draft LANL SWEIS analyzes the environmental impacts of operations at LANL.

LANL is located in north-central New Mexico and covers an area of about 40 square miles (104 square kilometers). LANL was established in 1943 as "Project Y" of the Manhattan Project with a single-focused national defense mission—to build the world's first nuclear weapon. After World War II ended, Project Y was designated a permanent research and development laboratory and its mission support work was expended from defense and related research and development to incorporate a wide variety of new work assignments in support of other Federal Government and civilian programs. LANL is now a multi-disciplinary, multipurpose institution engaged in theoretical and experimental research and development.

DOE issued a Final SWEIS and Record of Decision in 1999 for the continued operation of LANL. DOE regulations implementing NEPA require the evaluation of site-wide NEPA analyses every five years to determine their continued applicability; such a five-year evaluation was initiated for the 1999 SWEIS in 2004, and NNSA subsequently made a determination to prepare a new SWEIS for LANL operations. Decisions regarding LANL operations that will be based upon impact information contained within this SWEIS will replace previous decisions announced through the 1999 ROD for LANL operations.

The alternatives evaluated in the Draft LANL SWEIS represent a range of operational levels ranging from the minimal reasonable activity levels (Reduced Operations Alternative), to the highest reasonable activity levels that could be supported by current facilities, plus the potential expansion and construction of new facilities for existing capabilities and for specifically identified future actions (Expanded Operations Alternative). The No Action Alternative would continue current mission support work at LANL and includes approved interim actions and facility construction, expansions or modifications, and decontamination and decommissioning for which NEPA impact analysis has already been completed. All alternatives assume LANL will continue to operate as a NNSA national security laboratory for the foreseeable future.

Following the end of the public comment period described above, the NNSA will consider and respond to the comments received, and issue the Final LANL SWEIS. The NNSA will consider the environmental impact analysis presented in the Final LANL SWEIS, along with other information, in determining the Record of Decision for the continued operation of LANL.

Signed in Washington, DC, this 26th day of May 2006.

Thomas P. D'Agostino,

Acting Administrator, National Nuclear Security Administration.

[FR Doc. 06–6055 Filed 7–6–06; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

National Nuclear Security Administration

Extension of Comment Period on the Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, NM

AGENCY: U.S. Department of Energy (DOE), National Nuclear Security Administration (NNSA).

ACTION: Notice of comment period extension.

SUMMARY: On July 7, 2006, NNSA published a Notice of Availability for the Draft Site-wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (LANL Draft SWEIS) (DOE/EIS –0380) (71 FR 38638) and announced a 60-day public comment period ending September 5, 2006. Subsequently, in response to requests for additional time to review and comment on the document, NNSA is extending the public comment period until September 20, 2006.

DATES: Comments should be submitted to NNSA no later than September 20, 2006. NNSA will consider comments submitted after this date to the extent practicable.

ADDRESSES: Comments, or requests for copies of the LANL Draft SWEIS should be sent to: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Site Office, Attn: Ms. Elizabeth Withers, SWEIS Document Manager, 528 35th Street, Los Alamos, New Mexico, 87544; or by facsimile (1–505-667–5948); or by e-mail at: *LANL_SWEIS@doeal.gov*.

Requests for copies of the LANL Draft SWEIS or recorded comments may also be made by calling 1–877–491–4957. Please mark all envelopes, faxes and e-mail: "LANL Draft SWEIS Comments". The LANL Draft SWEIS and its reference documents are available for review at: the Robert J. Oppenheimer Study Center Research Library, Technical Area 3, Los Alamos National Laboratory, Los Alamos, New Mexico; the Office of the Northern New Mexico Citizens Advisory Board, 1660 Old Pecos Trail, Suite B, Santa Fe, New Mexico; and the Zimmerman Library, University of New Mexico, Albuquerque, New Mexico. The Draft SWEIS is available on the DOE Los Alamos Site Office's NEPA Web site at: *http://www.doeal.gov/laso/nepa/sweis.htm*.

FOR FURTHER INFORMATION CONTACT: U.S. Department of Energy, Los Alamos Site Office, Attn: Ms. Elizabeth Withers, SWEIS Document Manager, 528 35th Street, Los Alamos, New Mexico 87544; or telephone 1–505–845–4984.

Issued in Los Alamos, NM, this 24th day of August, 2006.

Edwin L. Wilmot,

Manager.

[FR Doc. 06–7298 Filed 8–30–06; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Notice of Intent To Prepare a Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement—Complex 2030

AGENCY: National Nuclear Security Administration, Department of Energy.

ACTION: Notice of intent.

SUMMARY: The National Nuclear Security Administration (NNSA), an agency within the U.S. Department of Energy (DOE or Department), announces its intent to prepare a *Supplement to the Stockpile Stewardship and Management Programmatic Environmental Impact Statement—Complex 2030* (Complex 2030 SEIS or SEIS, DOE/EIS–0236–S4), pursuant to the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 *et seq.*), the Council on Environmental Quality's (CEQ's) and DOE's regulations implementing NEPA (40 CFR parts 1500–1508 and 10 CFR part 1021, respectively). The SEIS will analyze the environmental impacts from the continued transformation of the United States' nuclear weapons complex by implementing NNSA's vision of the complex as it would exist in 2030, which the Department refers to as Complex 2030, as well as alternatives. Since the end of the Cold War, there continue to be significant changes in the requirements for the nation's nuclear arsenal, including reductions in the number of nuclear weapons. To fulfill its responsibilities for certifying the safety and reliability of nuclear weapons without underground testing, DOE proposed and implemented the Stockpile Stewardship and Management (SSM) Program in the 1990s. Stockpile Stewardship includes activities required to maintain a high level of confidence in the safety and reliability of nuclear weapons in the absence of underground testing, and in the capability of the United States to resume nuclear testing if directed by the President. Stockpile Management activities include dismantlement, maintenance, evaluation, repair, and replacement of weapons and their components in the existing stockpile.

NNSA's proposed action is to continue currently planned modernization activities and select a site for a consolidated plutonium center for long-term research and development, surveillance, and pit [1] manufacturing; consolidate special nuclear materials throughout the complex; consolidate, relocate, or eliminate duplicative facilities and programs and improve operating efficiencies; identify one or more sites for conducting NNSA flight test operations; and accelerate nuclear weapons dismantlement activities. This Notice of Intent (NOI), the initial step in the NEPA process, informs the public of NNSA's intention to prepare the Complex 2030 SEIS, announces the schedule for public scoping meetings, and solicits public input. Following the scoping period, NNSA will prepare and issue a draft of the Complex 2030 SEIS that will describe the Complex 2030 proposal, the alternatives analyzed, and potential impacts of the proposal and the alternatives.

This NOI also announces that NNSA has cancelled the previously planned *Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (DOE/EIS–0236–S2).

DATES: NNSA invites comments on the scope of the Complex 2030 SEIS. The public scoping period starts with the publication of this NOI in the **Federal Register** and will continue through January 17, 2006. Scoping comments received after this date will be considered to the extent practicable. NNSA will hold public scoping meetings to discuss issues and receive oral and written comments on the scope of the Complex 2030 SEIS. The locations, dates, and times for these public scoping meetings are listed below and will be announced by additional appropriate means. NNSA requests federal agencies that desire to be designated as cooperating agencies on the SEIS to contact NNSA's Office of Transformation at the address listed under **ADDRESSES** by the end of the scoping period.

- North Augusta, South Carolina, North Augusta Community Center, 495 Brookside Avenue. November 9, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.
- Oak Ridge, Tennessee, Oak Ridge City Center Club Room, 333 Main Street. November 13, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.
- Amarillo, Texas, Amarillo Globe-News Center, Education Room, 401 S. Buchanan. November 15, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.
- Las Vegas, Nevada, Cashman Center, 850 Las Vegas Boulevard North (at Washington). November 28, 2006. 11 a.m.—3 p.m., 6 p.m.—10 p.m.
- Tonopah, Nevada, Tonopah Convention Center, 301 Brougher Avenue. November 29, 2006, 6 p.m.—10 p.m.
- Socorro, New Mexico, Macey Center (at New Mexico Tech), 801 Leroy Place. December 4, 2006, 6 p.m.—10 p.m.
- Albuquerque, New Mexico, Albuquerque Convention Center, 401 2nd St. NW. December 5, 2006, 11 a.m.—3 p.m., 6 p.m.—10 p.m.
- Los Alamos, New Mexico, Mesa Public Library, 2400 Central Avenue. December 6, 2006, 10:30 a.m.—2:30 p.m.
- Santa Fe, New Mexico, Genoveva Chavez Community Center, 3221 Rodeo Road. December 6, 2006, 6 p.m.—10 p.m.
- Livermore, California, Robert Livermore Community Center, 4444 East Avenue. December 12, 2006, 11 a.m.—3 p.m.
- Tracy, California, Tracy Community Center, 950 East Street. December 12, 2006, 6 p.m.—10 p.m.
- U.S. Department of Energy, 1000 Independence Avenue, SW., Room 1E–245, Washington, DC. December 14, 2006, 1 p.m.—5 p.m.

NNSA officials will be available to informally discuss the Complex 2030 proposal during the first hour. Following this, NNSA intends to hold a plenary session at each scoping meeting in which officials will explain the Complex 2030 proposal and the SEIS, including preliminary alternatives. The meetings will provide the public with an opportunity to provide oral and written comments to NNSA on the scope of the SEIS. Input from the scoping meetings will assist NNSA in preparing the draft SEIS.

ADDRESSES: General questions concerning the NOI can be asked by calling toll-free 1–800–832–0885 (ext. 63519), e-mailing to *Complex2030@nnsa.doe.gov*, or writing to Theodore A. Wyka, Complex 2030 SEIS Document Manager, Office of Transformation, U.S. Department of Energy, NA–10.1, 1000 Independence Avenue, SW., Washington, DC 20585. Written comments on the scope of the SEIS or requests to be placed on the document distribution list can be sent to the Complex 2030 SEIS Document Manager. Additional information regarding Complex 2030 is available on Complex2030PEIS.com.

For general information on the DOE NEPA process, please contact Carol M. Borgstrom, Director, Office of NEPA Policy and Compliance, U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–4600 or 1–800–472–2756. Additional information regarding DOE NEPA activities and access to many DOE NEPA documents are available on the Internet through the DOE NEPA Web site at *http://www.eh.doe.gov/nepa.*

SUPPLEMENTARY INFORMATION:

[1] A pit is the central core of a nuclear weapon typically containing plutonium-239 that undergoes fission when compressed by high explosives.

Background: The early days of the nuclear weapons complex after World War II saw a rapid build-up of capability and capacity to support the growth of the stockpile to fight the Cold War. By the 1960s, the United States had built a large stockpile of nuclear weapons, and the nation began to focus on improving, rather than expanding, the stockpile. NNSA's predecessor agencies began to consolidate operations and close some production facilities. In the 1980s, facilities were shut down across the nuclear weapons complex, including certain facilities at the Savannah River Site in South Carolina; the Oak Ridge Reservation in Tennessee; the Rocky Flats Plant in Colorado; the Fernald Site in Ohio; the Hanford Reservation in Washington; and elsewhere.

Prior DOE NEPA Reviews: DOE completed a Nuclear Weapons Complex Reconfiguration (''Complex-21'') Study in January 1991, which identified significant cost savings that could be achieved by further downsizing of the nuclear weapons complex.

DOE then initiated a programmatic EIS (Reconfiguration PEIS) examining alternatives for reconfiguring the nuclear weapons complex. However, in December 1991, the Department decided to separate proposals for transforming non-nuclear production from the Reconfiguration PEIS because (1) proposals to consolidate non-nuclear facilities might not require preparation of an EIS, and (2) proposals and decisions regarding transformation of non-nuclear production would neither significantly affect nor be affected by proposals and decisions regarding transformation of nuclear production. On January 27, 1992, the Department issued an NOI (57 FR 3046) to prepare an environmental assessment (DOE/EA–0792) for the consolidation of non-nuclear production activities within the nuclear weapons complex. Following the collapse of the Soviet Union, the United States reduced the budget for the nuclear weapons program. President George H. W. Bush imposed a moratorium in 1992 on underground nuclear testing.

On September 14, 1993, DOE published a Finding of No Significant Impact (FONSI) regarding its proposal to consolidate non-nuclear component production (58 FR 48043). This proposal included termination of non-nuclear production missions at the Mound Plant in Ohio, the Pinellas Plant in Florida, and the Rocky Flats Plant in Colorado. The electrical and mechanical manufacturing functions were consolidated at the Kansas City Plant. Detonators and beryllium capabilities for technology and pit support were consolidated at Los Alamos National Laboratory (LANL) in New Mexico, and neutron generator production was relocated to Sandia National Laboratories in New Mexico.

In October 1993, President William J. Clinton issued Presidential Decision Directive 15 (PDD–15), which directed DOE to establish the Stockpile Stewardship Program. PDD–15 significantly redirected the nuclear weapons program. Throughout the Cold War, the Department of Defense (DOD) and DOE's nuclear weapons laboratories had based a portion of their confidence in the reliability of nuclear weapons on performance data from atmospheric and underground tests. To ensure weapons reliability during the moratorium on testing, DOE proposed to invest in new scientific tools to assess the complex phenomena involved in the detonation of nuclear weapons. DOE also began to develop sophisticated tools and computer-based simulation techniques to assess various aging phenomena as nuclear weapons continued to serve well beyond their originally anticipated lifetimes. These actions enhanced research and development (R&D) and deferred spending on the production complex.

DOE concluded in October 1994 that the alternatives described in the Reconfiguration PEIS no longer contained realistic proposals for reconfiguration of the nuclear weapons complex. That conclusion was based on several factors, including: comments offered at the September-October 1993 Reconfiguration PEIS scoping meetings; the anticipation that no production of new nuclear weapons types would be required for the foreseeable future; budget constraints; and the Department's decision to prepare a separate PEIS on Storage and Disposition of Weapons-Usable Fissile Materials (DOE/EIS–0229; NOI published June 21, 1994, 59 FR 17344).

Consequently, the Department separated the Reconfiguration PEIS into two new PEISs: (1) A Tritium Supply and Recycling PEIS (DOE/EIS–0161); and (2) the SSM PEIS (DOE/EIS–0236). The Final PEIS for Tritium Supply and Recycling was issued on October 27, 1995 (60 FR 55021). In its Record of Decision (ROD) on May 14, 1999 (64 FR 26369 [2]), DOE decided it would produce the tritium needed to maintain the nuclear arsenal at commercial light water reactors owned and operated by the Tennessee Valley Authority and extract tritium at a new DOE-owned Tritium Extraction Facility at the Savannah River Site. With regard to the SSM PEIS, DOE issued an NOI on June 6, 1995 (60 FR 31291), a final SSM PEIS on November 19, 1996 (61 FR 58871), and a ROD on December 26, 1996 (61 FR 68014) announcing its decision to transform the weapons production complex by (1) reducing the weapon assembly capacity located at the Pantex Plant in Texas; (2) reducing the high-explosives fabrication capacity at Pantex; (3) reducing the uranium, secondary, and case fabrication capacity in the Y–12 National Security Complex in Tennessee; (4) reducing nonnuclear component fabrication capacity at the Kansas City Plant; and (5) reestablishing a modest interim pit fabrication capability at Los Alamos National Laboratory in New Mexico while evaluating the need for greater pit manufacturing capacity in the future.

In accordance with the decisions in the SSM PEIS, the *Non-nuclear Consolidation Environmental Assessment* (EA), and the Tritium Supply and Recycling PEIS, DOE began transforming the nuclear weapons complex to its present configuration. DOE has also prepared other EISs that facilitated the transformation of the complex. The relevant RODs for these site-wide and project-specific EISs are listed below:

- 1996 ROD for the *EIS for the Nevada Test Site and Off-Site Locations in the State of Nevada* (61 FR 65551, December 13, 1996).
- 1997 ROD for the *EIS for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (62 FR 3880, January 27, 1997).
- 1999 ROD for the Site-wide EIS for Continued Operation of the Los Alamos National Laboratory (64 FR 50797, September 20, 1999).
- 1999 ROD for the *EIS for Site-wide Operation of Sandia National Laboratories* (64 FR 69996, December 15, 1999).
- 2000 *Amended ROD for the Nevada Test Site EIS* (65 FR 10061, February 25, 2000).
- 2002 ROD for the *Site-wide EIS for the Oak Ridge Y–12 National Security Complex* (67 FR 11296, March 13, 2002).
- 2002 ROD for the *EIS for the Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (67 FR 79906, December 31, 2002).
- 2004 ROD for the *EIS for the Chemistry and Metallurgy Research Building Replacement Project, Los*

[2] This ROD also contains decisions for the EIS for Construction and Operation of a Tritium Extraction Facility at the Savannah River Site (DOE/EIS–0271) and EIS for the Production of Tritium in a Commercial Light Water Reactor (DOE/EIS–0288).

Alamos National Laboratory (69 FR 6967, February 12, 2004).

• 2005 ROD for the *Site-wide EIS for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic EIS* (70 FR 71491, November 29, 2005).

Nuclear Weapons Complex: The current nuclear weapons complex consists of eight major facilities located in seven states. NNSA maintains a limited capability to design and manufacture nuclear weapons; provides surveillance of and maintains nuclear weapons currently in the stockpile; and dismantles retired nuclear weapons. Major facilities and their primary responsibilities within the nuclear weapons complex are listed below:

Savannah River Site (SRS) (Aiken, South Carolina)—Extracts tritium (when the Tritium Extraction Facility becomes operational in 2007); provides loading, unloading and surveillance of tritium reservoirs. SRS does not maintain Category I/II [3] quantities of special nuclear material (SNM) [4] associated with weapons activities, but does maintain Category I/II quantities of SNM associated with other Department activities (*e.g.*, environmental management).

Pantex Plant (PX) (Amarillo, Texas)—Dismantles retired weapons; fabricates high-explosives components; assembles high explosive, nuclear, and non-nuclear components into nuclear weapons; repairs and modifies weapons; and evaluates and performs non-nuclear testing of weapons. Maintains Category I/II quantities of SNM for the weapons program and material no longer needed by the weapons program.

Y–12 National Security Complex (Y–12) (Oak Ridge, Tennessee)—Manufactures nuclear weapons secondaries, cases, and other weapons components; evaluates and performs testing of weapon components; maintains Category I/II quantities of SNM; conducts dismantlement, storage, and disposition of nuclear weapons materials; and supplies SNM for use in naval reactors.

Kansas City Plant (KCP) (Kansas City, Missouri)—Manufactures and acquires non-nuclear weapons components; and evaluates and performs testing of weapon components. No Category I/II quantities of SNM are maintained at the KCP.

Lawrence Livermore National Laboratory (LLNL) (Livermore, California)—Conducts research and development of nuclear weapons; designs and tests advanced technology concepts; designs weapons; maintains a limited capability to fabricate plutonium components; and provides safety and reliability assessments of the stockpile. Maintains Category I/II quantities of SNM associated with the weapons program and material no longer needed by the weapons program.

Los Alamos National Laboratory (LANL) (Los Alamos, New Mexico)—Conducts research and development of nuclear weapons; designs and tests advanced technology concepts; designs weapons; provides safety and reliability assessments of the stockpile; maintains interim production capabilities for limited quantities of plutonium components (e.g., pits); and manufactures nuclear weapon detonators for the stockpile. Maintains Category I/II quantities of SNM associated with the nuclear weapons program and material no longer needed by the weapons program.

Sandia National Laboratories (SNL) (Albuquerque, New Mexico; Livermore, California)—Conducts system engineering of nuclear weapons; designs and develops non-nuclear components; conducts field and laboratory non-nuclear testing; conducts research and development in support of the nuclear weapon non-nuclear design; manufactures non-nuclear weapon components; provides safety and reliability assessments of the stockpile; and manufactures neutron generators for the stockpile. Maintains Category I/II quantities of SNM associated with the nuclear weapons program.

Nevada Test Site (NTS) (Las Vegas, Nevada)—Maintains capability to conduct underground nuclear testing; conducts experiments involving nuclear material and high explosives; provides capability to disposition a damaged nuclear weapon or improvised nuclear device; conducts non-nuclear experiments; and conducts research and training on nuclear safeguards, criticality safety and emergency response. Maintains Category I/II quantities of SNM associated with the nuclear weapons program.

Purpose and Need for the Stockpile Stewardship and Management Program: Under the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), DOE is responsible for providing nuclear weapons to support the United States' national security strategy. The National Nuclear Security Administration Act (Pub. L. 106–65, Title XXXII) assigned this responsibility to NNSA within DOE. One of the primary missions of NNSA is to provide the nation with safe and reliable nuclear weapons, components and capabilities, and to accomplish this in a way that protects the environment and the health and safety of workers and the public.

Changes in national security needs and budgets have necessitated changes in the way NNSA meets its responsibilities regarding the nation's nuclear stockpile. As a result of a changed security environment, unilateral decisions by the United States and international arms control agreements, the nation's stockpile is significantly smaller today and by 2012, it will be the smallest since the Eisenhower administration (1953–1961). The Treaty of Moscow will eventually lead to a level of 1,700–2,200 operationally-deployed strategic nuclear weapons.

However, nuclear deterrence will continue to be a cornerstone of United States national security policy, and NNSA must continue to meet its responsibilities for ensuring the safety and reliability of the nation's nuclear weapons stockpile. The current policy is contained in the Nuclear Posture Review, submitted to Congress in early 2002, which states that the United States will:

• Change the size, composition and character of the nuclear weapons stockpile in a way that reflects that the Cold War is over;

• Achieve a credible deterrent with the lowest possible number of nuclear warheads consistent with national security needs, including obligations to allies; and

• Transform the NNSA nuclear weapons complex into a responsive infrastructure that supports the specific stockpile requirements established by the President and maintains the essential United States nuclear capabilities needed for an uncertain global future.

Complex 2030 SEIS: NNSA has been evaluating how to establish a more responsive nuclear weapons complex infrastructure since the Nuclear Posture Review was transmitted to Congress in early 2002. The Stockpile Stewardship Conference in 2003, the Department of Defense Strategic Capabilities Assessment in 2004, the recommendations of the Secretary of Energy Advisory Board (SEAB) Task Force on the Nuclear Weapons Complex Infrastructure in 2005, and the Defense

[3] Category I/II quantities of special nuclear material are determined by grouping materials by type, attractiveness level, and quantity. These grouping parameters are defined in DOE Manual 470.4–6, Nuclear Material Control and Accountability [see *https://www.directives.doe.gov*].

[4] As defined in section 11 of the Atomic Energy Act of 1954, special nuclear material are: (1) Plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the U.S. Nuclear Regulatory Commission determines to be special nuclear material; or (2) any material artificially enriched by plutonium or uranium 233 or 235.

Science Board Task Force on Nuclear Capabilities in 2006 have provided information for NNSA's evaluations.

In early 2006, NNSA developed a planning scenario for what the nuclear weapons complex would look like in 2030. See *http://www.nnsa.doe.gov* for more information regarding Complex 2030 planning. The Complex 2030 planning scenario incorporates many of the decisions NNSA has already made based on the evaluations in the SSM PEIS, Tritium Supply and Recycling PEIS, and other NEPA documents. See discussion in background above. The following table identifies which components of Complex 2030 are based on the existing SSM PEIS and Tritium PEIS RODs, including RODs for subsequent tiered EISs:

Components of Complex 2030 that reflect earlier decisions	SSM PEIS ROD	Tritium PEIS ROD
Maintain but reduce the existing weapon assembly capacity located at Pantex	X	....
Maintain but reduce the high-explosives fabrication capacity at Pantex	X	....
Maintain but reduce the existing uranium, secondary, and case fabrication capacity at the Y–12 Plant at Oak Ridge	X	....
Reduce the non-nuclear component fabrication capacity at the Kansas City Plant	X	....
Reestablish limited pit fabrication capability at Los Alamos National Laboratory while evaluating the need for a larger capability	X	....
Irradiate tritium producing rods in commercial light water reactors; construct and operate a new Tritium Extraction Facility at DOE's Savannah River Site	....	X

Types of Decisions that Would Be Based on the Complex 2030 SEIS: The decisions set forth in the Complex 2030 ROD would:

- Identify the future missions of the SSM Program and the nuclear weapons complex; and
- Determine the configuration of the future weapons complex needed to accomplish the SSM Program.

For specific programs or facilities, NNSA may need to prepare additional NEPA documents to implement the decisions announced in the ROD. The baseline that will be used for the analyses of program and facility needs in the SEIS is 1,700–2,200 operationally-deployed strategic nuclear weapons, in addition to augmentation weapons, reliability-reserve weapons and weapons required to meet NATO commitments. The numbers are consistent with international arms-control agreements. Consistent with national security policy directives, replacement warhead design concepts may be pursued under the alternatives as a means of, for example, enhancing safety and security, improving manufacturing practices, reducing surveillance needs, and reducing need for underground tests.

The SEIS will evaluate reasonable alternatives for future transformation of the nuclear weapons complex. The Proposed Action and alternatives to the Proposed Action will assume continued implementation of the following prior siting decisions that DOE made in the SSM PEIS and Tritium PEIS RODs, including RODs for subsequent tiered EISs:

- Location of the weapon assembly/disassembly operations at the Pantex Plant in Texas.
- Location of uranium, secondary, and case fabrication at the Y–12 National Security Complex in Tennessee.
- Location of tritium extraction, loading and unloading, and support operations at the Savannah River Site in South Carolina.

NNSA does not believe it is necessary to identify additional alternatives beyond those present in the SSM PEIS. Regarding the uranium, secondary, and case fabrication at Y–12, NNSA is currently preparing a Y–12 Site-wide EIS to evaluate reasonable alternatives for the continued modernization of the Y–12 capabilities. The Complex 2030 SEIS will incorporate any decisions made pursuant to the Y–12 Site-wide EIS.

While the Complex 2030 planning scenario proposes to consolidate further non-nuclear production activities performed at the Kansas City Plant, this proposal will be evaluated in a separate NEPA analysis, as was done in the 1990s. NNSA believes that it is appropriate to separate the analyses of the transformation of non-nuclear production from the SEIS because decisions regarding those activities would neither significantly affect nor be affected by decisions regarding the transformation of nuclear production activities.

The SSM PEIS ROD announced NNSA's decision to establish a small interim pit production capacity at LANL. In the 1999 LANL Site-wide EIS ROD, NNSA announced it would achieve a pit production capacity at LANL of up to 20 pits per year. The 2006 draft LANL Site-wide EIS evaluates a proposal for a production capacity of 50 certified pits annually. This proposed capacity is based on an annual production rate of 80 pits per year in order to provide NNSA with sufficient flexibility to obtain 50 certified pits. Any decisions made pursuant to the LANL Site-wide EIS will be included in the Complex 2030 SEIS.

Based upon the studies [5] and analyses that led to NNSA's development of the Complex 2030 scenario, NNSA has developed alternatives that are intended to facilitate public comment on the scope of the SEIS. NNSA's decisions regarding implementation of Complex 2030 will be based on the following alternatives, or a combination of those alternatives.

The Proposed Action—Transform to a More Modern, Cost-Effective Nuclear Weapons Complex (Complex 2030). This alternative would undertake the following actions to continue the transformation of NNSA's nuclear weapons complex:

- Select a site to construct and operate a consolidated plutonium center for long-term R&D, surveillance, and manufacturing operations for a baseline capacity of 125 qualified pits per year at a site with existing Category I/II SNM.
- Reduce the number of sites with Category I/II SNM and consolidate SNM to fewer locations within each given site.
- Consolidate, relocate or eliminate duplicative facilities and programs and improve operating efficiencies, including at facilities for nuclear materials storage, tritium R&D, high explosives R&D, environmental testing, and hydrotesting facilities.
- Identify one or more sites for conducting NNSA flight test operations.

[5] The Stockpile Stewardship Conference in 2003, the Department of Defense Strategic Capabilities Assessment in 2004, the recommendations of the Secretary of Energy Advisory Board (SEAB) Task Force on the Nuclear Weapons Complex Infrastructure in 2005, and the recommendations of the Defense Science Board Task Force on Nuclear Capabilities in 2006.

Existing DOD and DOE test ranges (*e.g.*, White Sands Missile Range in New Mexico and Nevada Test Site in Nevada) would be considered as alternatives to the continued operation of the Tonopah Test Range in Nevada.

• Accelerate dismantlement activities.

The DOE sites that will be considered as potential locations for the consolidated plutonium center and consolidation of Category I/II SNM include: Los Alamos, Nevada Test Site, Pantex Plant, Y–12 National Security Complex, and the Savannah River Site. Other DOE sites are not considered reasonable alternative locations because they do not satisfy certain criteria such as population encroachment, or mission compatibility or synergy with the site's existing mission.

Alternatives to the Proposed Action

No Action Alternative. The No Action Alternative represents the status quo as it exists today and is presently planned. It includes the continued implementation of decisions made pursuant to the SSM PEIS and the Tritium Supply and Recycling PEIS (as summarized above) and related site-specific EISs and EAs. These decisions are contained in RODs and Findings of No Significant Impact (FONSIs), including those discussed above, and copies can be located on the DOE NEPA Document Web page at *http://www.eh.doe.gov/nepa/documents.html.*

The No Action Alternative would also include any decisions made as a result of the new Y–12 Site-wide EIS and the LANL Site-wide EIS once these EISs are finished. NNSA expects to issue RODs on these EISs prior to publication of the draft Complex 2030 SEIS.

The No Action Alternative is illustrated in the following matrix:

Capability	Sites (no action alternative)							
	KCP	LANL	LLNL	NTS	Y–12	PX	SNL	SRS
Weapons assembly/Disassembly				X		X		
Nonnuclear components	X	X					X	
Nuclear components:								
—Pits		X						
—Secondaries and cases					X			
High explosives components						X		
Tritium Extraction, Loading and Unloading								X
High explosives R&D		X	X			X	X	
Tritium R&D		X	X					X
Large Scale Hydrotesting		X	X	X				
Category I/II SNM Storage		X	X	X	X	X	X	X

The No Action Alternative also includes continuation of environmental testing at current locations and flight-testing activities at the Tonopah Test Range in Nevada.

Reduced Operations and Capability-Based Complex Alternative

In this alternative, NNSA would maintain a basic capability for manufacturing technologies for all stockpile weapons, as well as laboratory and experimental capabilities to support stockpile decisions, but would reduce production facilities to a ''capability-based'' [6] capacity. This alternative would not have a production capacity sufficient to meet current national security objectives. This alternative would be defined as follows:

• Do not construct and operate a consolidated plutonium center for long-term R&D, surveillance, and manufacturing operations; and do not expand pit production at LANL beyond 50 certified pits per year.

• Reduce the number of sites with Category I/II SNM and consolidate SNM to fewer locations within a given site.

• Consolidate, relocate or eliminate duplicative facilities and programs and improve operating efficiencies, including at facilities for nuclear materials storage, tritium R&D, high explosives R&D, environmental testing facilities, and hydrotesting facilities.

• Identify one or more sites for conducting NNSA flight test operations. Existing DOD and DOE test ranges (*e.g.* White Sands Missile Range in New Mexico and Nevada Test Site in Nevada) would be considered as potential alternatives to the continued operation of the Tonopah Test Range in Nevada.

• Production capacities at Pantex, Y–12, and the Savannah River Site would be considered for further reductions limited by the capability-based capacity.

• NNSA would continue dismantlement activities.

Proposal Not Being Considered for Further Analysis. The SEAB Task Force on the Nuclear Weapons Complex Infrastructure recommended that NNSA pursue a consolidated nuclear production center (CNPC) as a single facility for all research, development, and production activities relating to nuclear weapons that involve significant amounts (*i.e.* Category I/II quantities) of SNM. The CNPC, as envisioned by the SEAB Task Force, would contain all the nuclear weapons manufacturing, production, assembly, and disassembly facilities and associated weapon surveillance and maintenance activities for the stockpile weapons. The CNPC would include the plutonium activities of the consolidated plutonium center proposed by NNSA in its Complex 2030 vision, as well as the consolidated activities of the uranium, tritium, and high explosive operations. DOE believes that creation of a CNPC is not a reasonable alternative and does not intend to analyze it as an alternative in the SEIS because of the technical and schedule issues involved in constructing a CNPC, as well as associated costs. NNSA invites and will consider comments on this matter during the scoping process.

The SEAB Task Force developed three business cases for transforming the nuclear weapons complex, two of which were characterized as high risk. Its preferred least-risk option was to establish a CNPC ''quickly'' by accelerating site selection, NEPA analyses, regulatory approvals, and construction. The Task Force assumed that NNSA could, under these circumstances, begin operating a CNPC in 2015, start consolidation of SNM shortly thereafter, accelerate dismantlements, and begin other major transformational activities. Until the CNPC was completed, NNSA would have to maintain, and in some cases improve, existing production and research facilities. According to the Task Force's estimates, this option would require an additional 1 billion dollars per year for weapons programs

[6] The capability to manufacture and assemble nuclear weapons at a nominal level.

activities for the next 10 years, and lead to a net savings through 2030 of 15 billion dollars.

Accelerated construction of a CNPC would not allow NNSA to avoid immediate expenditures to restore and modernize interim production capabilities to meet essential Life Extension Program (LEP) schedules and support the existing stockpile during the next decade. LEP is the refurbishment of nuclear weapons parts and components to extend the weapon deployment life. NNSA has concluded that the SEAB Task Force underestimated the nonfinancial challenges of constructing a CNPC. A CNPC would require moving a unique and highly skilled workforce to a new location. It would require NNSA to obtain significant regulatory approvals rapidly, and to construct a unique and complex facility on a tight schedule. It would put many of the significant aspects of the weapons complex transformation into "one basket"—until the CNPC began operations, all the other facilities and activities would be delayed. NNSA's Proposed Action would achieve many of the benefits of the CNPC approach—consolidation of SNM and facilities, integrated R&D and production involving SNM, and aggressive dismantlements—in a way that addresses immediate national security needs in a technically feasible and affordable manner.

Nuclear Materials Consolidation: DOE is pursuing SNM consolidation from all DOE sites including those that comprise the nuclear weapons complex. The SEIS will look at alternatives for the storage and consolidation of nuclear materials within the nuclear weapons complex including materials needed to maintain the United States' nuclear weapons arsenal. There is a potential overlap between the SEIS and the activities of the Department's other nuclear materials consolidation activities, and DOE will ensure that there is appropriate coordination between the two activities.

Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility: NNSA issued a *Draft Supplemental Programmatic Environmental Impact Statement on Stockpile Stewardship and Management for a Modern Pit Facility* (MPF) on June 4, 2003 (68 FR 33487; also 68 FR 33934, June 6, 2003) that analyzed alternatives for producing the plutonium pits that are an essential component of nuclear weapons. On January 28, 2004, NNSA announced that it was indefinitely postponing any decision on how it would obtain a large capacity pit manufacturing facility. Because the Complex 2030 SEIS will analyze alternatives for plutonium-related activities that include pit production, DOE, effective upon publication of this NOI, cancels the MPF PEIS.

Public Scoping Process: The scoping process is an opportunity for the public to assist the NNSA in determining the issues for analysis. NNSA will hold public scoping meetings at locations identified in this NOI. The purpose of these meetings is to provide the public with an opportunity to present oral and written comments, ask questions, and discuss concerns regarding the transformation of the nuclear weapons complex and the SEIS with NNSA officials. Comments and recommendations can also be communicated to NNSA as discussed earlier in this notice.

Complex 2030 PEIS Supplement Preparation Process: The SEIS preparation process begins with the publication of this NOI in the **Federal Register**. NNSA will consider all public comments that it receives during the public comment period in preparing the draft SEIS. NNSA expects to issue the draft SEIS for public review during the summer of 2007. Public comments on the draft SEIS will be received during a comment period of at least 45 days following the U.S. Environmental Protection Agency's publication of the Notice of Availability in the **Federal Register**. Notices placed in local newspapers will specify dates and locations for public hearings on the draft SEIS and will establish a schedule for submitting comments on the draft SEIS, including a final date for submission of comments. Issuance of the final SEIS is scheduled for 2008.

Classified Material: NNSA will review classified material while preparing the SEIS. Within the limits of classification, NNSA will provide the public as much information as possible to assist its understanding and ability to comment. Any classified material needed to explain the purpose and need for the action, or the analyses in the SEIS, will be segregated into a classified appendix or supplement, which will not be available for public review. However, all unclassified information or results of calculations using classified data will be reported in the unclassified section of the SEIS, to the extent possible in accordance with federal classification requirements.

Issued in Washington, DC on October 11, 2006.

Linton F. Brooks,

Administrator, National Nuclear Security Administration.

[FR Doc. E6–17508 Filed 10–18–06; 8:45 am]

BILLING CODE 6450–01–P

APPENDIX B
NONRADIOLOGICAL AIR QUALITY

APPENDIX B
NONRADIOLOGICAL AIR QUALITY

Introduction

This appendix provides additional information about the nonradiological air quality analyses presented in Chapter 5 of this Site-Wide Environmental Impact Statement (SWEIS), including details on the modeling and analysis for criteria pollutants and other chemical emissions.

B.1 Assumptions, Data Sources, Standards, and Models

B.1.1 Applicable Guidelines and Standards and Emission Sources

Criteria Pollutants

The Clean Air Act mandates that the U.S. Environmental Protection Agency (EPA) establish primary and secondary National Ambient Air Quality Standards for pollutants of concern. These pollutants, known as criteria pollutants, are carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, lead, particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}), and particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$).

The State of New Mexico also has established ambient air quality standards for carbon monoxide, sulfur dioxide, nitrogen dioxide, total suspended particulates, hydrogen sulfide, and total reduced sulfur (New Mexico Administrative Code, Title 20, Chapter 2, Part 3). The more restrictive of the State of New Mexico ambient air quality standards and the National Ambient Air Quality Standards, are listed in **Table B–1**.

Criteria pollutants released into the atmosphere from Los Alamos National Laboratory (LANL) operations are emitted primarily from combustion facilities such as boilers, emergency generators, and motor vehicles.

Other Nonradiological Air Pollutants

Chemicals are currently used at LANL in separately located groups of operations or laboratory complexes called "technical areas" (TAs), which comprise large geographic areas. Air pollutants from these TAs may be released into the atmosphere from many ongoing activities, including laboratory, maintenance, and waste management operations. In the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (*1999 SWEIS)* (DOE 1999), two types of toxic air pollutants were considered: noncarcinogenic and carcinogenic. Chemical pollutants are classified as hazardous air pollutants or as toxic air pollutants.

Table B–1 Criteria Pollutant Standards

Pollutant	*Time Period*	*Controlling Ambient Air Quality Standards* [a] *(micrograms per cubic meter)*
Carbon Monoxide	8 hours 1 hour	7,961 [b] 11,987 [b]
Nitrogen Dioxide	Annual 24 hours	75 [b] 150 [b]
Sulfur Dioxide	Annual 24 hours 3 hours	42 [b] 209 [b] 1,046 [c]
Total Suspended Particulates	Annual 30-day 7-day 24 hours	60 [b] 90 [b] 110 [b] 150 [b]
PM_{10}	Annual 24 hours	– [c,d] 150 [c]
$PM_{2.5}$	Annual 24 hours	15 [c] 35 [c,d]
Ozone	8 hours	125 [c]
Lead	Calendar quarter	1.5 [c]
Hydrogen sulfide	1 hour	11.1 [b]

PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.
[a] Ambient standards for gaseous pollutants are stated in parts per million. These values were converted to micrograms per cubic meter, with appropriate corrections for temperature and pressure (elevation), following New Mexico *Dispersion Modeling Guidelines* (NMED 2003, LANL 2003).
[b] State standard.
[c] Federal standard.
[d] The EPA recently revoked the annual PM_{10} standard and changed the 24-hour $PM_{2.5}$ standard from 65 to 35 micrograms per cubic meter.
Note: The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (Title 40 *Code of Federal Regulations* [CFR] Part 50), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic $PM_{2.5}$ mean standard is attained when the expected annual arithmetic mean concentration (3 year average) is less than or equal to the standard. The 24-hour $PM_{2.5}$ standard is met when the 98th percentile over 3 years of 24-hour average concentrations is less than or equal to the standard value. The 24-hour PM_{10} standard is met when the 99th percentile over 3 years of 24-hour concentrations is less than or equal to the standard value.
Sources: NMAC 20.2.3 (New Mexico Administrative Code – Environmental Protection, Air Quality, Ambient Air Quality Standards 2002); 40 CFR Part 50 (National Ambient Air Quality Standards); 71 *Federal Register* (FR) 61143.

For the purpose of this SWEIS, the estimated chemical emissions during recent years were compared to the emissions evaluated in the *1999 SWEIS*. The total emissions of toxic or hazardous air pollutants and volatile organic compounds showed considerable variation over the period 1999 through 2004. Operation of the air curtain destructors resulted in increases of hazardous air pollutants and volatile organic compounds during 2002 and 2003. The air curtain destructors accounted for 2.1 and 22.9 tons (1.9 and 20.8 metric tons) of hazardous air pollutants and volatile organic compounds, respectively, in 2002. In 2003, they accounted for 3.3 and 36.0 tons (3.0 and 32.7 metric tons) of hazardous air pollutants and volatile organic compounds, respectively (LANL 2004b). With the completion of the Cerro Grande Fire Rehabilitation Project tree thinning and removal, emissions of hazardous air pollutants and volatile organic compounds returned to lower levels more typical of prefire conditions.

Toxic and hazardous air pollutant emissions from LANL activities are released primarily from laboratory, maintenance, and waste management operations. Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility with great fluctuations in both the types of chemicals emitted and their emission rates. LANL has a program to review new operations for their potential to emit chemicals. Toxic air pollutant emissions from the use of chemicals are generally below the levels for which the State would require a permit for a new source under the New Mexico permit regulations for toxic air pollutant emissions (NMAC 20.2.72.400 - 502). The Title V operating permit limits the emissions of hazardous air pollutants such that operations at LANL are below the major source threshold for hazardous air pollutants. Emissions of hazardous air pollutants are monitored and reported annually to the New Mexico Environmental Department as required by the permit. Past actual emissions of hazardous air pollutants have been well below the threshold (LANL 2004a).

The chemical database information system used to estimate emissions in recent years is called ChemLog. It was used to estimate emissions for the annual *SWEIS Yearbooks* for 2002 through 2005 (LANL 2006). ChemLog includes all chemicals purchased at each LANL facility in each calendar year. Prior to 2002, another inventory system was used to estimate emissions based on chemical use. For the *1999 SWEIS*, 51 of the 382 chemicals evaluated were considered to be carcinogenic. For the purpose of the analysis, it was assumed that air emissions could result from the use of any of the 382 chemicals from any of the TAs that purchased them (DOE 1999). In the *SWEIS Yearbooks* chemical usage was summed by facility. It was then estimated that 35 percent of the chemical used was released to the atmosphere. Emission estimates for some metals were based on an emission factor of less than 1 percent because these metal emissions were assumed to result from cutting or melting activities. Fuels such as propane and acetylene were assumed to be completely combusted; therefore, no emissions were reported. A list of chemicals purchased in 2005 are provided in **Table B–2**.

Noncarcinogens

Short-Term Guideline Values. While no national or State of New Mexico standards have been established for noncarcinogens, the New Mexico Environment Department has developed guideline values for determining whether a new or modified source emitting a toxic air pollutant would be issued a construction permit (New Mexico Environment Department, Air Quality Control Regulations, revised November 17, 1994). These guideline values are 8-hour concentrations that are one-hundredth of the Occupational Exposure Limits established by the American Conference of Governmental Industrial Hygienists or the National Institute of Occupational Safety and Health. The State of New Mexico listing was supplemented with information on the lowest values for Occupational Exposure Limits from these sources. These guideline values were used in this analysis in screening for potential short-term impacts of chemical releases from LANL operations.

Annual Average Guideline Values. The guideline values used in the *1999 SWEIS* analysis were the inhalation reference concentrations from EPA's Integrated Risk Information System. Reference concentrations are daily exposure levels to the human population (including sensitive subgroups) during a lifetime (70 years) that could occur without appreciable risk of deleterious effects.

Table B–2 Chemicals Purchased at Los Alamos National Laboratory – 2005 [a]

Chemical Name	Key Facility													
	CMR	*HRL – Biosciences*	*High Explosives Processing*	*High Explosives Testing*	*LANSCE*	*Machine Shops*	*Materials Science Lab*	*Pajarito Site*	*Pu Facility Complex*	*Radio-chemistry Site*	*Sigma Complex*	*Target Fabrication Facility*	*Tritium Operations*	*Waste Management Operations*
1,3,5-Trimethylbenzene					X									
1,4-Dioxane					X					X				
2- Methoxyethanol												X		
2- Nitropropane					X									
Acetic Acid		X								X		X		
Acetic Anhydride										X				
Acetone		X	X	X	X		X		X	X	X	X		
Acetonitrile		X	X		X					X		X		
Acetylene			X						X					
Acrolein			X											
Acrylamide		X												
Aluminum numerous forms											X			
Ammonia										X				
Ammonium Chloride	X								X	X				
Arsenic, El. & inorg, exc. Arsine											X			
Benzene										X		X		
Beryllium											X			
Bromine	X		X							X				
Carbon Tetrachloride	X									X				
Chlorine Trifluoride											X			
Chloroform		X			X							X		
Chromium, Metal & Cr III Compounds, as Cr	X													
Cobalt					X									
Copper	X		X											

Chemical Name	Key Facility													
	CMR	HRL – Biosciences	High Explosives Processing	High Explosives Testing	LANSCE	Machine Shops	Materials Science Lab	Pajarito Site	Pu Facility Complex	Radio-chemistry Site	Sigma Complex	Target Fabrication Facility	Tritium Operations	Waste Management Operations
Cyclohexane					X		X							
Cyclohexene														
Dicyclopentadiene										X				
Diethanolamine										X				
Diethylamine										X				
Diethylene Triamine							X				X			
Diisopropylamine										X				
Dipropylene Glycol Methyl Ether	X													
Ethanol	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ethyl Acetate			X				X			X				
Ethyl Ether					X		X			X		X		
Ethylene Diamine					X					X				
Formamide		X												
Hexane (other isomers) or n-Hexane		X	X		X		X			X		X		
Hydrogen Bromide	X									X				
Hydrogen Chloride	X	X	X		X		X		X	X	X			X
Hydrogen Cyanide												X		
Hydrogen Fluoride, as F		X			X					X	X			
Hydrogen Peroxide	X						X		X	X		X		
Hydroquinone					X					X				
Isobutane	X				X									
Isopropyl Alcohol	X	X			X		X			X	X	X		
Isopropylamine					X									
Kerosene			X			X								
Lead, elemental and inorganic compounds as lead					X									
Magnesium Oxide							X		X	X				

Chemical Name	Key Facility													
	CMR	*HRL – Biosciences*	*High Explosives Processing*	*High Explosives Testing*	*LANSCE*	*Machine Shops*	*Materials Science Lab*	*Pajarito Site*	*Pu Facility Complex*	*Radio-chemistry Site*	*Sigma Complex*	*Target Fabrication Facility*	*Tritium Operations*	*Waste Management Operations*
Fume														
Manganese Dust & Compounds or Fume					X									
Mercury, numerous forms											X	X		
Methyl Alcohol		X	X	X	X		X		X	X	X	X		
Methyl Ethyl Ketone			X		X							X		
Methyl Iodide										X				
Methyl Methacrylate										X				
Methyl Silicate										X		X		
Methylene Chloride		X	X	X	X					X		X		
Molybdenum	X									X	X			
Morpholine														
n,n-Dimethyl Acetamide or Dimethyl Acetamide			X				X							
n,n-Dimethylformamide		X					X			X		X		
n-Butyl Acetate							X							
Naphtalene										X	X			
n- Heptane										X				
Nitric Acid	X	X	X		X		X		X	X		X	X	
Nitromethane				X										
Oxalic Acid	X								X	X				
Pentane (all isomers)				X						X		X		
Phenol		X												
Phosphoric Acid	X						X			X	X			
Phosphorus											X			
Potassium Hydroxide		X							X	X		X		X
p-Phenylenediamine							X							

Chemical Name	Key Facility													
	CMR	***HRL – Biosciences***	***High Explosives Processing***	***High Explosives Testing***	***LANSCE***	***Machine Shops***	***Materials Science Lab***	***Pajarito Site***	***Pu Facility Complex***	***Radio-chemistry Site***	***Sigma Complex***	***Target Fabrication Facility***	***Tritium Operations***	***Waste Management Operations***
Propane	X			X	X	X		X	X	X			X	X
Propionic Acid										X				
Propyl Alcohol			X											
Pyridine										X				X
Rhodium Metal	X													
Selenium Compounds				X										
Silver	X													
Sulfur Hexafluoride			X											
Sulfuric Acid	X	X		X	X					X	X	X		X
Tert-Butyl Alcohol	X				X							X		
Tetrahydrofuran			X		X		X			X		X		X
Tin numerous forms					X									
Toluene	X		X							X		X		
Tributyl Phosphate									X					
Trichloroacetic Acid		X												
Tungsten as W insoluble compounds										X		X		
Uranium											X			
Vanadium					X									
VM&P Naphtha										X				
Zinc Chloride Fume								X						
Zinc Oxide Fume					X		X							

CMR = Chemistry and Metallurgy Research Building, HRL = Health Research Laboratory, LANSCE = Los Alamos Neutron Science Center, Pu = plutonium.

[a] These chemicals are representative of those purchased at LANL. Additional chemicals listed in the New Mexico permit regulations on toxic air pollutants and emission (NMAC 20.2.72.502), listed in the EPA list of hazardous air pollutants, and other chemicals could be used and potentially emitted from activities at LANL as needed.

Source: LANL 2006.

Carcinogens

The guideline values used in the *1999 SWEIS* analysis to estimate potential impacts of carcinogenic toxic air pollutants from LANL operations were based on an incremental cancer risk of one in a million (1.0×10^{-6}) (in other words, one person in a population of a million would develop cancer if this population was exposed to this concentration over a lifetime), a level of concern established in the Clean Air Act. This value was used in the screening for the estimated combined incremental cancer risk associated with all of the carcinogenic pollutants emitted from LANL facilities at any location. For the purpose of screening individual carcinogens, a cancer risk of one in one hundred million (1.0×10^{-8}) was established as the guideline value.

B.1.2 Receptors and Receptor Sets

For the purpose of evaluating the impact of criteria pollutant emissions, the analysis prepared for the LANL operating permit was used (LANL 2003). In this analysis, two sets of receptors (locations where air quality levels were estimated) were considered: 1) a regular Cartesian grid with 329 feet (100-meter) grid spacing, and 2) a discrete Cartesian grid that followed actual fence lines, property boundaries, and roads of interest. The discrete Cartesian grid distance was less than 164 feet (50 meters) between receptor points. The regular Cartesian grid was created large enough to show the full extent of the areas of significant impact and the grid spacing was fine enough that it could serve as the receptor grid for the refined analysis (LANL 2003).

For the purpose of evaluating the impact of criteria pollutant emissions from construction activities for various projects, a discrete Cartesian grid that followed the fence line, property boundary, and public roads of interest was used, plus a regular Cartesian grid with a 1,600-foot (500-meter) spacing to 6,600 feet (2 kilometers) from the boundary and a 3,300-foot (1,000-meter) spacing beyond 6,600 feet (2 kilometers).

For the purpose of the air pollutant analysis in the *1999 SWEIS*, two sets of receptor locations were used: (1) locations representing actual locations of human activity, and (2) fence line locations to which the public has access (DOE 1999).

The potential impacts of air pollutants on workers employed at LANL facilities were not considered as part of the analysis in the *1999 SWEIS*. Different regulations apply to an occupational setting, and the controlled nature of the work, along with surveillance systems associated with those controls, restricts routine exposures for workers. The analysis focused on exposure to the public and was based on a methodology that initially assumed that chemicals that were purchased were entirely available for release to the atmosphere outside the facility in which the chemicals were used.

Air quality standards have been established by the State of New Mexico and the EPA for criteria pollutants for both short-term (1-hour, 3-hour, 8-hour, and 24-hour) and long-term (30-day, quarterly, and annual) time periods. In addition, guideline values were developed for other air pollutants for both short-term (8-hour) and long-term (annual) time periods. Using these standards and guideline values, the potential impacts of the pollutant emissions from LANL operations on these receptor sets were analyzed as discussed in the following paragraphs.

Criteria Pollutants

Short-term and long-term impacts for carbon monoxide, nitrogen dioxide, sulfur dioxide, total suspended particulates, and PM_{10} were estimated at the receptor locations, and the results were compared with applicable air quality standards. Both time frames were analyzed to address the potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities. Hydrogen sulfide and total reduced sulfur emissions are associated mostly with oil and gas industry; therefore, analysis for these pollutants was not necessary at LANL.

Other Air Pollutants

Noncarcinogens. The potential short-term (acute) and long-term (chronic) impacts of these pollutants at locations where the public could have both short-term and long-term exposure to emissions from LANL facilities were considered.

Short-term impacts were analyzed for fence line receptors. Long-term impacts were not considered at these receptor locations because, although it is possible that the public could have access to fence line areas for short periods of time, these locations would not be inhabited or visited on a regular (long-term) basis.

Carcinogens. The annual impacts from the emissions of carcinogenic air pollutants were analyzed for sensitive receptors. Although guideline values for short-term exposure were used in the screening steps, the more meaningful comparisons were to long-term guideline values for sensitive receptors.

B.1.3 Air Quality Dispersion

Models

The EPA's Industrial Source Complex Air Quality Dispersion Model (ISCST3) was used for the nonradiological air pollutant analyses in this SWEIS and the *1999 SWEIS*. ISCST3 is a versatile model that is often used to predict pollutant concentrations from continuous point, area, volume, and open disposal cell sources (EPA 1995, 2002). This versatile model is often used because of the many features that enable the user to estimate concentrations from nearly any type of source emitting nonreactive pollutants.

EPA's PUFF computer model was used for a screening level analysis of emissions from LANL's High Explosive Firing Sites at TA-14, TA-15, TA-36, TA-39, and TA-40. The PUFF model was designed to estimate downwind concentrations from instantaneous releases of pollutants (DOE 1999). The HOTSPOT computer code was used in combination with the ISCST3 computer model for a detailed analysis of emissions from the high explosive firing sites in order to provide a more readily usable input data file than that provided by PUFF for the health effects analysis in the *1999 SWEIS*. The HOTSPOT code was designed for detonation of high explosives, and was used specifically to provide input data to the ISCST3 model (DOE 1999).

B.2 Criteria Pollutants – General Approach

The combustion sources that were evaluated in the facility-wide analysis of criteria pollutants included each permitted emission source, and, for completeness, two of the largest insignificant sources[1]. These sources included boilers, TA-3 and TA-15 carpenter shops, TA-33 generators, TA-52 paper shredder, TA-60 asphalt plant, TA-3 power plant, TA-21 rock crusher, TA-21 steam plant, boilers at TA-9 and TA-35, and air curtain destructors. An atmospheric dispersion modeling analysis was conducted to estimate the combined potential air quality impacts of the emissions from each of these emission sources (DOE 1999).

No quantitative analysis of vehicular-related emissions was performed as part of the analysis for the *1999 SWEIS,* but these emissions were assumed to be included in the background (DOE 1999). The alternatives considered in this SWEIS may have different effects on the travel patterns in the study area as a result of changes in the number of LANL employees and the future population of Los Alamos. Therefore, changes in regional emissions from traffic were considered for each alternative.

B.2.1 Criteria Pollutants – Methodology

The analysis of combustion-related pollutants used standard analytical modeling techniques based on atmospheric dispersion modeling and emissions estimated under the peak and actual annual average operating conditions of each major combustion unit. Estimates of emission rates were based on the potential emissions from each source. For the purpose of the site-wide analysis, it was assumed that all three TA-3 boilers were operating at full capacity, using the fuel with highest air emissions. This approach was taken to obtain a conservative and complete modeling analysis of these emission sources. Emission rates used in the modeling are presented in **Table B–3**. Other details of the modeling are summarized in the *Facility-Wide Air Quality Impact Analysis* report (LANL 2003). With respect to emission rates from the combustion sources, the analysis bounds the air quality impacts from all the alternatives because the analysis is based on the maximum potential emission from the sources.

B.2.2 Results of Criteria Pollutant Analysis

The results of the analysis of criteria pollutants from LANL's combustion sources are presented in Chapter 5, Table 5–8 of this SWEIS. As shown, the highest estimated concentration of each pollutant would be below the appropriate ambient air quality standard. None of the alternatives considered in this SWEIS, therefore, would exceed the applicable ambient air quality standards, and impacts on the public would be minor.

[1] Stationery sources that emit criteria pollutants in quantities smaller than those requiring inclusion in the Title V operating permit are called insignificant sources. The analysis included two of the largest of these insignificant sources.

Table B–3 Criteria Pollutant Emissions Summary [a] (grams per second)

Source	Nitrogen Oxides	Sulfur Oxides	Carbon Monoxide	Total Suspended Particulates	PM_{10}
TA-3 Power Plant, Stack 1 (2 boilers)	2.495	17.312	1.865	0.68	0.68
TA-3 Power Plant, Stack 2 (1 boiler)	1.247	8.656	0.932	0.34	0.34
TA-33 Diesel Generator	5.078	0.693	4.246	0.176	0.176
TA-21-357 Boilers (3)	0.563	1.38	0.315	0.093	0.093
TA-60 Asphalt Plant	0.252	0.046	4.032	0.097	0.097
TA-59-1 Boilers (2)	0.131	0.001	0.11	0.01	0.01
TA-55-6 Boilers (2)	0.303	0.002	0.255	0.023	0.023
TA-53-365 Boilers (2)	0.174	0.001	0.146	0.013	0.013
TA-50-2 Boiler	0.131	0.001	0.011	0.01	0.01
TA-48-1 Boilers (3)	0.218	0.001	0.183	0.017	0.017
TA-16-1484 Boilers (2)	0.058	0.001	0.13	0.012	0.012
TA-16-1485 Boilers (2)	0.071	0.001	0.161	0.015	0.015
TA-3-38 Carpenter Shop	0.0	0.0	0.0	0.178	0.178
TA-15-563 Carpenter Shop	0.0	0.0	0.0	0.163	0.163
TA-52-11 Paper Shredder	0.0	0.0	0.0	0.374	0.374

TA = technical area, PM_n = particulate matter with an aerodynamic diameter less than or equal to *n* micrometers.

[a] Emissions represent the values modeled in the *Facility-Wide Air Quality Impact Analysis*. Not included in this table are the results of the analysis for air curtain destructors and a rock crusher that are no longer operated by LANL. About half of the boilers shown are actually backup boilers and would not be operated at the same time as the primary boiler at a facility, but were included for the purpose of bounding the potential impacts considered in the Title V permit.

Source: LANL 2003.

B.3 Other Air Pollutants – General Approach

The approach used to evaluate chemical air pollutants in the *1999 SWEIS* was based on the use of screening level emission values to identify chemicals that would be evaluated in more detail. Screening level emission values were conservatively estimated hypothetical emission rates for each of the air pollutants that could potentially be emitted from each of LANL's TAs and that would not result in air quality levels harmful to human health under current or future conditions. These screening level emission values were compared with conservatively estimated pollutant emission rates on a TA-by-TA basis to determine potential air quality impacts of air pollutants from LANL operations. This process consisted of the following steps:

- From over 2,000 chemical compounds listed as being used at LANL, 382 air pollutants (including 51 carcinogens) were selected for consideration based on chemical properties, volatility, and toxicity.

- A methodology based on screening level emission values was used to estimate the potential worst-case impacts of the air pollutants. Screening level emission values for each chemical for each TA were compared with emission rates conservatively estimated from chemical use rates. If a conservatively estimated emission rate for a given pollutant from a given TA was less than the screening level emission value, that pollutant emission source was deemed not to have the potential to cause significant air quality impacts, and, as such, no detailed analysis was required. If the screening level emission value was less than the estimated emission rate for a given pollutant from a given TA, a more detailed analysis was conducted.

- An additive impact analysis was conducted to estimate the potential total impact from the emissions of each pollutant from more than one TA and the total incremental cancer risk from all of the carcinogenic pollutants combined at any of the sensitive receptor locations considered.

The methodology used in the analysis followed modeling guidelines for toxic pollutants established by the EPA in that it first used screening level evaluations based on conservative assumptions and resulting in maximum potential impacts, followed by more detailed analyses based on more realistic assumptions. The overall procedure used for the air quality assessment, including the development of screening level emission values, is summarized in the *1999 SWEIS* (DOE 1999).

B.3.1 Other Pollutants – Methodology for Individual Pollutants

Screening Level Analysis

The following sections provide more detail on the methodology used for screening and detailed analysis for air pollutants from chemical use in the *1999 SWEIS* (DOE 1999).

Once screening level emission values (both short-term and long-term) were established for each of the air pollutants on a TA-specific basis, a comparison was made between these values and conservatively estimated emission rates. A ratio was developed for each chemical by dividing the screening level emission value by the estimated emission rate (SLEV/Q).

These results, in the form of worksheets, were presented to knowledgeable site personnel who were aware of the activities and processes occurring at each TA, as well as those that might occur in the future. To streamline the process, the relationship between screening level emission values and the estimated emission rates for each TA were presented in two data sets.

The first data set included those chemicals having SLEV/Q ratios greater than 100. For each of these chemicals, a determination was made as to whether the use of that chemical would increase by more than 100 times under future operation(s) of LANL under any of the alternatives considered in this SWEIS. Essentially, this meant that for each TA a determination had to be made as to whether the use of a chemical would increase over current use rates by a factor of 100. If a determination could be made that the future use of that chemical would not increase by this factor, no further evaluation of that chemical was required. If such a determination was not possible, a more detailed analysis was conducted.

The second data set included all chemicals having a SLEV/Q ratio less than 100, and all chemicals having an SLEV/Q ratio greater than 1 but less than 100, and all chemicals having a ratio less than 1. For each chemical having a ratio greater than 1 but less than 100, an evaluation was made as to whether the estimated emissions under any of the future alternatives would exceed the screening level emission values. Essentially, this meant that for each TA a determination had to be made as to whether the use of that chemical would increase over current rates by a factor greater than the SLEV/Q ratio. If a determination could be made that the future use of that chemical would not increase by this factor, no further evaluation of that chemical was required. If such a determination was not possible, a more detailed analysis was conducted. For those chemicals having an SLEV/Q ratio less than 1 (in other words, screening level emission values were potentially being exceeded under current conditions), more detailed analyses were conducted.

Two exceptions to the methodology described above were made. Information on the TAs for high explosive operations were derived using a model more appropriate for screening short-term exposure concentrations under those conditions. The second exception involved screening the emissions of chemicals from the Bioscience Facilities (formerly the Health Research Laboratory Complex) at TA-43. Because of the proximity of the Bioscience Facilities to actual receptors, all analyses for carcinogens, as well as noncarcinogens, were performed for actual receptors rather than fence line receptors.

Detailed Analysis

The detailed air quality analysis consisted of one or both of the following steps:

- Development of emission rates and source term parameters using actual process knowledge, and

- Dispersion modeling using actual stack parameters and receptor locations.

Two consequences may result from detailed analysis of each chemical from each TA: (1) either there is no potential to exceed a guideline value (in which case no additional analyses were required), or (2) there is a potential to exceed a guideline value (in which case additional analyses were required). A pollutant having the potential to exceed a guideline value was subject to evaluation in the health and ecological risk assessment process.

B.3.2 Other Pollutants – Results of Individual Pollutants Analysis

Screening Level

The first data set considered those chemicals having SLEV/Q ratios greater than 100. For more than 90 percent of the air pollutants from chemical use, a determination was made that the use of these chemicals would not increase by more than 100 times under any of the SWEIS alternatives. The second data set included chemicals having SLEV/Q ratios greater than 1 but less than 100, and ratios less than 1. A determination was made as to whether the use of that chemical would increase over current use rates by a factor greater than the SLEV/Q ratio. The list of carcinogens also was reduced from 51 to 35 because some of the chemicals are no longer used and were not projected for future use. Based on worksheets for the chemicals in the data sets, and information on potential future use, operations at 13 locations were identified with the potential to exceed a guideline value, and more detailed analyses were conducted.

Emissions from two sources were referred to the health and ecological risk analysis process. The analysis for TA-43 showed the potential to exceed the guideline values for four chemical carcinogens from the Bioscience Facilities: chloroform, trichloroethylene, formaldehyde, and acrylamide.

The detailed analysis for the High Explosive Firing Sites indicated that the same chemicals that had the potential to exceed a guideline value in the previous screening step would also have the potential to exceed their respective guideline values using somewhat different parameters and a different model than that used in the screening analysis. The HOTSPOT 8.0 and ISCST3 models were used in the detailed analysis in order to provide output data in a form more readily usable for the health risk analysis. Additional information on the following chemicals was referred to the health and ecological risk assessment process for the *1999 SWEIS*:

- Depleted uranium, beryllium, and lead from TA-15;
- Depleted uranium, beryllium, and lead from TA-36;
- Beryllium and lead from TA-39; and
- Depleted uranium and lead from TA-14.

The health risk analysis calculated Hazard Indices for two of the three metals. A Hazard Index equal to or greater than 1 is considered consequential from a human toxicity standpoint. The Expanded Operations Alternative in the *1999 SWEIS* is comparable to the No Action Alternative in this SWEIS. For the Expanded Operations Alternative, the worst-case Hazard Index for lead did not exceed 0.000015, and, for depleted uranium, the worst-case Hazard Index did not exceed 0.000065. Beryllium has no established EPA reference dose from which to calculate the Hazard Index. However it was evaluated as a carcinogen. The estimate of excess latent cancer fatalities for beryllium under the Expanded Operations Alternative in the *1999 SWEIS* was 1 chance in 2.7 million (3.6×10^{-7}) per year (DOE 1999).

B.3.3 Other Pollutants – Methodology for Combined Impacts Analyses

The following analyses were conducted for the *1999 SWEIS* to ensure that the combined effects from the releases of all of the chemicals from all the TAs would not exceed the guideline values.

Noncarcinogens

An analysis of potential short-term impacts at a TA's fence line receptor location showed that the 8-hour impacts from the releases of that TA were greater (more than two orders of magnitude) than the impacts from the releases of a nearby TA. This is because the TAs are relatively far apart compared to the distances between the emission sources of a TA and its fence line receptors. Therefore, it is unlikely that the additive short-term impacts of noncarcinogenic pollutants at the fence line receptors of a TA would be significantly different from the maximum concentrations previously estimated for that TA.

An analysis of annual potential impacts at sensitive receptor locations showed that these impacts were significantly less (less than two orders of magnitude) relative to the appropriate guideline values than the corresponding short-term impacts at the fence line receptors. Therefore, it would be unlikely that the additive annual impacts of the noncarcinogenic pollutants at the sensitive receptor locations would be significant.

Carcinogens

Two different versions of additive impacts for carcinogens were presented. Both versions considered impacts at sensitive receptor locations based on annual ambient concentrations of pollutants. Short-term additive impacts for carcinogens at fence line receptor locations were not considered (for the same reasons as for noncarcinogens). However, long-term impacts at sensitive receptor locations were considered because EPA considers in their standard setting process that risk from carcinogens can be additive for all carcinogenic chemicals.

The first version considered whether emissions of the same chemical from all TAs (whether or not it was actually used at that TA), at the screening level emission value rate (whether or not that maximum rate was actually projected at that TA), would exceed the total guideline risk value of 1×10^{-6}. The risk due to exposure at the maximum concentration over a lifetime for any receptor for each of the TAs was added to the separately calculated maximum concentration for any receptor for each of the other TAs, regardless of whether the same receptor was indicated.

The second version modeled simultaneous emissions of the same chemical at actual projected rates for each of the TAs, and recorded the maximum concentration at any receptor location. The risk due to exposure at that concentration over a lifetime was then added to the risks calculated in a similar fashion for each of the other chemicals. Risks were added regardless of whether the same receptor was involved. That total risk was also compared to the guideline risk value of 1×10^{-6} of any excess cancer from a lifetime of exposure.

B.3.4 Other Pollutants – Results of Combined Impact Analysis

Releases of Each Carcinogenic Pollutant from All TAs

The estimated combined cancer risk associated with releases of each of these pollutants from all TAs was 1.23 in ten million (1.23×10^{-7}), which was below the guideline value of one in a million (1.0×10^{-6}). As such, no potentially significant air quality impacts were estimated.

Releases of All Carcinogenic Pollutants from All TAs

Results of this analysis indicated that the potential combined incremental cancer risk associated with releases of all carcinogenic pollutants from all TAs would be slightly above the guideline value of one in a million (1.0×10^{-6}).

The major contributors to the estimated combined cancer risk values were chloroform, formaldehyde, and trichloroethylene from the Bioscience Facilities at TA-43, and multiple sources for methylene chloride. Of these, the relative contribution of chloroform emissions alone to the combined cancer risk value was more than 87 percent. The impacts of TA-43 emissions were due to a combination of relatively high emission rates, close proximity between receptors and sources, and the elevation of the receptors. A more detailed analysis that considered the impact at each specific receptor location was conducted. This more refined analysis estimated the combined cancer risk at each of the 180 sensitive receptor locations. The health risk analysis concluded that the combined cancer risk at the two receptor locations at the Los Alamos Medical Center was 0.73 to 0.74 in a million (7.3 to 7.4×10^{-7}). This value was below the guideline value for human health consequences from carcinogenic air emissions (DOE 1999).

B.4 References

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

EPA (U.S. Environmental Protection Agency), 1995, *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Vol. 1, User Instructions*, EPA-454/B-95-003a, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, September.

EPA (U.S. Environmental Protection Agency), 2002, *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Vol. 1, User Instructions*, Addendum, EPA-454/B-95-003a, Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, February.

LANL (Los Alamos National Laboratory), 2003, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, RRES-MAQ, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2004a, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004b, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

NMED (New Mexico Environment Department), 2003, *Dispersion Modeling Guidelines*, Air Quality Bureau, Santa Fe, New Mexico, July.

APPENDIX C
EVALUATION OF HUMAN HEALTH IMPACTS FROM NORMAL OPERATIONS

APPENDIX C
EVALUATION OF HUMAN HEALTH IMPACTS FROM NORMAL OPERATIONS

This appendix provides a brief general discussion of radiation and its effects on human health, as well as the methods and assumptions used for estimating the potential impacts and risks to individuals, workers, and the general public from exposure to releases of radioactivity and hazardous chemicals during normal operations at Los Alamos National Laboratory (LANL). It also discusses methods used to safely control biological material during research activities.

This appendix addresses the methods used to assess human health impacts from normal operations at LANL. To do so, it considers: (1) radionuclides potentially released into the air from Key Facilities as a function of the three alternatives considered in this site-wide environmental impact statement (SWEIS); and (2) radionuclides and chemicals that may be present in environmental pathways (such as ground and surface water and game animals) in and around the LANL environs. In addition, background information is presented regarding the effects on human health from exposure to radiation, biological agents, and hazardous chemicals. Both the methods used to assess impacts and the impacts themselves from the proposed projects that may be implemented at LANL as part of the Expanded Operations Alternative are addressed elsewhere in this SWEIS (see Appendices G, H, I, and J).

The release of pollutants to ambient air is the focus in these analyses because they are projected to dominate possible exposures to the public as a result of future LANL operations. Other releases such as those through outfalls into surface water bodies are not expected to be dominant contributors to future exposures because of the significant reduction in the use of outfalls and the extensive implementation of environmental controls such as those of the National Pollutant Discharge Elimination System. Past releases, however, have resulted in some radiological and chemical contamination in several environmental media, and impacts from this contamination are addressed in this appendix. This approach for evaluating human health impacts from normal operations is consistent with the approach used for the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS).*

C.1 Impacts on Human Health from Radiological Exposure

Radiation exposure and its consequences are of interest to the public. For this reason, this section provides information on the nature of radiation, emphasizes the consequences of exposure to radiation, and explains the basic concepts used to evaluate radiation health effects.

C.1.1 About Radiation and Radioactivity

C.1.1.1 What Is Radiation?

Radiation is energy transferred in the form of particles or waves. Globally, human beings are exposed constantly to radiation from the solar system and the Earth's rocks and soil. This radiation contributes to the natural background radiation that always surrounds us. Manmade sources of radiation also exist, including medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired power plants.

All matter in the universe is composed of atoms. Radiation comes from the activity of tiny particles within an atom. An atom consists of a positively charged nucleus (central part of an atom) with a number of negatively charged electron particles in various orbits around the nucleus. There are two types of particles in the nucleus: neutrons that are electrically neutral and protons that are positively charged. All atoms of a given chemical element have the same number of protons in their nuclei. There are more than 100 natural and manmade elements. Atoms that have the same number of protons in their nuclei, but different numbers of neutrons, are called isotopes of an element. Elements may have one or more stable isotopes and others that are unstable (decay with time).

Unstable isotopes undergo spontaneous change known as radioactive disintegration or radioactive transformation. The process of continuously undergoing spontaneous transformation is called radioactivity. The radioactivity (number of transformations per second) of a given amount of material decreases with time. Each radioactive isotope is distinguished by the time it takes for a given quantity of the material to lose half of its original radioactivity. This time is its half-life, and is characteristic of the isotope. For example, an isotope with a half-life of 8 days will lose one-half of its radioactivity in that amount of time. In 8 more days, the radioactivity will again decrease by half, to one-fourth of the original value. The half-lives of various radioactive elements can vary from millionths of a second to millions of years.

As unstable isotopes change into more stable forms, they emit electrically-charged particles. The particle may be either an alpha particle (a helium nucleus) or a beta particle (an electron) and have various levels of kinetic energy. Sometimes these particles are emitted in conjunction with gamma rays. The alpha and beta particles and gamma rays are frequently referred to as “ionizing radiation”, a term that reflects the fact that the charged particle or gamma ray can strip or displace electrons away from atoms of matter through which they pass, leaving those atoms with an electrical charge. The ionization caused by radiation can change the chemical composition of many substances, including living tissue, which can affect the way they function.

Ionizing radiation is used in a variety of ways, many of which are familiar to us in our everyday lives. The machines used by doctors to diagnose and treat medical patients typically use x-rays, which are a form of ionizing radiation. The process by which a television displays a picture is by ionizing coatings on the inside of the screen with electrons. Most home smoke detectors use a small source of ionizing radiation to detect smoke particles in room air.

When a radioactive isotope of an element emits a particle, it changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation, which may take several steps, is known as a decay chain. For example, radium, which is a member of the radioactive decay chain of uranium, has a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays first to polonium, then through a series of further decay steps to bismuth, and ultimately to a stable isotope of lead. Meanwhile, the decay products will build up and eventually disappear as time progresses.

The characteristics of various forms of ionizing radiation are briefly described below and in the box to the right.

Alpha (α)—Alpha particles are the heaviest type of ionizing radiation. They can travel only a few centimeters in air. Alpha particles lose their energy almost as soon as they collide with anything. They can be stopped easily by a sheet of paper or by the surface of one's skin.

Radiation Type	*Typical Travel Distance in Air*	*Barrier*
α	Few inches	Sheet of paper or skin's surface
β	Few feet	Thin sheet of aluminum foil or glass
γ	Very large	Thick wall of concrete, lead, or steel
n	Very large	Water, paraffin, graphite

Beta (β)—Beta particles are much (7,330 times) lighter than alpha particles. They can travel a longer distance than alpha particles in the air. A high-energy beta particle can travel a few feet in the air. Beta particles can pass through a sheet of paper, but can be stopped by a thin sheet of aluminum or glass.

Gamma (γ)—Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light. Gamma radiation is very penetrating and requires concrete, lead, or steel shielding to stop it.

Neutrons (n)—The most prolific source of neutrons is a nuclear reactor. Neutrons produce ionizing radiation indirectly by collision with hydrogen nuclei (protons) and when gamma rays and alpha particles are emitted following neutron capture in matter. A neutron has about one-quarter the weight of an alpha particle. It will travel in the air until it is absorbed in another nucleus.

C.1.1.2 Units of Radiation Measure

During the early days of radiological experience, there was no precise unit of radiation measurement. Therefore, a variety of units was used to measure the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or effects using units of calories or degrees, amounts of radiation or its effects can be measured in units of curies, radiation absorbed dose (rad), or dose equivalent (roentgen equivalent man, or rem). The following summarizes these units.

Curie—The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" (activity) of a sample of radioactive material. The rate of decay of 1 gram of radium was the basis for this unit of measure. Because the measured decay rate kept changing slightly as measurement techniques became more accurate, the curie was subsequently defined as exactly 3.7×10^{10} disintegrations (decays) per second.

Radiation Units and Conversions to International System of Units	
1 curie	= 3.7×10^{10} disintegrations per second
	= 3.7×10^{10} becquerels
1 becquerel	= 1 disintegration per second
1 rad	= 0.01 gray
1 rem	= 0.01 sievert
1 gray	= 1 joule per kilogram

Rad—The rad is used to measure the physical absorption of radiation. The total energy absorbed per unit quantity of tissue is referred to as absorbed dose (or simply dose). As sunlight heats pavement by giving up energy to it, radiation similarly gives up energy to objects in its path. One rad is equal to the amount of radiation that leads to the deposition of 0.01 joule of energy per kilogram of absorbing material.

Rem (roentgen equivalent man)—A rem is a measurement of the dose equivalent from radiation based on its biological effects. The rem is used to measure the effects of radiation on the body as degrees centigrade are used to measure the effects of sunlight heating pavement. Thus, 1 rem of one type of radiation is presumed to have the same biological effects as 1 rem of any other kind of radiation. This allows comparison of the biological effects of radionuclides that emit different types of radiation.

The units of radiation measurement in the International System of Units are becquerels (a measure of source intensity [activity]), grays (a measure of absorbed dose), and sieverts (a measure of dose equivalent).

An individual may be exposed to ionizing radiation externally (from a radioactive source outside the body) or internally (from ingesting or inhaling radioactive material). The external dose is different from the internal dose because an external dose is delivered only during the actual time of exposure to the external radiation source, while an internal dose continues to be delivered as long as the radioactive source is in the body. The dose from internal exposure is calculated over 50 years following the initial exposure. Both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time.

C.1.1.3 Sources of Radiation

The average American receives a total of approximately 360 millirem per year from all sources of radiation, both natural and manmade, of which approximately 300 millirem per year are from natural sources. A person living in Los Alamos receives an average background dose between 300 and 500 millirem, depending on where they live (LANL 2004d). The sources of radiation can be divided into six different categories: cosmic radiation, terrestrial radiation, internal radiation, consumer products, medical diagnosis and therapy, and other sources (NCRP 1987). These categories are discussed in the following paragraphs.

Cosmic Radiation—Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the Earth's atmosphere. Cosmic radiation comprises these particles and the secondary particles and photons they create. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with the altitude above sea level. The average dose to people in the United States from this source is approximately 27 millirem per year. Doses from cosmic radiation range from 50 millirem per year at lower elevations near the Rio Grande River to about 90 millirem per year in the mountains near Los Alamos (LANL 2004d).

External Terrestrial Radiation—External terrestrial radiation is the radiation emitted from the radioactive materials in the Earth's rocks and soils. The average dose from external terrestrial radiation is approximately 28 millirem per year. Doses from terrestrial radiation in Los Alamos range from about 50 to 150 millirem a year, depending on the amounts of natural uranium, thorium, and potassium in the soil (LANL 2004d).

Internal Radiation—Internal radiation results from radioactive material that has entered the body by inhalation or ingestion and is retained by the affected organs or tissues. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon, which contribute approximately 200 millirem per year. The average dose from other internal radionuclides is approximately 40 millirem per year.

Consumer Products—Consumer products also contain sources of ionizing radiation. In some products, such as smoke detectors and airport x-ray machines, the radiation source is essential to the product's operation. In other products, such as televisions and tobacco, the radiation source is a byproduct of the product's function. The average dose from consumer products is approximately 10 millirem per year.

Radiation Source	***Average Annual Dose (millirem)***
Cosmic	50-90
External Terrestrial	50-150
Internal	240
Consumer Products	10
Medical Diagnostic and Treatment	50
Other	1 +

Medical Diagnosis and Therapy—Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x-rays result in an average exposure of 50 millirem per year. Nuclear medical procedures result in an average exposure of 14 millirem per year.

Other Sources—There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The dose from nuclear fuel cycle facilities (for example, uranium mines, mills, and fuel processing plants) and nuclear power plants has been estimated to be less than 1 millirem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions from certain mineral extraction facilities, and transportation of radioactive materials contribute less than 1 millirem per year to the average dose to an individual. Air travel contributes approximately 1 millirem per year to the average dose.

C.1.1.4 Exposure Pathways

As stated earlier, an individual may be exposed to ionizing radiation both externally and internally. The different ways that an individual can be exposed to radiation are called exposure pathways. Each type of exposure is discussed separately in the following paragraphs.

External Exposure—External exposure can result from a number of different pathways where the exposure is external to the body. These pathways include exposure to a cloud of radiation passing over the receptor (an exposed individual), standing on ground that is contaminated with radioactivity, and swimming or boating in contaminated water. If the receptor leaves the source of radiation exposure, the dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year. The appropriate dose measure is called the effective dose equivalent.

Internal Exposure—Internal exposure results from a radiation source entering the human body through either inhalation of contaminated air or ingestion of contaminated food or water. In contrast to external exposure, once a radiation source enters the body, it remains there for a period of time that varies depending on its physical decay and biological half-life. The absorbed dose to each organ of the body is calculated for a period of 50 years following the intake. The calculated absorbed dose is called the committed dose equivalent. Various organs have different susceptibilities to damage from radiation. The committed effective dose equivalent takes these different susceptibilities into account and provides a broad indicator of risk to the health of an individual from radiation. The committed effective dose equivalent is a weighted sum of the committed dose equivalent in each major organ or tissue. The concept of committed effective dose equivalent applies only to internal pathways.

C.1.1.5 Limits of Radiation Exposure

Limits of exposure to members of the public and radiation workers are derived from International Commission on Radiological Protection recommendations. The U.S. Environmental Protection Agency (EPA) uses the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection recommendations to set specific annual exposure limits (usually less than those specified by the Commission) in *Radiation Protection Guidance to Federal Agencies* documents. Each regulatory organization then establishes its own set of radiation standards. The various exposure limits set by the U.S. Department of Energy (DOE) and EPA for radiation workers and members of the public are given in **Table C–1**.

Table C–1 Exposure Limits for Members of the Public and Radiation Workers

Guidance Criteria (Organization)	*Public Exposure Limits at the Site Boundary*	*Worker Exposure Limits*
10 CFR Part 835 (DOE)	Not applicable	5,000 millirem per year [a]
DOE Order 5400.5 (DOE) [b]	10 millirem per year (all air pathways) 4 millirem per year (drinking water pathway) 100 millirem per year (all pathways)	Not applicable
40 CFR Part 61 (EPA)	10 millirem per year (all air pathways)	Not applicable
40 CFR Part 141 (EPA)	4 millirem per year (drinking water pathways)	Not applicable

CFR = *Code of Federal Regulations*, EPA = U.S. Environmental Protection Agency.

[a] Although this limit (or level) is enforced by DOE, worker doses must be managed in accordance with as low as reasonably achievable (ALARA) principles. An annual limit of 2,000 millirem per year was established by DOE to assist in achieving its goal to maintain radiological doses at ALARA levels (DOE 1999b).

[b] Derived from 40 CFR Part 61, 40 CFR Part 141, and 10 CFR Part 20.

C.1.2 Health Effects

To provide a background for discussing impacts, this section explains the basic concepts used to evaluate radiation effects.

Radiation can cause a variety of damaging health effects in people. The most significant effects are induced cancer fatalities. These effects are referred to as "latent" cancer fatalities because the cancer may take many years to develop. In the discussions that follow, all fatal cancers are considered latent; therefore, the term "latent" is not used.

The National Research Council prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposures. The most recent of these, *Health Effects from Exposure to Low Levels of Ionizing Radiation, BEIR VII-Phase 2* (National Research Council 2005), provides current estimates for excess mortality from leukemia and other cancers that are expected to result from exposure to ionizing radiation. Biological Effects of Ionizing

Radiation (BEIR) VII provides estimates that are not significantly different from those in its predecessor, BEIR V, and recent United Nations Scientific Committee on the Effects of Atomic Radiation and International Commission on Radiological Protection reports. The report, however, concludes that recent data and analyses have reduced the uncertainties associated with the risk estimates. BEIR V developed models in which the excess relative risk was expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. The models were based on the assumption that the relative risks are comparable between the atomic bomb survivors and the U.S. population.

The models and risk coefficients in BEIR VII are derived through review of the most current information on the biological mechanisms of radiation tumorigenesis as well as analyses of relevant epidemiologic data that includes the Japanese atomic bomb survivors, medically-exposed persons, and large-scale occupational radiation studies. The BEIR VII Committee concluded that the balance of evidence tends to support a simple proportionate relationship at low doses between radiation dose and risk. This conclusion essentially affirms the Linear-No-Threshold model that has long been the basis for the regulation and control of occupational and environmental radiation exposure in the United States.

The National Council on Radiation Protection and Measurements (NCRP 1993), based on the radiation risk estimates provided in BEIR V and the International Commission on Radiological Protection (ICRP 1991), estimates the total detriment resulting from low dose[1] or low dose rate exposure to ionizing radiation to be 0.00076 per rem for the working population and 0.00083 per rem for the general population. The total detriment includes fatal and nonfatal cancers as well as severe hereditary (genetic) effects. The major contribution to the total detriment is from fatal cancer, estimated to be 0.0006 per rem for both radiation workers and the general population. For comparison, the BEIR VII Committee's preferred estimates of lifetime attributable risk of mortality for all solid cancers and leukemia are 0.00048 for males and 0.00066 for females. The breakdowns of the risk estimators for both workers and the general population are given in **Table C–2**. Nonfatal cancers and genetic effects are less probable consequences of radiation exposure.

Table C–2 Nominal Health Risk Estimators Associated with Exposure to 1 Rem of Ionizing Radiation

Exposed Individual	*Fatal Cancer* [a, c]	*Nonfatal Cancer* [b]	*Genetic Disorders* [b]	*Total*
Worker	0.0006	0.00008	0.00008	0.00076
Public	0.0006	0.0001	0.00013	0.00083

[a] For fatal cancer, the health effect coefficient is the same as the probability coefficient. When applied to an individual, the units are the lifetime probability of a cancer fatality per rem of radiation dose. When applied to a population of individuals, the units are the excess number of fatal cancers per person-rem of radiation dose. These factors are from DOE 2003a.
[b] In determining a means of assessing health effects from radiation exposure, the International Commission on Radiological Protection has developed a weighting method for nonfatal cancers and genetic effects. These factors are from NCRP 1993.
[c] For high individual exposures (greater than or equal to 20 rem), the health factors are multiplied by a factor of 2.
Sources: NCRP 1993, DOE 2003a.

[1] *Low dose is defined as the dose level where deoxyribonucleic acid (DNA) repair can occur in a few hours after irradiation-induced damage. Currently, a dose level of about 0.2 grays (20 rad), or a dose rate of 0.1 milligrays (0.01 rad) per minute is considered low enough to allow the DNA to repair itself in a short period (EPA 1994).*

EPA, in coordination with other Federal agencies involved in radiation protection, issued *Federal Radiation Guidance Report No. 13, Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, in September 1999 (EPA 1999). This document is a compilation of risk factors for doses from external gamma radiation and internal intakes of radionuclides. *Federal Radiation Guidance Report No. 13* is the basis for the radionuclide risk coefficients used in the EPA Health Effects Assessment Summary Tables (EPA 2001) and in computer dose codes. The Interagency Steering Committee on Radiation Standards (ISCORS) issued a technical report entitled, *A Method for Estimating Radiation Risk from TEDE* (DOE 2003a). ISCORS technical reports are guidance to Federal agencies to assist them in preparing and reporting the results of analyses and implementing radiation protection standards in a consistent and uniform manner. This report provides dose-to-risk conversion factors where doses are estimated using total effective dose equivalent (TEDE). It is recommended for use by DOE personnel and contractors when computing potential radiation risk from calculated radiation dose for comparison purposes. For situations in which a radiation risk assessment is required for making risk management decisions, however, the radionuclide-specific risk coefficients in Federal Guidance Report No. 13 should be used.

DOE and other agencies regularly conduct dose assessments using models and codes that calculate radiation dose from exposure or intake using dose conversion factors and do not compute risk directly. In those cases where it is necessary or desirable to estimate risk for comparative purposes (for example, comparing the risk associated with alternative actions), it is common practice to simply multiply the calculated TEDE by a risk-to-dose factor. DOE previously recommended a TEDE-to-fatal cancer risk factor of 0.0005 per rem for the public and 0.0004 per rem for working-age populations. ISCORS recommends that agencies use a conversion factor of 0.0006 fatal cancers per TEDE (rem) for mortality and 0.0008 cancers per rem for morbidity when making qualitative or semi-quantitative estimates of risk from radiation exposure to members of the general public[2] (DOE 2003a).

The ISCORS report notes that the recommended risk coefficients used with TEDE dose estimates generally produce conservative radiation risk estimates (they overestimate risk). Regarding the ingestion pathway for the 11 radionuclides included in the report, the risks are overestimated compared to the values in Federal Radiation Guidance Report No. 13 for about 8 radionuclides and significantly overestimated (by up to a factor of 6) for 4 of these. The Office of Environmental Policy and Guidance also compared the TEDE-to-cancer risk conversion factor approach to Federal Radiation Guidance Report No. 13 for the inhalation pathway and found a bias toward overestimating risk, although it was not as severe as for ingestion. For 16 radionuclides and chemical states evaluated, 7 were overestimated (by more than a factor of 2) and 5 were underestimated. The remainder agreed within about a factor of two. Generally, these differences were within the uncertainty of transport and the uptake portions of dose or risk modeling; therefore, the approach recommended is fully acceptable for comparative assessments. It is recommended, however, that the more rigorous approach using Federal Radiation Guidance Report No. 13 cancer risk coefficients be employed wherever possible (DOE 2003a).

Different methods of extrapolation to the low-dose region could yield higher or lower numerical estimates of fatal cancers. Studies of human populations exposed to low doses are inadequate to

---

[2] *Such estimates should not be stated with more than one significant digit.*

demonstrate the actual level of risk. There is scientific uncertainty about cancer risk in the low-dose region below the range of epidemiologic observation, and the possibility of no risk cannot be excluded (CIRRPC 1992).

C.1.2.1 Health Effect Risk Estimators Used in this SWEIS

Health impacts from radiation exposure, whether from external or internal sources, generally are identified as "somatic" (affecting the exposed individual) or "genetic" (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects than genetic effects. The somatic risks of most importance are induced cancers. Except for leukemia, which can have an induction period (the time between exposure to a carcinogen and a cancer diagnosis) of as little as 2 to 7 years; most cancers, however, have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues; the thyroid and skin demonstrate a greater sensitivity than other organs. Such cancers, however, also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because fatal cancer is the most probable serious effect of environmental and occupational radiation exposures, estimates of cancer fatalities rather than cancer incidence are presented in this new SWEIS. The numbers of fatal cancers can be used to compare the risks among the various alternatives.

The fatal cancer estimators are used to calculate the statistical expectation of the effects of exposing a population to radiation. For example, if 100,000 people were each exposed to a one-time radiation dose of 100 millirem (0.1 rem), the collective dose would be 10,000 person-rem. The exposed population would then be expected to experience 6 additional cancer fatalities from the radiation (10,000 person-rem times 0.0006 lifetime probability of cancer fatalities per person-rem = 6 cancer fatalities).

Calculations of the number of excess fatal cancers associated with radiation exposure do not always yield whole numbers. These calculations may yield numbers less than 1, especially in environmental impact applications. For example, if a population of 100,000 were exposed to a total dose of only 0.001 rem per person, the collective dose would be 100 person-rem (100,000 persons times 0.001 rem = 100 person-rem). The corresponding estimated number of cancer fatalities would be 0.06 (100 person-rem times 0.0006 cancer fatalities per person-rem = 0.06 cancer fatalities). This estimate of 0.06 cancer fatalities means that there is 1 chance in 16.6 that the exposed population would experience 1 fatal cancer. In other words, 0.06 cancer fatalities is the *expected* number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person would incur a fatal cancer from the 0.001 rem dose each member would have received. In a small fraction of the groups, 1 cancer fatality would result; in exceptionally few groups, 2 or more cancer fatalities would occur. The *average* expected number of deaths over all the groups would be 0.06 cancer fatalities (just as the average of 0, 0, and 0 added to 1 is 1/4, or 0.25). The most likely outcome is no cancer fatalities.

C.1.2.2 Material of Interest at Los Alamos National Laboratory

LANL scientists have a large involvement in nuclear science and its applications. Therefore, many types of radioactive materials and radiation sources are in use at LANL; however, many of these uses require only very small amounts of material. Note that all radioactive materials are considered in this new SWEIS, but three radionuclides tend to dominate the human health effects at LANL due to their particular radioactive and biological characteristics, the quantities of material being used, or the potential for dispersion in an accident. These radionuclides are plutonium, uranium, and tritium.

Plutonium is a manmade element that has several applications in weapons, nuclear reactors, and space exploration. There are several types of plutonium atoms, called isotopes, which are distinguished by the different numbers of neutrons in their nucleus. (Note that isotopes of a particular element all behave the same chemically.) In most cases, the isotopes of plutonium decay by alpha particle emission and have radioactive half-lives ranging from tens to thousands of years. Plutonium that is taken into the body tends to be deposited in certain organs (notably the bone, liver and lung) and is excreted very slowly. Because alpha particles have a very short range in tissue, the radiation dose from plutonium in the body is largely delivered to the organs where the material is deposited.

Uranium is a naturally-occurring radioactive element. The discovery that an atom of uranium could be fissioned with neutrons was the starting point of the Nuclear Age. Uranium-235 is one of several fissile materials that fission with the release of energy. Various applications require the use of different isotopes of uranium. Because isotopes cannot be chemically separated, processes have been developed to enrich uranium to various isotopic ratios. Natural uranium consists mostly of uranium-238, with very small amounts of uranium-234 and uranium-235. Enriched uranium is enhanced in the isotope uranium-235 above its natural concentration of 0.72 percent. Highly enriched uranium has a greater than 20 percent concentration of uranium-235 or greater. Depleted uranium results from the enrichment process, where most of the uranium-235 is removed.

Most uranium isotopes of interest here have very long half-lives and are alpha-emitters. Their half-lives are much longer than plutonium isotopes; as a result, uranium is generally of lower radiological concern than plutonium. Its actual radiological concern, however, varies with its enrichment. As a heavy metal, uranium can be chemically toxic to the kidneys. Depending on the enrichment and chemical form, either chemical or radiological considerations dominate.

Tritium is a radioactive isotope of hydrogen. It is generated at low levels in the environment by interactions of cosmic radiation with the upper atmosphere, but for practical applications, it is normally produced in a nuclear reactor. The radioactive properties of tritium are very useful. By mixing tritium with a chemical that emits light in the presence of radiation, a phosphor, a continuous light source, is created. This can be applied to situations where a dim light is needed but using batteries or electricity is not possible. Rifle sights and exit signs are common applications. Tritium has a half-life of around 12 years and decays by emitting a low-energy beta particle that cannot penetrate the outer layer of human skin. The main hazard associated with tritium is internal exposure. Because tritium is an isotope of hydrogen, it can be incorporated into a water molecule, forming tritiated water. In the environment, tritium is most often found in its elementary form as a gas, or as water. Tritiated water is a concern to the human body because the body is composed mostly of water. Tritiated water will easily and rapidly enter the body and irradiate it rather uniformly; however, it also is removed from the body rather quickly because it can be easily displaced with regular water and has a biological half-life of about 12 days under normal conditions.

C.1.3 Methods Used to Estimate Radiological Impacts from Normal Operations

Dose assessments for members of the public were performed at LANL to determine the incremental doses that would be associated with the alternatives addressed in this SWEIS. This section provides supplemental information regarding those assessments. Incremental doses for members of the public were calculated for the following types of receptors:

- *Facility-Specific Maximally Exposed Individual (MEI)*—The facility-specific MEI represents a location near a facility where the greatest modeled dose to a hypothetical public individual would be received from all modeled emissions.
- *LANL Site-Wide MEI*—The LANL MEI represents the location where the single highest modeled dose would be received by a hypothetical public individual. The highest facility-specific MEI becomes the LANL MEI.
- Collective dose to the population within a 50-mile (80-kilometer) radius from LANL.

C.1.3.1 Key Facilities Modeled

Several facilities at LANL release radioactive materials to the ambient air through stacks, vents, or diffuse emissions. The facilities modeled for this SWEIS are listed in **Table C–3**. Those facilities not modeled were eliminated from detailed analysis because they either have historically low emission rates or would not be expected to operate during the period analyzed in this SWEIS. In addition, all of the facilities modeled in the *1999 SWEIS* as non-Key Facilities (High Pressure Tritium Facility [Technical Area (TA) 33] and Nuclear Safeguards Research Facilities [TA-35]) no longer have facility emissions. The following are changes from the *1999 SWEIS* to the list of Key Facilities:

- The Pajarito Site (TA-18) was removed from the LANL Key Facility list in both the Reduced and Expanded Operations Alternatives of this SWEIS (see Chapter 3, Section 3.1.3.9). Because the normal operational releases will still be applicable for the No Action Alternative at the Pajarito Site, a dose assessment was performed for this SWEIS.
- The Tritium Facilities in TA-21 were removed from the LANL Key Facilities list in the Expanded Operations Alternative. The buildings will continue to have radioactive air emissions until the decontamination, decommissioning, and demolition process has begun. Since these air emissions will result in potential doses to the MEI and public, a dose assessment was performed for the Tritium Facilities in TA-21 in this SWEIS.

Table C–3 Los Alamos National Laboratory Key Facilities

Technical Area	*Facility Name*
TA-3-29	Chemistry and Metallurgy Research Building
TA-3-66	Sigma Complex
TA-3-102	Machine Shops
TA-11	High Explosives Processing Facilities
TA-15 and TA-36	High Explosives Testing Facilities
TA-16	Tritium Facility [a]
TA-18	Pajarito Site [b]
TA-48	Radiochemistry Facility
TA-53	Los Alamos Neutron Science Center
TA-54	Waste Management Operations [c]
TA-55	Plutonium Facility Complex
Non-Key (TA-21)	TA-21 Non-Key Facilities [a]

[a] The Tritium Facility includes the Weapons Engineering Tritium Facility at TA-16. The non-Key Facilities at TA-21 were formerly part of the Tritium Facilities and include the Tritium Science and Fabrication Facility and the Tritium Systems Test Assembly that will continue to produce emissions while awaiting decontamination, decommissioning, and demolition and are under non-Key Facilities.
[b] A LANL Key Facility in the No Action Alternative, it will continue to produce emissions until the Solution High-Energy Burst Assembly moves to another DOE site.
[c] Area G and the Decontamination and Volume Reduction System.

The new LANL Key Facilities were reviewed for potential radiological air releases. It was determined that no significant air emissions from these facilities would produce doses that could affect the public. In addition, the radiological air emissions from the Radioactive Liquid Waste Treatment Facility at TA-50 were considered in the *1999 SWEIS* to be minimal (DOE 1999a) relative to other sources at LANL and therefore were not modeled. It was anticipated that the replacement Radioactive Liquid Waste Treatment Facility also would have minimal radiological air emissions; therefore, it was not modeled in this SWEIS (Appendix G).

As part of LANL's zero liquid discharge program, two concrete basins located at the east end of TA-53 are used to evaporate radioactive liquid discharge from the Los Alamos Neutron Science Center (LANSCE) facility. LANSCE radioactive liquid is first placed in a collection tank for decay. Measurement of the radioisotope concentration of the liquid in this tank after decay is used to determine when it can be released to one of the evaporation basins. Each basin has a 125,000-gallon (473,125-liter) capacity and is lined with a nonpermeable material. The measured radioisotope concentrations in liquid released to the evaporation basin in 2006 were used to calculate the dose to the MEI residing at the East Gate at State Highway 502 located 800 meters (2,625 feet) from the evaporation basins. The calculation used the Clean Air Act Assessment Package – 1988 (CAP88) computer code (EPA 2002) and assumed that all radioisotopes present in the liquid in the evaporation basin during the year, regardless of physical form, were released to the air. The resulting calculated dose to the MEI was 0.035 millirem per year. This 0.035 millirem evaporation basin MEI dose is less than 0.5 percent of the LANL MEI dose of 7.8 millirem for the No Action Alternative. The effect of these evaporation basins on the 50-mile (80-kilometer) population dose from normal operations was calculated to be 0.0278 person-rem per year, which is small (0.13 percent) compared to the population dose from LANSCE emissions (22 person-rem per year).

C.1.3.2 Clean Air Act Assessment Package – 88 Model

CAP88-PC Version 3.0 computer code was used for this SWEIS to calculate population radiation doses from normal releases of radioisotopes (EPA 2002). There were significant changes in dose calculations between the (CAP88-PC) DOS Version 1.0 used in the *1999 SWEIS* and the Version 3.0 used here, including:

- Incorporation of the new Federal Guidance Report No. 13 dose and risk factors;
- Incorporation of options to choose different chemical forms for each radionuclide;
- Addition of pathways, such as drinking water ingestion and external exposure from multiple depths of soil contamination;
- Ability to account for the effect of humidity; and
- Addition of more than 800 isotopes, consistent with those in Federal Guidance Report No. 13.

C.1.3.3 Model Input Parameters

The CAP88 model requires many input parameters to perform dose calculations. Most of these parameters are built into the model and require no input from the user. The user-defined inputs are discussed below, along with how the data were derived.

Population Data

The evaluation of collective offsite dose considers the population living within 50 miles (80 kilometers) of LANL. Potential doses to the local population from airborne radioactive emissions at each Key Facility at LANL were estimated using a 50-mile radius centered on the facility whose emissions were being analyzed. The 50-mile radius is typically used in EISs to evaluate impacts from both emissions from normal operations and releases from postulated accidents. Dose calculations using emissions from LANSCE were performed to support the use of the 50-mile distance. In this analysis, in addition to the dose to the MEI, the dose to an individual was calculated in the direction of the highest dose (north-northeast) for various distances out to 50 miles. As shown in **Figure C–1**, the dose dropped dramatically with increasing distance from the source, due primarily to the dispersion of the emitted contaminants, which reduced their concentrations. Therefore, anywhere beyond 50 miles in any direction, the dose would be smaller than the dose at 50 miles (0.035 millirem per year).

The Sector Population, Land Fraction, and Economic Estimation Program (NRC 2003) was used to create population distribution files that were then configured to work as data input files for CAP88. The SECPOP2000 software can calculate estimated population and economic data about any point (specified by longitude and latitude) that lies within the continental United States. SECPOP2000 used the latest (2000) census data. Population estimates were made using block level census data.

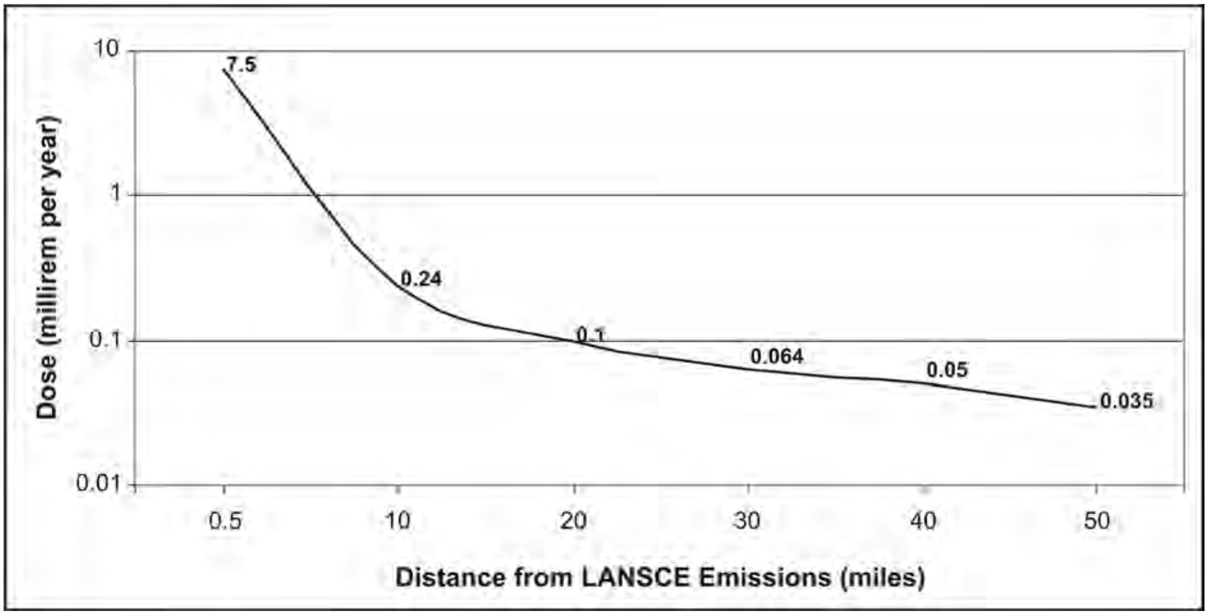


Figure C–1 Maximum Dose to an Individual at Selected Distances

In its population files, CAP88 uses edgepoints for each sector, which are entered in the population file in kilometers. The edgepoints used for CAP88 were consistent with those used for the accident analyses (1, 2, 3, 4, 5, 10, 20, 30, 40, 50 miles). Each CAP88 population file was subsequently analyzed for residents inappropriately listed as residing on LANL property. One block of 184 individuals was consistently listed on a LANL-only sector. Those 184 individuals were manually moved to the adjoining sector to ensure no individuals were assessed as living on LANL property.

Maximally Exposed Individual Locations

The facility-specific MEI represents the location near a specific facility where a hypothetical person receives the greatest dose. These locations do not represent actual residences or individuals, but rather a hypothetical receptor (see Chapter 5, Section 5.6). Some points at the LANL boundary do have residences close to them. This is especially true for those TAs located in the northern part of the LANL site, such as TA-3 and TA-53.

The facility-specific MEI locations remained the same in this SWEIS as those in the *1999 SWEIS*. Due to the expected changes in LANL boundaries near TA-21 and TA-54, the MEIs for TA-21 and TA-54 were reviewed. The review of the TA-21 MEI location included the conveyance of segments A-5-1, A-6, A-8, A-9, A-10, A-11, and A-15. The review of the TA-54 MEI location included the conveyance of segments A-19-1, A-19-2, A-19-3, B-1 and C-1, all of which are near White Rock (LANL 2006a). Since the highest dose for TA-54 in the *1999 SWEIS* was located northeast of the site at the boundary with San Ildefonso Pueblo, the conveyance of land near White Rock, further away, did not affect the TA-54 MEI location.

For some Key Facilities, there are areas nearby that are not populated by LANL workers (such as the Los Alamos County Landfill). These areas were not considered populated by public receptors. Some modeled facilities share the same MEI location. The Chemistry and Metallurgy

Research Building (TA-3-29) and the Sigma Complex (TA-3-66) share the same MEI location, as do the Radiochemistry Facility (TA-48) and the Plutonium Facility Complex (TA-55).

Meteorological Data

There are six towers that gather meteorological data. Four of the towers are located on mesa tops and are used with the CAP88 model to estimate air dispersion of emitted nuclides. The data used for each tower covered an average of 9 years (January 1, 1995 through December 31, 2003) of actual meteorological data. Using average meteorological data over a period of time better reflects conditions than data from any individual year. The tower nearest to the modeled facility was used for data input.

Tower	***Key Facility Locations***
TA-6	TA-3, TA-16, TA-48, TA-55
TA-49	TA-11, TA-15, TA-36
TA-53	TA-21, TA-53
TA-54	TA-18, TA-54

The other meteorological data used in CAP88 is listed below. Previous versions of CAP88 used a default value of 8 grams per cubic meter for the Average Absolute Humidity. For this SWEIS, a value of 3.85 grams per cubic meter (LANL 2004a) was used. All other parameters were confirmed from the *1999 SWEIS*.

- Annual precipitation = 19 inches (48 centimeters) per year.
- Annual ambient temperature = 48 degrees Fahrenheit (8.8 degrees Celsius).
- Height of lid (atmosphere mixing level) = 5,000 feet (1,525 meters).
- Average absolute humidity = 4 grams per cubic meter (3.85 grams per cubic meter rounded up by CAP88).

Emissions Data

For this SWEIS, all actual emissions from 1999 through 2004 (LANL 2000, 2001, 2002a, 2003a, 2004c, 2005a) were reviewed and analyzed to ensure that the projected emissions from the *1999 SWEIS* were bounding. Based on the above review and additional data from LANL, some changes were made to the projected air emissions. Specific changes can be found in the appropriate Radiological Air Emissions **Tables C–4** through **C–15**. In addition, each Key Facility's activities were reviewed for the three alternatives considered in this SWEIS (No Action, Reduced Operations, and Expanded Operations). The projected releases are based on those activities. A complete description of the alternatives can be found in Chapter 3.

Changes to CAP88 Version 3.0 included the ability of the user to choose the specific chemical form and type. The chemical form used in the assessments was based on each facility's process knowledge. For example, LANSCE produces a variety of materials generated through the process of activation; consequently, emissions occur as gaseous mixed activation products. Other activation products occur in particulate and vapor form.

Gaseous mixed activation product emissions included argon-41, carbon-11, nitrogen-13, nitrogen-16, oxygen-14, and oxygen-15. Various radionuclides such as mercury-193, mercury-197, germanium-68, and bromine-82 made up the majority of the particulate and vapor form emissions (LANL 2004c). Tritium can be released in different forms, either as tritium oxide (vapor) or as elemental tritium (gas), at each facility where it is present. Area G at TA-54, for instance, is a known source of diffuse emissions of tritium vapor (LANL 2004c). These forms are noted in Tables C–4 through C–15.

At some Key Facilities, the emissions were modeled using the most conservative radioisotope. For example, actinide emissions at the Chemistry and Metallurgy Research Building include plutonium, uranium, thorium, and americium isotopes. Of these isotopes, plutonium-239 was used for modeling purposes to conservatively represent all of the actinides released. By using plutonium-239, the estimated dose for members of the public presented in this SWEIS is higher than would be experienced if the actual actinides were used in the model calculations.

Some Key Facility projected emissions included radionuclides that are not in the dose conversion factor database of CAP88 Version 3.0. Impacts from these radionuclides would be minimal due to their extremely short half-lives and small inventory amounts. All of the radionuclides omitted from the dose assessment have half-lives of less than 2 minutes. Chlorine-39, whose portion among the LANSCE air emissions was negligible (less than 0.01 percent per year), also was omitted from the dose assessment.

Table C–4 Radiological Air Emissions (curies per year) from the Chemistry and Metallurgy Research Building (Technical Area 3-29) [a]

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack ES-14 Height (meters) = 15.9 Diameter (meters) = 1.07 Exit velocity (meters per second) = 6.8			
Actinides [b]	0.00076	0.00003	Same as No Action
Stack ES-46 [c] Height (meters) = 16.5 Diameter (meters) = 1.88 Exit velocity (meters per second) = 1.9			
Krypton-85	100	Same as No Action	Same as No Action
Xenon-131m	45	Same as No Action	Same as No Action
Xenon-133	1,500	Same as No Action	Same as No Action

[a] Projected emission rates are from the *CMRR EIS* (DOE 2003b). For the No Action and Expanded Operations Alternatives, because of the start of the Chemistry and Metallurgy Research Replacement Facility Project, there would be no emissions from the Chemistry and Metallurgy Research Building after approximately 2014. The actinide processes and resulting emissions would move to a new facility near TA-55 and the Wing 9 processes would move to the Radiological Sciences Institute. The support for hydrodynamic testing and tritium separation activities would remain at TA-55.
[b] Actinides were not broken down by isotope and were represented by plutonium-239. Actinides are emitted from almost all wings. The most conservative stack (ES-14) was chosen to model these emissions. The most conservative lung absorption rate for plutonium-239 (moderate) was chosen.
[c] Fission products are emitted from Wing 9. The most conservative stack (ES-46) was chosen for modeling.
Note: To convert meters to feet, multiply by 3.2808.

Table C–5 Radiological Air Emissions (curies per year) from the Sigma Complex (Technical Area 3-66)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
All Stacks [a] Height (meters) = 15.2 Diameter (meters) = 1.2 Exit velocity (meters per second) = 1			
Uranium-234 [b]	0.0000660	Same as No Action	Same as No Action
Uranium-238 [b, c]	0.0018	Same as No Action	Same as No Action

[a] Stacks are no longer monitored. Emissions now based on process knowledge and inventory. Depleted uranium is considered as uranium-238 and enriched uranium is considered as uranium-234.
[b] The most conservative lung absorption rate (slow) was chosen for all uranium and thorium isotopes. A moderate lung absorption rate was used for protactinium.
[c] All uranium-238 is assumed to be in equilibrium with thorium-234 and protactinium-234m.
Note: To convert meters to feet, multiply by 3.2808.

Table C–6 Radiological Air Emissions (curies per year) from the Machine Shops (Technical Area 3-102)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack ES-22 Height (meters) = 13.4 Diameter (meters) = 0.91 Exit velocity (meters per second) = 0.8			
Uranium-238 [a]	0.00015	Same as No Action	Same as No Action

[a] Uranium-238 was used to model all uranium. Protactinium-234m and thorium-234 are in equilibrium with uranium-238. The most conservative lung absorption rate (slow) was chosen for uranium and thorium. A moderate lung absorption rate was used for protactinium.
Note: To convert meters to feet, multiply by 3.2808.

Table C–7 Radiological Air Emissions (curies per year) from High Explosives Processing Facilities (Technical Area 11)

Radionuclide	*No Action*	*Reduced Operations* [a]	*Expanded Operations*
Area size (square meters) = 10,000 [b]			
Uranium-234 [c]	3.71×10^{-7}	2.97×10^{-7}	3.71×10^{-7}
Uranium-235 [d, c]	1.89×10^{-8}	1.51×10^{-8}	1.89×10^{-8}
Uranium-238 [e, c]	9.96×10^{-7}	7.97×10^{-7}	9.96×10^{-7}

[a] For Reduced Operations, a 20 percent reduction in operations was assumed to result in a 20 percent reduction in air emissions.
[b] No stack emissions. This is an area source.
[c] The most conservative lung absorption rate (slow) was chosen for all uranium and thorium. A moderate lung absorption rate was used for protactinium.
[d] Thorium-231 is in equilibrium with uranium-235.
[e] Thorium-234 and protactinium-234m are in equilibrium with uranium-238.
Note: To convert square meters to square feet, multiply by 10.764.

Table C–8 Radiological Air Emissions (curies per year) from High Explosives Testing Facilities (Technical Area 15 and Technical Area 36) [a]

Radionuclide	No Action	Reduced Operations [b]	Expanded Operations
Area size (square meters) = 100 [c]			
Uranium-234 [f]	0.0345	0.0276	0.0345
Uranium-235 [d, f]	0.0015	0.0012	0.0015
Uranium-238 [e, f]	0.114	0.0912	0.114

[a] Depleted uranium was modeled as 27 percent uranium-234, 1 percent uranium-235, and 72 percent uranium-238 per curie of release, per LANL guidance in *Dose Assessment Using CAP88*, RRES-MAQ-501, R6 (LANL 2003b).
[b] For Reduced Operations, a 20 percent reduction in operations was assumed to result in a 20 percent reduction in air emissions. The reduction of experiments with special nuclear material at the Dual Axis Radiographic Hydrodynamic Test Facility was assumed to have no effect on air emissions.
[c] No stack emissions. This is an area source.
[d] Thorium-231 is in equilibrium with uranium-235.
[e] Thorium-234 and protactinium-234m are in equilibrium with uranium-238.
[f] The most conservative lung absorption rate (slow) was chosen for all uranium and thorium. A moderate lung absorption rate was used for protactinium.
Note: To convert square meters to square feet, multiply by 10.764.

Table C–9 Radiological Air Emissions (curies per year) from the Tritium Facility (Technical Area 16)

Radionuclide	No Action	Reduced Operations	Expanded Operations
Stack FE-04 Height (meters) = 18.3 Diameter (meters) = 0.46 Exit velocity (meters per second) = 19.3			
Tritium (gas)	300	Same as No Action	Same as No Action
Tritium (water vapor)	500	Same as No Action	Same as No Action

Note: To convert meters to feet, multiply by 3.2808.

Table C–10 Radiological Air Emissions (curies per year) from the Pajarito Site (Technical Area 18)

Radionuclide	No Action	Reduced Operations [a]	Expanded Operations [a]
Area size (square meters) = 45,200 [b]			
Argon-41	102	Same as No Action	Same as No Action

[a] Under reduced and expanded operations, the Solution High-Energy Burst Assembly would be removed from TA-18 in about 2009, thereafter there would be no radiological air emissions.
[b] No stack emissions. This is an area source from operations that activate argon atoms in the air surrounding the assembly.
Note: To convert square meters to square feet, multiply by 10.764.

Table C–11 Radiological Air Emissions (curies per year) from the Radiochemistry Facility (Technical Area 48)

Radionuclide [a]	***No Action***	***Reduced Operations***	***Expanded Operations***
Fan Exhaust FE-51/54 [b] Height (meters) = 13.1 Diameter (meters) = 0.91 Exit velocity (meters per second) = 7.9			
Plutonium-239 [c]	0.0000121	Same as No Action	Same as No Action
Uranium-235 [c]	0.000000484	Same as No Action	Same as No Action
Mixed Fission Products [d]	0.000154	Same as No Action	Same as No Action
Fan Exhaust FE-63/64 [e] Height (meters) = 13.4 Diameter (meters) = 0.3 Exit velocity (meters per second) = 12.5			
Arsenic-72 [f]	0.000121	Same as No Action	Same as No Action
Arsenic-73 [f]	0.00255	Same as No Action	Same as No Action
Arsenic-74 [f]	0.00133	Same as No Action	Same as No Action
Beryllium-7 [f]	0.0000165	Same as No Action	Same as No Action
Bromine-77 [f]	0.000935	Same as No Action	Same as No Action
Germanium-68 [f, h]	0.00897	Same as No Action	Same as No Action
Rubidium-86 [g]	0.000000308	Same as No Action	Same as No Action
Selenium-75 [g]	0.000385	Same as No Action	Same as No Action
Other Activation Products [i]	0.00000558	Same as No Action	Same as No Action

[a] All radionuclides at TA-48 were increased 10 percent (over *1999 SWEIS* amounts or highest actual emission rate, whichever was higher).
[b] Actinides are emitted through several unmonitored stacks at TA-48. The most conservative stack (Fan Exhaust FE-51/54 exits through stack 54) was chosen to model emissions from these stacks.
[c] The most conservative lung absorption rates (moderate for plutonium and slow for uranium) were chosen.
[d] Mixed Fission Products were not broken down by isotopes and were represented by strontium-90 and yttrium-90 in equilibrium. The default lung absorption rate (moderate) was used.
[e] Activation products are emitted through several stacks at TA-48. The most conservative stack (Fan Exhaust FE-63/64 exits through stack 7) was chosen to model emissions from these stacks.
[f] The lung absorption rate (moderate) was used.
[g] The default lung absorption rate (fast) was used
[h] Germanium-68 was assumed to be in equilibrium with gallium-68.
[i] Other Activation Products are a mixed group of activation products represented by strontium-90 and yttrium-90 in equilibrium. The default lung absorption rate (moderate) was used.
Note: To convert meters to feet, multiply by 3.2808.

Table C–12 Radiological Air Emissions (curies per year) from the Los Alamos Neutron Science Center (LANSCE) (Technical Area 53) [a, b]

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Stack ES-2 Height (meters) = 13.1 Diameter (meters) = 0.91 Exit velocity (meters per second) = 7			
Argon-41	453	0	453
Carbon-11 (dioxide)	18,400	0	18,400
Mercury-193	30.1	0	30.1
Nitrogen-13	2,860	0	2,860
Oxygen-15	3,820	0	3,820
Stack ES-3 [c] Height (meters) = 33.5 Diameter (meters) = 0.91 Exit velocity (meters per second) = 12.5			
Argon-41	431	0	431
Carbon-11[d] (dioxide)	4,090	0	4,090
Nitrogen-13	240	0	240
Oxygen-15	60	0	60
Area size (square meters) = 1,432 [e]			
Argon-41	3.2	0	3.2
Carbon-11 (dioxide)	76.8	0	76.8

[a] The total curies emitted changed from the *1999 SWEIS* emission rates based on a revised curie per microamp-hour ratio. Under the Reduced Operations Alternative, there would be no emissions due to the shutdown of all activity at LANSCE.
[b] Carbon-10 and oxygen-14 were not modeled. They both are very short-lived nuclides (less than 2 minutes) and have no published dose conversion factor. They would have minimal health impacts.
[c] Emission projections for the Isotope Production Facility were modeled as being released from stack ES-3 in addition to evacuations from experimental areas A, B, and C and associated lines B and C tunnels. Expanded Operations include emissions for up to 100 irradiated targets for medical isotope processing.
[d] Total carbon-11 from stack ES-3 and the Isotope Production Facility.
[e] These are fugitive sources created at the accelerator target cells that have migrated into room air and into the environment.
Note: To convert meters to feet, multiply by 3.2808.

Table C–13 Radiological Air Emissions (curies per year) from Waste Management Operations (Technical Area 54)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations*
Area size (square meters) = 5,000 [a]			
Tritium (water vapor)	60.9	Same as No Action	Same as No Action
Americium-241 [b]	6.6×10^{-7}	Same as No Action	Same as No Action
Plutonium-238 [c]	4.80×10^{-6}	Same as No Action	Same as No Action
Plutonium-239 [c]	6.80×10^{-7}	Same as No Action	Same as No Action
Uranium-234 [c]	8.00×10^{-6}	Same as No Action	Same as No Action
Uranium-235 [c]	4.10×10^{-7}	Same as No Action	Same as No Action
Uranium-238 [c]	4.00×10^{-6}	Same as No Action	Same as No Action
Stack 54-412 (DVRS) Height (meters) = 10.7 Diameter (meters) = 0.69 Exit velocity (meters per second) = 16.6			
Americium-241 [b]	3.53×10^{-6}	Same as No Action	Same as No Action
Plutonium-238 [c]	1.76×10^{-5}	Same as No Action	Same as No Action
Plutonium-239 [c]	7.78×10^{-6}	Same as No Action	Same as No Action

DVRS = Decontamination and Volume Reduction System.

[a] These emissions are from an area source. They are conservatively based on a 5-year average plus two standard deviations of nearby environmental concentration measurements.

[b] The default lung absorption rate (moderate) was used.

[c] The most conservative lung absorption rates (moderate for plutonium and slow for uranium) were chosen.

Note: To convert meters to feet, multiply by 3.2808; to convert square meters to square feet, multiply by 10.764.

Table C–14 Radiological Air Emissions (curies per year) from the Plutonium Facility Complex (Technical Area 55)

Radionuclide	*No Action*	*Reduced Operations*	*Expanded Operations* [a]
Stack ES-15 Height (meters) = 9.5 Diameter (meters) = 0.93 Exit velocity (meters per second) = 6.8			
Plutonium-239 [b]	0.0000025	Same as No Action	Same as No Action
Stack ES-16 Height (meters) = 9.5 Diameter (meters) = 0.94 Exit velocity (meters per second) = 10.8			
Plutonium-239 [b]	0.000017	Same as No Action	0.000036
Tritium (gas)	250	Same as No Action	Same as No Action
Tritium (water vapor)	750	Same as No Action	Same as No Action

[a] Expanded operations include pit production (80 pits), pit surveillance (65 pits), actinide processing 1,764 pounds (800 kilograms), and pit disassembly capacity (500 pits).

[b] No isotopic breakdown of particulates was available; therefore all particulates were represented by plutonium-239. The most conservative lung absorption rate (moderate) was chosen.

Note: To convert meters to feet, multiply by 3.2808.

Table C–15 Radiological Air Emissions (curies per year) from Non-Key Facilities (Technical Area 21)

Radionuclide	*No Action* [a]	*Reduced Operations* [a]	*Expanded Operations* [a]
Stack ES-1 (TA-21 Tritium Science and Fabrication Facility) Height (meters) = 22.9 Diameter (meters) = 1.22 Exit velocity (meters per second) = 10.3			
Tritium (water vapor) [b]	50	Same as No Action	Same as No Action
Stack ES-5 (TA-21 Tritium Systems Test Assembly) Height (meters) = 29.9 Diameter (meters) = 0.79 Exit velocity (meters per second) = 7.8			
Tritium (gas)	100	Same as No Action	Same as No Action
Tritium (water vapor) [c]	400	Same as No Action	Same as No Action

TA = technical area.

[a] Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. Decontamination, decommissioning, and demolition of TA-21 under the Expanded Operations Alternative would permanently eliminate this potential source of emissions.

[b] Tritium emissions are based on LANL estimates of neutron target tube loading operations through the end of 2006 while awaiting decontamination, decommissioning, and demolition. The more conservative water vapor form of tritium was used.

[c] Tritium emissions (water vapor) were increased from the *1999 SWEIS* based on actual emission data (1999 through 2004) and expected emission rate while awaiting decontamination, decommissioning, and demolition.

Note: To convert meters to feet, multiply by 3.2808.

Stack Parameters

The height and diameter measurements of monitored stacks were taken from the 2003 LANL Radionuclide Air Emissions Report (LANL 2004c). The same exit velocities for those stacks were used as in the *1999 SWEIS*. The parameters used for unmonitored stacks were obtained from LANL staff (LANL 2006a). Stack parameters are listed in Tables C–4 through C–15.

Agricultural Data

One pathway of exposure modeled by CAP88 is emission of radionuclides to the air and their subsequent ingestion through food crops. CAP88 uses average agricultural productivity data for New Mexico based on the address of LANL when determining the agricultural data. The EPA Food Source Scenario used in CAP88 describes the fraction of vegetables, milk, and meat produced in the area. The ingestion (consumption) rates are the same for all scenarios. The "rural" scenario was used and included the following fractions.

Fraction	***Vegetable***	***Milk***	***Meat***
Produced at home	0.7	0.399	0.442
From the region (not imported)	0.3	0.601	0.558

C.1.3.4 Results of Analyses

The sequence of analyses performed to generate the radiological impact estimates from normal operations included selection of normal operational modes, estimation of source terms, estimation of environmental transport and uptake of radionuclides, calculation of radiation doses to exposed individuals, and estimation of health effects. There are uncertainties associated with each of these steps. Uncertainties exist in the way the physical systems being analyzed are represented by the computational models and in the data required to exercise the models (due to measurement, sampling, or natural variability).

The analysis was designed to ensure—through judicious selection of release scenarios, models, and parameters—that the results represent the potential risks. This was accomplished by making conservative assumptions in the calculations at each step. The models, parameters, and release scenarios used in the calculations were selected such that most intermediate results and, consequently, final estimates of impacts, were greater than would be expected. As a result, even though the range of uncertainty in a quantity might be large, the value calculated for any one modeled dose would be close to one of the extremes in the range of possible values, so the chance of the actual dose being greater than the calculated value would be low. The goal of the radiological assessment for normal operations in this SWEIS is to produce conservative results in order to capture any uncertainties in normal operations.

Maximally Exposed Individual

The facility-specific MEI represents a location near a facility that was modeled as having the greatest dose to a hypothetical public individual from all modeled emissions. This location was determined for each Key Facility and was calculated based on meteorological data for the site, as well as the type and amount of radiological air emissions from the Key Facility. For the purposes of this analysis, it was very conservatively assumed that the MEI is a person who stays in the same location 24 hours a day, 365 days a year. Furthermore, it was assumed that this person is not shielded from emissions by clothing or shelter (for example, a building, auto, home, etc.).

The doses were then calculated at each facility-specific MEI location from all other modeled facilities; thus, the facility-specific MEI represents the estimated dose to an individual near the specified facility from all modeled facilities. **Table C–16** summarizes the dose to each facility MEI from emissions from all modeled facilities. **Tables C–17** through **C–19** compare the facility-specific MEI for each of the three alternatives considered in this SWEIS. Each facility-specific MEI was totaled and the facility-specific MEI with the highest total dose was designated the LANL site-wide MEI for that alternative. Therefore any facility-specific MEI dose would be less than the LANL site-wide MEI for that alternative.

Table C–16 Summary of Facility-Specific Maximally Exposed Individual Dose (millirem per year) [a, b]

	No Action Alternative	*Reduced Operations Alternative*	*Expanded Operations Alternative*
Chemistry and Metallurgy Research Building and Sigma Complex [c]	0.46	0.13	0.46
Machine Shops	0.37	0.08	0.37
High Explosives Processing Facilities	0.38	0.11	0.38
High Explosives Testing Facilities	2.9	0.78	2.9
Tritium Facility	0.32	0.09	0.32
Pajarito Site [d]	2.9	0.78	2.9
Radiochemistry Facility and Plutonium Facility Complex [e]	0.78	0.20	0.78
Los Alamos Neutron Science Center [f]	14	0.24	14
Waste Management Operations	1.2	0.33	1.2
Non-Key Facilities (TA-21) [g]	1.9	0.29	1.9

TA = technical area.

[a] Doses are from all modeled facilities.

[b] Under the No Action Alternative and the Expanded Operations Alternative, the LANL site-wide MEI would be located near LANSCE. Under the Reduced Operations Alternative, the LANL site-wide MEI would be located near the Firing Sites at TA-36.

[c] Chemistry and Metallurgy Research Building and Sigma Complex had the same MEI location.

[d] Under the Reduced and Expanded Operations Alternatives, Pajarito Site (TA-18) would not be operational after about 2009, thereby eliminating the need for a designated facility-specific MEI dose.

[e] Radiochemistry Facility and Plutonium Facility Complex had the same MEI location.

[f] As a mitigating measure, operational controls at LANSCE would limit their portion of the MEI dose to 7.5 millirem, resulting in lower doses.

[g] Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. Decontamination, decommissioning, and demolition of TA-21 under the Expanded Operations Alternative would permanently eliminate this potential source of radiation dose.

LANL site-wide MEI dose impacts for the No Action (Table C–17) and Expanded Operations (Table C–19) Alternatives reflect the change in location of the actinide processes at the Chemistry and Metallurgy Research Building to the new Chemistry and Metallurgy Research Replacement Facility near TA-55. These impacts on the doses were determined by calculating the net dose (removal of the dose from operations at the Chemistry and Metallurgy Research Building and addition of the dose from operations at the new Chemistry and Metallurgy Research Replacement Facility). These impacts to the MEI were minimal. For the Reduced Operations Alternative (Table C–18), LANL site-wide MEI dose impacts reflect the continued operations at the existing Chemistry and Metallurgy Research Building in TA-3.

Under the No Action and Expanded Operations Alternatives, operational controls at LANSCE would limit the amount of radiological air emissions. It is assumed that there is a dose limit of 7.5 millirem to the MEI from LANSCE emissions. This dose limit, when added to the doses from operations at all other Key Facilities, would result in a LANL site-wide MEI dose of 7.8 millirem under the Expanded Operations Alternative. The regulatory limit of 10 millirem per year (Title 40 *Code of Federal Regulations* [CFR] 61.92) to a member of the public, therefore, would not be exceeded under any of the SWEIS alternatives. The highest estimated dose to the MEI from normal LANL operations, 8.2 millirem per year, would be under the Expanded Operations Alternative and includes the additional dose (0.42 millirem per year) from remediation activities (see Chapter 5, Section 5.6 and Appendix I, Section I.5.6).

Table C–17 Maximally Exposed Individual Dose for the No Action Alternative (millirem per year)

Source	*CMR/ Sigma MEI*	*Machine Shop MEI*	*TA-11 MEI*	*TA-15/ TA-36 MEI*	*TA-16 MEI*	*TA-18 MEI*	*TA-48/ TA-55 MEI*	*TA-53 MEI*	*TA-54 MEI*	*Non-Key (TA-21) MEI*
CMR Building	0.0639	0.0435	0.00540	0.0158	0.00513	0.0111	0.0549	0.0113	0.00609	0.0158
Sigma Complex	0.0262	0.0114	0.00206	0.00598	0.00135	0.00411	0.0243	0.00412	0.00225	0.00598
Machine Shops	0.00225	0.00225	0.000165	0.000450	0.000165	0.000315	0.00165	0.000315	0.000180	0.000450
High Explosives Processing Facilities	0.00000118	0.00000127	0.0000212	0.00000230	0.00000736	0.00000212	0.00000281	0.00000134	0.00000109	0.00000142
High Explosives Testing Facilities	0.0866	0.0551	0.102	0.899	0.0716	0.809	0.131	0.247	0.304	0.292
Tritium Facility	0.00522	0.00491	0.0184	0.00447	0.0243	0.00455	0.00478	0.00362	0.00375	0.00393
Pajarito Site	0.000551	0.000520	0.000683	0.00796	0.000530	0.0979	0.000898	0.00704	0.0194	0.00326
Radiochemistry Facility	0.000192	0.000161	0.0000778	0.000496	0.0000703	0.000304	0.00194	0.000289	0.000151	0.000350
LANSCE	0.269	0.240	0.241	1.88	0.209	1.97	0.516	13.3 [a]	0.81	1.57
Waste Management Operation	0.00107	0.00106	0.00107	0.00116	0.00106	0.00121	0.00107	0.00117	0.0520	0.00110
Plutonium Facility Complex	0.00715	0.00663	0.00530	0.0240	0.00496	0.0145	0.0399	0.0117	0.00856	0.0153
TA-21 Non-Key Facilities	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total	**0.46**	**0.37**	**0.38**	**2.85**	**0.32**	**2.92**	**0.78**	**13.56 [a, b]**	**1.21**	**1.93**

CMR = Chemistry and Metallurgy Research, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] As a mitigating measure, operational controls at LANSCE would limit their portion of the MEI dose to 7.5 millirem resulting in a LANL site-wide MEI dose of 7.8 millirem.

[b] After approximately 2014, actinide emissions will move from the Chemistry and Metallurgy Research Building to the Chemistry and Metallurgy Research Replacement Facility near TA-55. The resulting dose (an additional 0.0023 millirem) will have minimal impact on the LANL MEI dose.

Table C–18 Maximally Exposed Individual Dose for the Reduced Operations Alternative (millirem per year)

Source	*CMR/ Sigma MEI*	*Machine Shop MEI*	*TA-11 MEI*	*TA-15/ TA-36 MEI*	*TA-16 MEI*	*TA-18 MEI*	*TA-48/ TA-55 MEI*	*TA-53 MEI*	*TA-54 MEI*	*Non-Key (TA-21) MEI*
CMR Building	0.0135	0.00921	0.00117	0.00342	0.00111	0.00235	0.0119	0.00250	0.00134	0.00342
Sigma Complex	0.0262	0.0114	0.00206	0.00598	0.00135	0.00411	0.0243	0.00412	0.00225	0.00598
Machine Shops	0.00225	0.00225	0.000165	0.000450	0.000165	0.000315	0.00165	0.000315	0.000180	0.000450
High Explosives Processing Facilities	0.000000947	0.00000102	0.0000169	0.00000184	0.00000589	0.00000169	0.00000225	0.00000107	0.000000872	0.00000114
High Explosives Testing Facilities	0.0693	0.0441	0.0816	0.720	0.0573	0.648	0.105	0.198	0.243	0.234
Tritium Facility	0.00522	0.00491	0.0184	0.00447	0.0243	0.00455	0.00478	0.00362	0.00375	0.00393
Pajarito Site [a]	0.000551	0.000520	0.000683	0.00796	0.000530	0.0979	0.000898	0.00704	0.0194	0.00326
Radiochemistry Facility	0.000192	0.000161	0.0000778	0.000496	0.0000703	0.000304	0.00194	0.000289	0.000151	0.000350
LANSCE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Waste Management Operation	0.00107	0.00106	0.00107	0.00116	0.00107	0.00121	0.00107	0.00117	0.0520	0.00110
Plutonium Facility Complex	0.00715	0.00663	0.00530	0.0240	0.00496	0.0145	0.0399	0.0117	0.00856	0.0153
TA-21 Non-Key [b] Facilities	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total (millirem per year)	**0.13**	**0.08**	**0.11**	**0.78**	**0.09**	**0.78**	**0.20**	**0.24**	**0.33**	**0.29**

CMR = Chemistry and Metallurgy Research, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] Pajarito Site (TA-18) would not be operational after 2009 under this alternative and would therefore not produce emissions. These values are potentially applicable for the first few years.

[b] Emissions from TA-21 stacks were stopped in September 2006 as part of TA-21 shutdown activities. However, some emissions are assumed until decontamination, decommissioning, and demolition are complete.

Table C–19 Maximally Exposed Individual Dose for the Expanded Operations Alternative (millirem per year)

Source	*CMR/ Sigma MEI*	*Machine Shop MEI*	*TA-11 MEI*	*TA-15/ TA-36 MEI*	*TA-16 MEI*	*TA-18 MEI*	*TA-48/ TA-55 MEI*	*TA-53 MEI*	*TA-54 MEI*	*Non-Key (TA-21) MEI*
CMR Building	0.0639	0.0435	0.00540	0.0158	0.00513	0.0111	0.0549	0.0113	0.00609	0.0158
Sigma Complex	0.0262	0.0114	0.00206	0.00598	0.00135	0.00411	0.0243	0.00412	0.00225	0.00598
Machine Shops	0.00225	0.00225	0.000165	0.000450	0.000165	0.000315	0.00165	0.000315	0.000180	0.000450
High Explosives Processing Facilities	0.00000118	0.00000127	0.0000212	0.00000230	0.00000736	0.00000212	0.00000281	0.00000134	0.00000109	0.00000142
High Explosives Testing Facilities	0.0866	0.0551	0.102	0.899	0.0716	0.809	0.131	0.247	0.304	0.292
Tritium Facility	0.00522	0.00491	0.0184	0.00447	0.0243	0.00455	0.00478	0.00362	0.00375	0.00393
Pajarito Site [a]	0.000551	0.000520	0.000683	0.00796	0.000530	0.0979	0.000898	0.00704	0.0194	0.00326
Radiochemistry Facility	0.000192	0.000161	0.0000778	0.000496	0.0000703	0.000304	0.00194	0.000289	0.000151	0.000350
LANSCE	0.269	0.240	0.241	1.88	0.209	1.97	0.516	13.3 [b]	0.81	1.57
Waste Management Operation	0.00107	0.00106	0.00107	0.00116	0.00106	0.00121	0.00107	0.00117	0.0520	0.00110
Plutonium Facility Complex	0.00729	0.00675	0.00538	0.0248	0.00503	0.0149	0.0412	0.0120	0.00874	0.0157
TA-21 Non-Key Facilities [a]	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total (millirem per year)	**0.46**	**0.37**	**0.38**	**2.85**	**0.32**	**2.92**	**0.78**	**13.56** [b, c]	**1.21**	**1.93**

CMR = Chemistry and Metallurgy Research, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] TA-18 and TA-21 are expected to be decontaminated, decommissioned, and demolished under this alternative and would not produce emissions after that time. These values are applicable for the first few years.

[b] As a mitigating measure, operational controls at LANSCE would limit their portion of the MEI dose to 7.5 millirem resulting in a LANL site-wide MEI dose of 7.8 millirem.

[c] After approximately 2014, actinide emissions will move from the Chemistry and Metallurgy Research Building to the Chemistry and Metallurgy Research Replacement Facility near TA-55. The resulting dose (an additional 0.0023 millirem) will have minimal impact on the LANL MEI dose.

Collective Population Dose

The collective dose to the population living within a 50-mile (80-kilometer) radius from normal operations at LANL was calculated based on emissions from all modeled facilities. The population doses from emissions at each Key Facility were compared and then totaled in **Table C–20**. The majority of the population dose comes from emissions at the High Explosives Testing Facilities and LANSCE under both the No Action and Expanded Operations Alternatives. Under the Reduced Operations Alternative, LANSCE would not be operating; therefore, it would produce no emissions contributing to a population dose.

Table C–20 Collective Population Dose Summary (person-rem per year)

Source	*No Action Alternative Estimated Dose*	*Reduced Operations Alternative Estimated Dose*	*Expanded Operations Alternative Estimated Dose*
Chemistry and Metallurgy Research Building [a]	0.43	0.11	0.43
Sigma Complex	0.16	0.16	0.16
Machine Shops	0.01	0.01	0.01
High Explosives Processing Facilities	0.00005	0.00004	0.00005
High Explosives Testing Facilities	6.4	5.2	6.4
Tritium Facility	0.09	0.09	0.09
Pajarito Site	0.23	0.23 [b]	0.23 [b]
Radiochemistry Facility	0.01	0.01	0.01
Los Alamos Neutron Science Center	22	0.00	22
Waste Management Operations	0.04	0.04	0.04
Plutonium Facilities Complex	0.19	0.19	0.20
Non-Key Facilities (TA-21)	0.09	0.09	0.09 [b]
Total Dose (person-rem per year)	**30**	**6.1**	**36.2** [c]

TA = technical area.

[a] For the No Action and Expanded Operations Alternatives, because of the start of the Chemistry and Metallurgy Research Replacement project there would be no emissions from the Chemistry and Metallurgy Research Building after approximately 2014. The actinide processes and resulting emissions would move to a new facility near TA-55 and the Wing 9 processes would move to the Radiological Sciences Institute. There would be no change in the population dose impact from this move.

[b] TA-18 and TA-21 would be decontaminated, decommissioned, and demolished under these alternatives and would not produce emissions after that time. These values are applicable for the first few years.

[c] The population dose includes 6.2 person-rem that is the maximum annual contribution that may occur from material disposal area remediation (see Appendix I).

Minority and Low-Income Population Dose

Radiological impacts of normal operations on minority, Hispanic, American Indian[3], and low-income populations are determined by applying a methodology similar to that used to determine dose to the total population. This approach is discussed in detail in Section C.1.3. It should be noted that the exposure scenario used to model the minority, Hispanic, American Indian, and low-income populations assumes that these individuals would be exposed in the same manner as

[3] *The term American Indian is used in this environmental justice analysis to reflect definitions used in the 2000 Census. The term Native American is used elsewhere in this SWEIS.*

the general population, that is, by external exposure to a radioactive plume and deposited radioactive materials and by internal exposure from inhalation and from ingestion of foodstuffs.

For purposes of evaluating potential for disproportionately high and adverse impacts caused by radiological emissions from normal operations, an annual collective dose was calculated for each of the subsets of the population being evaluated (minority, Hispanic, American Indian, and low-income) within 50 miles (80 kilometers) of the emission source. **Table C–21** shows the population estimates used for this environmental justice analysis. The average dose to an individual of the minority or low-income population is then calculated to compare to the average dose to an individual from the remainder of the population. The average dose to an individual of the population subset being evaluated is derived by dividing the annual collective dose for the subset by the number of people in the subset.

Table C–21 Potentially Affected Populations

Source Location	*Total Population*	*Total Minority Population*	*Hispanic Population*	*American Indian Population*	*Low-Income Population*
TA-53	283,766	155,261	127,641	17,811	35,826
TA-36	375,495	185,474	151,110	21,263	39,206

The result is then compared to the average dose to an individual who is not a member of the subset being evaluated. The average dose to a member of the remaining population is derived by dividing the annual collective dose to the remainder of the population (collective dose to the total population minus the collective dose to the subset population) by the number of people within 50 miles (80 kilometers) that are not in the population subset. The total minority population includes all Hispanic persons regardless of race. In addition, the American Indian population may include persons who indicated that they were of Hispanic ethnicity in the 2000 Census.

As shown in Table C–20, the total population within 50 miles (80 kilometers) of LANL is projected to receive an annual dose of about 30 person-rem under the No Action Alternative, and 36 person-rem under the Expanded Operations Alternative. Because the majority of these doses (22 person-rem) result from operations at LANSCE, the environmental justice analysis for these alternatives uses the 50-mile (80-kilometer) population centered on LANSCE in TA-53. For the Reduced Operations Alternative, the majority of the collective dose of 6.4 person-rem results from operations at the High-Explosive Testing firing sites at TA-36, therefore, the environmental justice analysis for this alternative uses the 50-mile (80-kilometer) population centered on TA-36.

Table C–22 shows the collective and annual average individual doses used to examine the potential for disproportionately high and adverse impacts on minority, Hispanic, American Indian, and low-income populations. The collective population dose is highest for those populations with the highest number of individuals. Under all alternatives, the largest population is associated with the white, non-Hispanic, and non-low-income populations. The differences, if any, would be most evident on the basis of average individual doses to members of the different population groups. As shown in Table C–22, there are no appreciable differences between the average dose to any minority, Hispanic, American Indian, or low-income individual and the comparable non-minority or non-low-income individual under any of the alternatives. Therefore, these alternatives would not pose disproportionately high and adverse impacts on minority and low-income populations or individuals surrounding each facility site.

Table C–22 Comparison of Total Minority, Hispanic, American Indian and Low-income Population and Average Individual Annual Doses

	No Action [a] *Alternative*	*Reduced* [a] *Operations Alternative*	*Expanded* [a] *Operations Alternative*
Collective Population Dose (person-rem) [b]	29.2	4.9	29.2
Average Individual Dose (millirem)	0.10	0.013	0.10
White (non-Hispanic) Population Dose (person-rem)	15.0	2.7	15.0
Non-Minority Average Individual Dose (millirem)	0.11	0.014	0.11
Minority Population Dose (person-rem)	14.1	2.2	14.1
Minority Average Individual Dose (millirem)	0.088	0.012	0.088
Hispanic Population Dose (person-rem) [c]	11.3	1.9	11.3
Hispanic Average Individual Dose (millirem)	0.086	0.012	0.086
American Indian Population Dose (person-rem) [d]	1.8	0.20	1.8
American Indian Average Individual Dose (millirem)	0.092	0.0094	0.092
Non-low-income Population Dose (person-rem)	25.9	4.4	25.9
Non-low-income Average Individual Dose (millirem)	0.10	0.013	0.10
Low-Income Population Dose (person-rem)	3.0	0.44	3.0
Low-Income Average Individual Dose (millirem)	0.082	0.011	0.082

[a] The collective population dose displayed in this table, accounts for the estimated dose from LANSCE at TA-53 and the High Explosive Testing firing sites at TA-36 for the No Action and Expanded Operations Alternatives, and the firing sites at TA-36 for the Reduced Operations Alternative.

[b] The collective population doses for this environmental justice analysis differ by plus or minus 3 to 6 percent from those in Table C–20. This difference is due to different models used to estimate the populations; both estimates are based on data drawn from the 2000 decennial census. The SECPOP computer program used for the analysis for Table C–20 does not allow for the identification of minority and low-income populations. Therefore an alternate method that uses a more refined distribution of the population is used for this analysis. The minor differences do not affect the conclusions supported by the analyses.

[c] The total Hispanic population includes all Hispanic persons regardless of race.

[d] The American Indian population may include persons who indicated that they were of Hispanic ethnicity in the 2000 census.

Under all alternatives, the annual population and average individual dose would be highest for the white (non-Hispanic) population. Similarly the projected annual population and average individual dose for persons living above the poverty level (non-low-income populations) would be higher than for those living below the poverty threshold. These data indicate that under all alternatives there would not be disproportionately high and adverse impacts on minority, Hispanic, American Indian, and low-income populations surrounding LANL.

C.1.4 Impacts to Offsite Resident, Recreational User, and Special Pathways Receptors from Radionuclides and Chemical Contaminants in the Environment

C.1.4.1 Methodology

Earlier investigation of exposure pathways in the vicinity of LANL (DOE 1999a) concluded that ingestion of foodstuffs and water and incidental ingestion of soil and sediment were of primary interest. Several other contact exposure pathways (including dermal absorption of contaminants from clays used in pottery, bathing or ceremonial use of springs, and smoking of native vegetation) were examined at that time and were not found to be significant contributors to risk. Recent environmental surveillance results and other reports on conditions following the 2000 Cerro Grande Fire indicated that diet, land use, and cultural practices remain largely unchanged from conditions noted in the *1999 SWEIS* analysis, and that, apart from inhalation, ingestion continues to be the only significant pathway by which people in the region adjacent to LANL might be exposed to radioactive and other contaminants resulting from operations at the site. Risks from radionuclides and chemicals in the environment, therefore, were evaluated for three receptors and ingestion exposure scenarios, collectively referred to as “specific receptors.” The specific receptors and the rationale for the selection of ingestion exposure parameters for this analysis are as follows:

- **Offsite Resident.** This receptor represents the resident of Los Alamos County whose living habits and diet tend to produce higher than average exposures to radioactive materials and chemicals in the local environment. The resident also was assumed to use water from the Los Alamos County water supply and to have a garden at their home that produced the fruit and vegetables that they consumed. The resident also was assumed to consume local game animals, game fish, honey, and pinyon nuts, as well as beef and milk produced on local farms and ranches. Accordingly, the pathways considered for this resident include ingestion of groundwater and the above-listed foods, plus inadvertent ingestion of soils and sediments on produce, such as leafy greens and root vegetables. The assumption that the offsite resident consumes all components of the diet and that all the foodstuffs are produced locally (that is no dilution by store-bought or processed foods from outside the area) tends to raise the intake of contaminants well above that of the average person living near LANL. In fact, at the 95th percentile consumer (high-intake) rates published by EPA for each foodstuff, a diet consisting of locally-raised beef, milk, fruits, and vegetables, plus local big game animals and fish, fairly approximates a “subsistence” diet (over 4 pounds [1.83 kilograms] of fruits and vegetables, 1.2 pounds [0.55 kilograms] of meat and fish, and 1.7 pints [0.8 liters] of milk per day), particularly when combined with the additional foods described under “specials pathways”. The 95th percentile consumer eats these foodstuffs at a rate greater than 95 percent of the population.

- **Recreational User of Wildlands.** The recreational user represents a hypothetical outdoor enthusiast who regularly uses the canyons on and near LANL for recreation (as a hiker, rockhound, photographer, etc.). This receptor was assumed to make an average of two visits per month to the canyons, spending 8 hours per visit. This receptor was assumed to be exposed to environmental contaminants by consumption of surface water and the incidental ingestion of soils and sediments at concentrations typical of the LANL canyons. Ingestion of sediments and soils occurs from consuming surface water and from swallowing inhaled dust. It is reasonable to assume that the recreational user is a local resident and that, in the extreme case, exposures received in the course of outdoor recreation might be *additional to* those depicted by the offsite resident.

- **Special Pathways – Subsistence Consumption of Fish and Wildlife**. Section 4–4 of Executive Order 12898 directs that "Federal agencies whenever practicable and appropriate, shall collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence" and that "Federal agencies shall communicate to the public the risks of those consumption patterns." Therefore, special exposure and diet pathways were evaluated to assess the potential impacts to Native American, Hispanic, and other residents whose traditional living habits and diets could cause larger exposures to environmental contaminants than those experienced by the hypothetical offsite resident. The foodstuffs and pathways of specific interest for this group are ingestion of game animals, including consumption of some organ meats not assumed for the "resident" receptor, ingestion of game fish and other fish taken from local waters, and ingestion of native vegetation through use of Indian Tea (Cota). In general, these intakes can be assumed to be *in addition to* the meat, milk, produce, water, and soil and sediment consumption reflected in the offsite resident plus recreational user pathway assumptions.

The types and amounts of foods represented in the offsite resident diet package suggested that consumption of all items at the *high* intake rates, plus the three additional special pathways components (non-game fish, herbal teas, organ meats), approximates a subsistence diet for someone living in the vicinity of LANL. To confirm that proposition, a trial was done in which the combined intakes (offsite resident plus recreational user plus special pathways) were adjusted to create a model diet consisting entirely of items that would likely be staple foods for a person living a subsistence life near Los Alamos. Milk, beef, and game fish were removed from the offsite resident diet package and groundwater was replaced by surface (stream) water as the sole source of drinking water. The intakes of the remaining foods – deer, elk, non-game fish; produce (beans, corn, squash, and greens); fruit (plums, apricots, and apples); honey and pinyon nuts – were then scaled up to deliver a total of 2,700 calories per day. The radiation dose from consumption of this subsistence diet was determined to be 9.1 millirem per year, consistent with the special pathways consumer at the high intake rates.

Concentrations of radionuclides and chemicals in environmental media reported in LANL Environmental Surveillance Reports for 2001 through 2004 (LANL 2002b, 2004b, 2004d, 2005b) were used in the dose and risk analysis except where noted in the table (see Tables C–24 through C–40). Chemical and radionuclide concentrations in the *2005 LANL Environmental Surveillance Report* (LANL 2006b) were reviewed and found to be enveloped by the 2001 through 2004 measurements. For each environmental medium, the mean and 95 percent upper confidence limit[4] of the reported values were calculated. Data from locations near the LANL boundary, identified in the reports as "perimeter" locations, were used to calculate dose and risk to the offsite resident receptor. For the special pathways receptor, data from bottom-feeder fish

[4] *Calculated using the methodology described in Appendix F.*

taken at locations downstream from LANL were used to represent the maximum impact of LANL emissions and runoff. Data from the limited number of published LANL analysis results for elk heart and liver and Indian Tea (Cota) were used to complete the intake for the special pathways receptor. For the recreational user receptor, soil, sediment and surface water analysis results for onsite locations accessible to the public were used.

Because of the small number of samples reported for some media (all items are not necessarily sampled every year) calendar year 1999 and 2000 results for foodstuffs were also considered, thereby increasing the number of data points used to develop the 95 percent upper confidence limit values and reducing uncertainty. Uncertainties associated with measured contaminant concentrations in environmental media may be quite large, and the 95 percent upper confidence limit values were used when calculating dose to hypothetical individuals to help ensure that the dose and risk estimates were conservative. For radionuclides, additional conservatism was introduced by calculating the 95 percent upper confidence limit values using only those reported values that were greater than zero. This was performed for several reasons. First, the same method was used to develop the 95 percent upper confidence limit values for calculating ingestion doses in the *1999 SWEIS.* By using the same approach, the results of the current analysis can be compared directly with the 1999 results for each pathway component. Second, concentrations of the radionuclides of interest in environmental media are typically quite low (near the threshold of detection) and, when corrected for counting background radiation, negative concentrations of some radionuclides were reported. Setting the negative values to zero or to the limit of detection for a particular radionuclide is complicated by the fact that analytical methods, detection limits, and data reporting formats may vary from year to year. Finally, the ingestion pathway doses are quite small even when they are biased upwards by eliminating the zero and negative sample results. When calculating 95 percent upper confidence limit values for nonradioactive contaminants, a similar conservatism was introduced by using a value *equal to the lower limit of detection* for all samples reported as below the detection limit.

Based on a review of LANL environmental surveillance data and the results of ingestion pathway exposure calculations published in the *1999 SWEIS*, it was determined that consumption of water, soil, sediment, fish, and produce would account for essentially all ingestion exposure to nonradioactive contaminants. Accordingly, only those five pathway components were analyzed for contribution to nonradiological risk. **Table C–23** summarizes the ingestion exposure pathway components that were evaluated for each receptor.

The consumption rate of each component of the ingestion pathway was assumed to equal the average adult daily intake. The average adult daily intake of each foodstuff is defined as the 50^{th} percentile. The "high" daily consumer is defined as the 95^{th} percentile consumer. In other words, 95 percent of the population eats at a rate less than the high daily consumption rate. These rates and doses are typically 2-3 times higher than for the average case. The intake rates, their sources, and the doses for both intake rates are reported in the notes following the dose calculation tables for the various components of the ingestion pathway. For chemicals, the health hazard index and cancer risk were calculated using the most current Reference Doses and Slope Factors published by EPA Region 6 (EPA 2005b).

Table C–23 Ingestion Exposure Pathway Components Evaluated for Offsite Resident, Recreational User, and Special Pathways Receptors

Exposure Pathway Component	*Offsite Resident* [a]	*Recreational User* [b]	*Special Pathways* [c]
Produce	✓	✓	✓
Meat (free-range beef)	✓	✓	✓
Milk	✓	✓	✓
Fish (game)	✓	✓	✓
Elk	✓	✓	✓
Deer	✓	✓	✓
Honey	✓	✓	✓
Pinyon nuts	✓	✓	✓
Groundwater	✓	✓	✓
Soil	✓	✓	✓
Sediment	✓	✓	✓
Surface water		✓	✓
Soil [d]		✓	✓
Sediment [d]		✓	✓
Fish (non-game)			✓
Elk (heart, liver)			✓
Indian Tea (Cota)			✓

[a] A hypothetical person who is conservatively assumed to intake various foodstuffs, water, soil and sediments with concentrations of contaminants at the 95 percent upper confidence limit for each contaminant.
[b] Assumed to visit the canyons on and near LANL 24 times per year, 8 hours per visit.
[c] Assumed to have traditional Native American or Hispanic lifestyles and diet.
[d] Soil and sediments from onsite locations.

C.1.4.2 Estimates of Ingestion Pathway Radiation Dose and Risk

The results of the radiation dose calculations for each of the receptors and components of the ingestion pathway are summarized in **Tables C–24** through **C–40**. Except where noted, all intake rates are in grams dry weight per year. The total doses from all pathway components are presented in **Table C–41**.

Table C–24 Dose from the Consumption of Produce

Exposure Pathway: Produce Ingestion				
Intake (grams per year)	*Nuclide*	*Concentration (picocuries per gram)*	*Dose Conversion Factor (rem per picocurie)*	*Dose (rem per year)*
32,200	Americium-241	0.000858	4.50×10^{-6}	0.000124
32,200	Cesium-137	0.0175	5.00×10^{-8}	0.0000282
32,200	Plutonium-238	0.00128	3.80×10^{-6}	0.000156
32,200	Plutonium-239, Plutonium-240	0.000430	4.30×10^{-6}	0.0000595
32,200	Strontium-90	0.129	1.30×10^{-7}	0.000541
32,200	Tritium	1.04	6.30×10^{-11}	2.11×10^{-6}
32,200	Uranium	0.0167	2.60×10^{-7}	0.000140
Total		–	–	**0.00105**

Notes: Average annual intakes are (4.5 grams per kilogram-day for vegetables + 3.7 grams per kilogram-day for fruits) × (a dry to wet weight ratio of 0.15) × 71.8-kilogram adult × (365 days per year) = 32,200 grams dry weight per year (EPA 2003). The *1999 SWEIS* reported 0.00162 rem per year (average intake) from combined fruit and vegetable consumption. High intake is 25.5 grams wet weight per kilogram-day. Thus, dose at high intake is (25.5/8.2) × 0.00105 or 0.00327 rem per year. To convert grams to ounces, multiply by 0.035274. To convert grams to ounces, multiply by 0.035274.

Table C–25 Dose from the Consumption of Free Range Beef

Exposure Pathway: Meat Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
14,900	Americium-241	0.000301	4.50×10^{-6}	0.0000202
14,900	Cesium-137	0.0560	5.00×10^{-8}	0.0000417
14,900	Plutonium-238	0.000230	3.80×10^{-6}	0.0000130
14,900	Plutonium-239, Plutonium-240	0.000218	4.30×10^{-6}	0.0000140
14,900	Strontium-90	0.0843	1.30×10^{-7}	0.000163
14,900	Tritium	0.00	6.30×10^{-11}	0.00
14,900	Uranium	0.00105	2.60×10^{-7}	4.07×10^{-6}
Total		–	–	**0.000256**

Notes: Average annual intake is 2.1 grams per kilogram-day × 0.27 dry to wet ratio × 71.8 kilogram adult × 365 days per year = 14,900 grams dry weight per year (EPA 1997). Concentration values are from the 1999 LANL Environmental Surveillance Report, Table 6-14 (mean plus 2 sigma). The *1999 SWEIS* reported 0.00027 rem per year from this source and pathway. High intake is 5.1 grams per kilogram-day. Thus, dose at high intake is (5.1/2.1) × 0.000256 or 0.000622 rem per year. To convert grams to ounces, multiply by 0.035274.

Table C–26 Dose from the Consumption of Milk

Exposure Pathway: Milk Ingestion				
Intake (liters per year)	***Nuclide***	***Concentrations (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
110	Americium-241	0.0785	4.50×10^{-6}	0.0000388
110	Cesium-137	25.8	5.00×10^{-8}	0.000142
110	Plutonium-238	0.00710	3.80×10^{-6}	2.97×10^{-6}
110	Plutonium-239, Plutonium-240	0.0856	4.30×10^{-6}	0.0000405
110	Strontium-90	3.76	1.30×10^{-7}	0.0000538
110	Tritium	450	6.30×10^{-11}	3.12×10^{-6}
110	Uranium	0.120	2.60×10^{-7}	3.43×10^{-6}
Total		–	–	**0.000284**

Notes: Average annual intake is 0.3 liters per day × 365 days per year 110 liters per year. Uranium total is 0.065 (U-234) + 0.013 (U-235) + 0.042 (U-238) = 0.120 picocuries per liter. The *1999 SWEIS* reported 0.0000733 rem per year (0.000195 for high intake) from this source and pathway. High intake is 0.8 liters per day. Thus, dose at high intake is (0.8/0.3) × 0.000284 or 0.000757 rem per year (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–27 Dose from the Consumption of Fish

Exposure Pathway: Fish Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1,880	Americium-241	0.000764	4.50×10^{-6}	6.46×10^{-6}
1,880	Cesium-137	0.0226	5.00×10^{-8}	2.13×10^{-6}
1,880	Plutonium-238	0.000517	3.80×10^{-6}	3.69×10^{-6}
1,880	Plutonium-239, Plutonium-240	0.000315	4.30×10^{-6}	2.55×10^{-6}
1,880	Strontium-90	0.0462	1.30×10^{-7}	0.0000113
1,880	Tritium	0.669	6.30×10^{-11}	7.92×10^{-8}
1,880	Uranium	0.00678	2.60×10^{-7}	3.31×10^{-6}
Total		–	–	**0.0000295**

Notes: Average annual intake is 20.1 grams per day (5.15 grams per day dry weight × 365 days = 1,880 grams per year dry weight). High intake is 53 grams per day (13.6 grams per day dry weight). Thus, dose at high intake is (53/20.1) × 0.0000295 or 0.0000778 rem per year (EPA 1997). The *1999 SWEIS* reported 0.0000542 rem per year (average intake) from this source and pathway (DOE 1999a). Uranium concentration of 9.55 nanograms per gram dry weight (0.00955 micrograms per gram dry weight) equates to 0.00678 picocuries per gram. Applying the reported 0.23 picocuries per milliliter tritium concentration value to the water fraction (1-0.256) yields: 0.744/0.256 or 2.91 grams water per gram dry weight × 0.23 picocuries per milliliter × 1 milliliter per gram water = 0.669 picocuries tritium per gram dry weight. To convert grams to ounces, multiply by 0.035274.

Table C–28 Dose from the Consumption of Elk

Exposure Pathway: Elk Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
2,420	Americium-241	0.000221	4.50×10^{-6}	2.40×10^{-6}
2,420	Cesium-137	0.0208	5.00×10^{-8}	2.52×10^{-6}
2,420	Plutonium-238	0.0000518	3.80×10^{-6}	4.76×10^{-7}
2,420	Plutonium-239, Plutonium-240	0.000210	4.30×10^{-6}	2.18×10^{-6}
2,420	Strontium-90	0.0315	1.30×10^{-7}	9.92×10^{-6}
2,420	Tritium	1.00	6.30×10^{-11}	1.52×10^{-7}
2,420	Uranium	0.00570	2.60×10^{-7}	3.59×10^{-6}
Total		–	–	**0.0000212**

Notes: Average annual intake is 26 grams per day × 0.255 dry to wet ratio × 365 days per year = 2,420 grams per year. Uranium concentration of 8.04 nanograms per gram dry weight (0.00804 micrograms per gram) equates to 0.00570 picocuries per gram. The *1999 SWEIS* reported 0.0000773 rem per year (average intake) from this source and pathway. High intake is 63 grams per day . Thus, dose at high intake is 63/26 × 0.0000212 or 0.0000514 rem per year (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–29 Dose from the Consumption of Deer

Exposure Pathway: Deer Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
2,370	Americium-241	0.000150	4.50×10^{-6}	1.60×10^{-6}
2,370	Cesium-137	0.0351	5.00×10^{-8}	4.16×10^{-6}
2,370	Plutonium-238	0.000132	3.80×10^{-6}	1.19×10^{-6}
2,370	Plutonium-239, Plutonium-240	0.000297	4.30×10^{-6}	3.03×10^{-6}
2,370	Strontium-90	0.0386	1.30×10^{-7}	0.0000119
2,370	Tritium	4.86	6.30×10^{-11}	7.26×10^{-7}
2,370	Uranium	0.00162	2.60×10^{-7}	9.98×10^{-7}
Total		–	–	**0.0000236**

Notes: Average annual intake is 26 grams per day × 0.25 dry to wet ratio × 365 days per year = 2,370 grams per year (dry weight). High intake is 63 grams per day. Thus, dose at high intake is 63/26 × 0.0000236 or 0.0000572 rem per year. Uranium concentration of 2.28 nanograms per gram dry weight (0.00228 micrograms per gram) equates to 0.00162 picocuries per gram. Tritium concentration on a dry weight basis equals picocuries per milliliter of water × milliliters of water per gram dry weight. If the dry to wet ratio is 0.25, 0.75 grams water (0.75 milliliter) is present for each 0.25 grams dry weight. Tritium concentration is 1.62 picocuries per milliliter × 0.75 milliliters/0.25 grams or 4.86 picocuries per gram dry weight. The *1999 SWEIS* reported 0.0000181 rem per year (average intake) from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–30 Dose from the Consumption of Honey

Exposure Pathway: Honey Ingestion				
Intake (milliliters per year)	***Nuclide***	***Concentration (picocuries per milliliter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
989	Americium-241	0.000599	4.50×10^{-6}	2.67×10^{-6}
989	Cesium-137	0.0177	5.00×10^{-8}	8.73×10^{-7}
989	Plutonium-238	0.0000294	3.80×10^{-6}	1.10×10^{-7}
989	Plutonium-239, Plutonium-240	0.0000728	4.30×10^{-6}	3.10×10^{-7}
989	Strontium-90	0.00406	1.30×10^{-7}	5.22×10^{-7}
989	Tritium	2.07	6.30×10^{-11}	1.29×10^{-7}
989	Uranium	0.00712	2.60×10^{-7}	1.83×10^{-6}
Total		–	–	$\mathbf{6.44 \times 10^{-6}}$

Notes: Average intake is 3.84 grams per day. At a specific gravity of 1.4171 (18 percent water, 20 degrees centigrade) this equates to 2.71 milliliters per day or 989 milliliters per year. High intake is 13.7 grams per day or 3,528 milliliters per year. Thus, dose at high intake is 13.7/3.84 × 6.44×10^{-6} or 0.0000230 rem per year. Uranium value is 0.00356 (uranium-234) plus 0.000394 (uranium-235) plus 0.00317 (uranium-238) = 0.00712 picocuries per milliliter. The *1999 SWEIS* reported 7.37×10^{-7} rem per year from this source and pathway (average intake), but addressed only tritium and did not include the contributions from the other nuclides reported here (DOE 1999a).

Table C–31 Dose from the Consumption of Pinyon Nuts

Exposure Pathway: Pinyon Nut Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1,410	Beryllium-7	0.140	1.10×10^{-10}	2.17×10^{-8}
1,410	Americium-241	0.00	4.50×10^{-6}	0.00
1,410	Cesium-137	0.0200	5.00×10^{-8}	1.41×10^{-6}
1,410	Plutonium-238	0.0170	3.80×10^{-6}	0.0000911
1,410	Plutonium-239, Plutonium-240	0.0130	4.30×10^{-6}	0.0000788
1,410	Strontium-90	0.230	1.30×10^{-7}	0.0000422
1,410	Tritium	0.364	6.30×10^{-11}	3.23×10^{-8}
1,410	Uranium	0.0568	2.60×10^{-7}	0.0000208
Total		–	–	**0.000234**

Notes: Calculated using concentrations from *1999 SWEIS* Table D.3.3-50 corrected for dry to wet ratio of 0.94 versus 0.06 (NutritionData 2006). Average intake of 1,500 grams per year corresponds to 1,410 grams per year dry weight. Tritium concentration is (0.06/0.94) × (1 milliliter per gram water) × (5.7 picocuries per milliliter) = 0.364 picocuries per gram. The *1999 SWEIS* reported 0.0000155 rem per year for from this source and pathway (DOE 1999a). No high intake was found. Thus, dose at high intake equals dose at average intake. To convert grams to ounces, multiply by 0.035274.

Table C–32 Dose from the Consumption of Groundwater

Exposure Pathway: Groundwater Ingestion				
Intake (liters per year)	***Nuclide***	***Concentration (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
551	Americium-241	0.0551	4.50×10^{-6}	0.000137
551	Cesium-137	6.49	5.00×10^{-8}	0.000179
551	Plutonium-238	0.0127	3.80×10^{-6}	0.0000267
551	Plutonium-239, Plutonium-240	0.0244	4.30×10^{-6}	0.0000577
551	Strontium-90	0.101	1.30×10^{-7}	7.26×10^{-6}
551	Tritium	311	6.30×10^{-11}	1.08×10^{-5}
551	Uranium	0.866	2.60×10^{-7}	0.000124
Total		–	–	**0.000542**

Notes: Average intake is 1.51 liters per day (551 liters per year). High intake is 2.44 liters per day. Thus, dose at high intake is (2.44/1.51) × 0.000542 or 0.000876 rem per year. Calculated using groundwater composite data (95 percent upper confidence limit) for 2001-2004 for "Water Supply Wells" (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.00234 rem per year for the offsite Los Alamos County resident from this source and pathway (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–33 Dose from the Consumption of Soil

Exposure Pathway: Soil Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
36.5	Americium-241	0.0126	4.50×10^{-6}	2.07×10^{-6}
36.5	Cesium-137	0.346	5.00×10^{-8}	6.31×10^{-7}
36.5	Plutonium-238	0.00358	3.80×10^{-6}	4.96×10^{-7}
36.5	Plutonium-239, Plutonium-240	0.0671	4.30×10^{-6}	0.0000105
36.5	Strontium-90	0.177	1.30×10^{-7}	8.39×10^{-7}
36.5	Tritium	1.04	6.30×10^{-11}	2.39×10^{-9}
36.5	Uranium	2.39	2.60×10^{-7}	0.0000227
Total		–	–	**0.0000372**

Notes: Average intake is 36.5 grams per year. High intake is 146 grams per year. Thus, dose at high intake is (146/36.5) × 0.0000372 or 0.000149 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for perimeter stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.000313 rem per year for the offsite resident from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–34 Dose from the Consumption of Sediment

Exposure Pathway: Sediment Ingestion				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
36.5	Americium-241	0.365	4.50×10^{-6}	0.0000600
36.5	Cesium-137	0.327	5.00×10^{-8}	5.97×10^{-7}
36.5	Plutonium-238	0.220	3.80×10^{-6}	3.05×10^{-5}
36.5	Plutonium-239, Plutonium-240	0.947	4.30×10^{-6}	0.000149
36.5	Strontium-90	0.244	1.30×10^{-7}	1.16×10^{-6}
36.5	Tritium	127	6.30×10^{-11}	2.92×10^{-7}
36.5	Uranium	1.77	2.60×10^{-7}	0.0000168
Total		–	–	**0.000258**

Notes: Average intake is 36.5 grams per year. High intake is 146 grams per year. Thus, dose at high intake is (146/36.5) × 0.000258 or 0.00103 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for perimeter stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.00262 rem per year for the offsite resident from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–35 Dose to the Recreational User Receptor from the Consumption of Surface Water

Exposure Pathway: Surface Water Ingestion (Recreational User)				
Intake (liters per year)	***Nuclide***	***Concentration (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
5.34	Americium-241	17.7	4.50×10^{-6}	0.000426
5.34	Cesium-137	13.9	5.00×10^{-8}	3.72×10^{-6}
5.34	Plutonium-238	20.4	3.80×10^{-6}	0.000415
5.34	Plutonium-239, Plutonium-240	14.6	4.30×10^{-6}	0.000336
5.34	Strontium-90	3.97	1.30×10^{-7}	2.75×10^{-6}
5.34	Tritium	380	6.30×10^{-11}	1.28×10^{-7}
5.34	Uranium	16.6	2.60×10^{-7}	0.0000230
Total		–	–	**0.00121**

Notes: Average intake is 5.34 liters per year. High intake is 8.64 liters per year. Thus, dose at high intake is (8.64/5.34) × 0.00121 or 0.00195 rem per year. Calculated using surface water onsite stations 2001-2004 composite data (95 percent upper confidence limit). The *1999 SWEIS* reported 0.000740 rem per year for the "resident recreational user" from this source and pathway (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–36 Dose to the Recreational User Receptor from the Consumption of Soil

Exposure Pathway: Soil Ingestion (Recreational User)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1.07	Americium-241	0.0176	4.50×10^{-6}	8.49×10^{-8}
1.07	Cesium-137	0.365	5.00×10^{-8}	1.95×10^{-8}
1.07	Plutonium-238	0.00236	3.80×10^{-6}	9.60×10^{-9}
1.07	Plutonium-239, Plutonium-240	0.0669	4.30×10^{-6}	3.08×10^{-7}
1.07	Strontium-90	0.154	1.30×10^{-7}	2.14×10^{-8}
1.07	Tritium	1.14	6.30×10^{-11}	7.71×10^{-11}
1.07	Uranium	2.34	2.60×10^{-7}	6.51×10^{-7}
Total		–	–	$\mathbf{1.09 \times 10^{-6}}$

Notes: Average intake is 1.07 grams per year. High intake is 4.27 grams per year. Thus, dose at high intake is (4.27/1.07) × 1.09×10^{-6} or 4.37×10^{-6} rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for onsite stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.0000125 rem per year for the "resident recreational user" from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–37 Dose to the Recreational User Receptor from the Consumption of Sediment

Exposure Pathway: Sediment Ingestion (Recreational User)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
1.07	Americium-241	0.696	4.50×10^{-6}	3.35×10^{-6}
1.07	Cesium-137	1.48	5.00×10^{-8}	7.89×10^{-8}
1.07	Plutonium-238	0.422	3.80×10^{-6}	1.72×10^{-6}
1.07	Plutonium-239, Plutonium-240	0.692	4.30×10^{-6}	3.18×10^{-6}
1.07	Strontium-90	0.286	1.30×10^{-7}	3.98×10^{-8}
1.07	Tritium	352	6.30×10^{-11}	2.37×10^{-8}
1.07	Uranium	1.86	2.60×10^{-7}	5.17×10^{-7}
Total		–	–	$\mathbf{8.91\times 10^{-6}}$

Notes: Average intake is 1.07 grams per year. High intake is 4.27 grams per year. Thus, the dose at high intake is (4.27/1.07) × 8.91×10^{-6} or 0.0000356 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for onsite stations (see Appendix F of this SWEIS). The *1999 SWEIS* reported 0.000176 rem per year for the “resident recreational user” from this source and pathway (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–38 Dose to the Special Pathways Receptor from the Consumption of Fish

Exposure Pathway: Fish Ingestion (Special Pathways)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
6,540	Americium-241	0.000482	4.50×10^{-6}	0.0000142
6,540	Cesium-137	0.00866	5.00×10^{-8}	2.83×10^{-6}
6,540	Plutonium-238	0.000653	3.80×10^{-6}	0.0000162
6,540	Plutonium-239, Plutonium-240	0.000210	4.30×10^{-6}	5.90×10^{-6}
6,540	Strontium-90	0.0450	1.30×10^{-7}	0.0000382
6,540	Tritium	1.16	6.30×10^{-11}	4.78×10^{-7}
6,540	Uranium	0.0184	2.60×10^{-7}	0.0000313
Total		–	–	**0.000109**

Notes: Calculated using average intake of 70 grams per day (17.92 grams per day dry weight). High intake is 170 grams per day (43.52 grams per day dry weight.). Thus, dose at high intake is (170/70) × 0.000109 or 0.000265 rem per year (EPA 1997). The *1999 SWEIS* reported 0.000189 rem per year (average intake) from this source and pathway. Uranium concentration of 24.5 nanograms per gram dry weight. (0.0245 micrograms per gram) equates to 0.0174 picocuries per gram. Applying the reported 0.40 picocuries per milliliter tritium concentration value to the water fraction (1-0.256) yields: 0.744 grams water per 0.256 grams dry weight × 0.40 picocuries per milliliter × 1 milliliter per gram water = 1.163 picocuries per gram dry weight. To convert grams to ounces, multiply by 0.035274.

Table C–39 Dose to the Special Pathways Receptor from the Consumption of Elk Heart and Liver

Exposure Pathway: Elk Ingestion (Special Pathways)				
Intake (grams per year)	***Nuclide***	***Concentration (picocuries per gram)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
436	Americium-241	0.00	4.50×10^{-6}	0.00
436	Cesium-137	0.0679	5.00×10^{-8}	1.48×10^{-6}
436	Plutonium-238	0.00	3.80×10^{-6}	0.00
436	Plutonium-239, Plutonium-240	0.000655	4.30×10^{-6}	1.23×10^{-6}
436	Strontium-90	0.00650	1.30×10^{-7}	3.68×10^{-7}
436	Tritium	0.00	6.30×10^{-11}	0.00
436	Uranium	0.0347	2.60×10^{-7}	3.93×10^{-6}
Heart Total		–	–	$\mathbf{7.01 \times 10^{-6}}$
763	Americium-241	0.00	4.50×10^{-6}	0.00
763	Cesium-137	0.596	5.00×10^{-8}	0.0000227
763	Plutonium-238	0.0000750	3.80×10^{-6}	2.17×10^{-7}
763	Plutonium-239, Plutonium-240	0.0000950	4.30×10^{-6}	3.12×10^{-7}
763	Strontium-90	0.00820	1.30×10^{-7}	8.13×10^{-7}
763	Tritium	0.00	6.30×10^{-11}	0.00
763	Uranium	0.0160	2.60×10^{-7}	3.17×10^{-6}
Liver Total		–	–	**0.0000273**
Heart + Liver Total		–	–	**0.0000343**

Notes: This represents consumption of heart and liver in addition to the meat consumption calculated for the resident. Average heart intake is based on 3.2 pounds per year for an individual × 454 grams per pound × 0.30 (wet to dry ratio). Average liver intake is based on 5.6 pounds per year for an individual × 454 grams per pound × 0.30 (wet to dry ratio). The *1999 SWEIS* reported 0.0000343 rem per year from this source and pathway (no new data were found – same data and consumption rates were used here as for *1999 SWEIS*) (DOE 1999a). To convert grams to ounces, multiply by 0.035274.

Table C–40 Dose to the Special Pathways Receptor from the Consumption of Indian Tea (Cota)

Exposure Pathway: Indian Tea (Cota) Ingestion (Special Pathways)				
Intake (liters per year)	***Nuclide***	***Concentration (picocuries per liter)***	***Dose Conversion Factor (rem per picocurie)***	***Dose (rem per year)***
213	Americium-241	0.0362	4.50×10^{-6}	0.0000347
213	Cesium-137	21.2	5.00×10^{-8}	0.000226
213	Plutonium-238	0.0250	3.80×10^{-6}	0.0000202
213	Plutonium-239, Plutonium-240	0.0302	4.30×10^{-6}	0.0000277
213	Strontium-90	0.642	1.30×10^{-7}	0.0000178
213	Tritium	117	6.30×10^{-11}	1.58×10^{-6}
213	Uranium	0.780	2.60×10^{-7}	0.0000432
Total		–	–	**0.000371**

Notes: Average intake is 0.58 liters per day (213 liters per year). High intake is 2.03 liters per day (741 liters per year). Thus, dose at high intake is (2.03/0.58) × 0.000371 or 0.00130 rem per year. The *1999 SWEIS* reported 0.000749 rem per year (average intake) from this source and pathway (DOE 1999a). To convert liters to gallons, multiply by 0.26418.

Table C–41 Summary of Ingestion Pathway Doses for Offsite Resident, Recreational User, and Special Pathways Receptors

Exposure Pathway	*Dose to Receptor (rem per year)*		
	Offsite Resident [a]	*Recreational User* [b]	*Special Pathways* [c]
Produce	0.00105	0.00105	0.00105
Meat (free-range beef)	0.000256	0.000256	0.000256
Milk	0.000284	0.000284	0.000284
Fish (game)	0.0000294	0.0000294	0.0000294
Elk	0.0000212	0.0000212	0.0000212
Deer	0.0000236	0.0000236	0.0000236
Honey	6.44×10^{-6}	6.44×10^{-6}	6.44×10^{-6}
Pinyon nuts	0.000234	0.000234	0.000234
Groundwater	0.000542	0.000542	0.000542
Soil	0.0000372	0.0000372	0.0000372
Sediment	0.000258	0.000258	0.000258
Surface water	–	0.00121	0.00121
Soil [d]	–	1.09×10^{-6}	1.09×10^{-6}
Sediment [d]	–	8.91×10^{-6}	8.91×10^{-6}
Fish (non-game)	–	–	0.000109
Elk (heart, liver)	–	–	0.0000343
Indian Tea (Cota)	–	–	0.000371
Totals	**0.00274**	**0.00396**	**0.00448**

[a] A hypothetical person who is conservatively assumed to intake various foodstuffs, water, soil and sediments with concentrations of contaminants at the 95 percent upper confidence limit for each contaminant.
[b] Assumed to visit the canyons on and near LANL 24 times per year, 8 hours per visit.
[c] Assumed to have traditional Native American or Hispanic lifestyles and diet.
[d] Soil and sediments from onsite locations.

The offsite resident receptor was estimated to receive a dose of about 0.00274 rem, or about 2.7 millirem, per year from the ingestion exposures reported here. Eliminating all zero and negative values when calculating the 95 percent upper confidence limit concentration from the reported environmental surveillance results adds a degree of conservatism. It is also quite unlikely that any given individual would derive all of their diet from local sources, as was assumed in this consumption model. Additional exposures to a person whose diet and activities reflect those of the recreational user and special pathways receptors would bring their total doses to about 4.0 and 4.5 millirem per year, respectively. Using a risk estimator value of 0.0006 lifetime probability of fatal cancer per person-rem, 4.5 millirem (0.0045 rem) per year would equate to a probability of fatal cancer of 2.7×10^{-6}, or just under a 3 in 1 million chance of developing a fatal cancer from the ingestion pathway. The high consumption rates for all components of the ingestion pathway are detailed in their respective tables (C–24 through C–40). The total doses to each receptor as a result of potential consumption at these higher rates would be increased by less than a factor of three. Using the high consumption rates, the lifetime probability of developing a fatal cancer would be about 4.3×10^{-6} for the offsite resident total dose of 0.0072 rem; 5.5×10^{-6} for the recreational user total dose of 0.0091 rem; and 6.4×10^{-6} for the special pathways receptor total dose of 0.0107 rem per year of exposure.

For perspective, the ingestion pathway doses of 2.7 to 10.7 millirem per year calculated here for the offsite resident and other specific receptors should be viewed against the dose of about 400 millirem (dose ranges from 300 to 500 millirem) per year that the average Los Alamos resident receives from all background radiation sources (see Section C.1.1.3). That average includes about 240 millirem from radioactive material that has entered the body by inhalation or ingestion. The largest fraction of the internal dose (about 200 millirem on average) is due to the short-lived decay products of naturally-occurring radon gas. It is also important to compare these ingestion pathway doses to the more significant inhalation pathway dose, where the bulk of the radiological air emissions and resulting dose come from LANSCE and the High Explosives Testing Key Facility (see Chapter 5, Section 5.6).

As shown in Table C–41, the highest estimated ingestion pathway dose to any specific receptor is about 4.5 millirem per year from radionuclides in the environment resulting from past LANL operations, global fallout, and naturally-occurring geologic sources. If a particular specific receptor also were to receive the maximum impact from projected future radionuclide LANL emissions to the atmosphere (see Tables C–19, C–20, and C–21), that specific receptor might receive a total annual dose from past and future site operations ranging from about 5.3 millirem (4.5 millirem plus the dose to the MEI of 0.79 millirem) for the Reduced Operations Alternative to about 12.3 millirem (4.5 millirem plus the dose to the MEI of 7.8 millirem) for the No Action and Expanded Operations Alternatives. The fatal cancer risk associated with these doses ranges from about 3 in 1 million to 7 in 1 million. To place these doses in perspective, that same individual would be expected to receive an annual dose from background sources of about 400 millirem. In addition, these are conservatively calculated doses because no one person would actually consume such a large concentration from each pathway component. These large concentrations are found at scattered locations around LANL.

When calculating ingestion pathway radiation doses, river surface water was considered as a potential dose source for certain recreational user and special pathways receptors. Surface water radioisotope concentrations were measured at locations both upstream and downstream of LANL on the Rio Grande and Jemez River during 2005 (LANL 2006b). The 95 percent upper confidence limit values of these measurements were used to calculate the radiation dose to an individual that consumed all their drinking water, at the rate of 2 liters per day, from these surface water sources. The total surface drinking water doses are presented in **Table C–42**. This table shows the location of the sampling station relative to LANL (that is, upstream or downstream), as well as the fraction of the EPA 4 millirem per year drinking water limit that the calculated dose at each location represents. Consumption of all drinking water from all of the river locations around LANL resulted in doses of less than 10 percent of the EPA limit. There was no trend between upstream and downstream locations relative to LANL.

The doses calculated here are generally lower than those reported in the *1999 SWEIS* for the same ingestion pathway components. Only 5 of the 17 pathway component doses are greater than those reported in the *1999 SWEIS*. The dose from honey consumption is greater than that reported in the *1999 SWEIS* because the 1999 dose calculation considered only the dose from tritium, whereas this calculation includes the dose from tritium and all other radionuclides reported in the LANL environmental surveillance data for honey. The dose from pinyon nut consumption reported here is higher because this calculation makes use of a higher dry to wet weight ratio than was assumed in the *1999 SWEIS* calculation. The doses from consumption of surface water (recreational user), milk, and deer are also higher, but not remarkably so. The calculated dose from consumption of elk heart and liver is unchanged from the *1999 SWEIS* because no more current radionuclide concentration data were found. The lower doses calculated here for the other 12 pathway components are due to lower average radionuclide concentrations in environmental media reported during the 2001 through 2004 period compared to the 1991 through 1996 data used in the *1999 SWEIS* calculations.

Table C–42 Total Los Alamos National Laboratory River Surface Water Consumption Radiation Doses

Surveillance Sample River Site	*Location Upstream or Downstream of LANL*	*Total Annual (2 liters per day) Drinking Water Dose (millirem)*	*Percent of Annual EPA Drinking Water Dose Limit of 4 Millirem*
Jemez River	Upstream	0.384	9.6%
Embudo at Rio Grande	Upstream	0.118	3.0%
Otowi at Rio Grande	Upstream	0.159	4.0%
Chamita at Rio Grande	Upstream	0.236	5.9%
Frijoles at Rio Grande	Downstream	0.297	7.4%
Cochiti at Rio Grande	Downstream	0.172	4.3%

C.2 Impacts on Human Health from Nonradioactive Contaminants in the Environment

Many nonradioactive substances (chemical elements, compounds, and mixtures) found in the environment are potentially harmful to human health. Some substances, small amounts of which are beneficial or necessary for good health, may be harmful in larger amounts or higher concentrations (examples: iron, selenium, zinc). Even at very low concentrations or levels of intake, exposure to some substances may cause long-term health effects or increase the likelihood of developing certain diseases, particularly when the exposure continues over a long period of time (that is, chronic exposure). The health impact (harmful effect) of taking any substance into the body depends on the toxicity of the material (a measure of the amount needed to produce a given harmful effect) and the dose or intake (the rate at which the substance was taken into the body). For many substances, humans have the capacity to metabolize, excrete, or otherwise detoxify small quantities or small chronic intakes without showing ill effects. Substances that accumulate in the body over time, however, may cause harm that becomes evident only after many years of exposure.

Humans may be exposed to toxic substances in their environment by several different routes, of which ingestion, inhalation, and skin contact are usually most important. At concentrations typically found in the general living environment, acute health effects (those having a rapid onset followed by a short, severe course of symptoms) are seldom observed. Elevated levels of some contaminants in air, water, soil, and other environmental media, however, have been linked statistically to the occurrence rate (or frequency) of specific health problems in populations exposed to those media. The health effects from exposure to carcinogenic substances are evaluated using risk factors from the EPA Integrated Risk Information System database (EPA 2005a). The risk factor for a substance is an estimate of the upper-bound lifetime probability, per unit oral intake or concentration in the air, of an individual developing cancer from exposure to the substance. The potential for noncancer health effects from exposure to a toxic substance is evaluated by dividing the estimated average daily intake of that substance by its Oral Reference Dose value (RfD) to obtain a hazard index. The Oral Reference Dose is an estimate of the average daily oral intake that is believed to pose no appreciable risk of harmful health effects (EPA 2005b). If the calculated hazard index is greater than 1, the individual is considered to be at some risk of adverse health effects as a result of exposure to the substance.

C.2.1 Methods Used to Estimate Risks from Ingestion of Nonradioactive Contaminants

Environmental media and foodstuffs collected on and near LANL are regularly analyzed for various nonradioactive contaminants. Measured concentrations of contaminants in food, water, soils and sediments are used here to calculate the health risks to residents and special pathways receptors from the ingestion of those materials. The same dietary intake assumptions used to calculate radiation dose and risk were used to estimate health risk from a range of nonradioactive contaminants, some of which occur naturally in the LANL environment and others that are a result of past LANL operations, natural processes, or human activities in the region.

Naturally-occurring contaminants with possible health implications for residents include metals derived from local soil and rock that are consumed via ingestion of groundwater, surface water, soil, sediment and various foodstuffs. As part of this group, arsenic and beryllium are known to be present in concentrations that represent a significant increment of ingestion risk. Contaminants known to have been released to the environment from site operations include nitrates and perchlorate, as well as various high explosives and organics. These materials are present in groundwater and surface water on and near LANL, and therefore represent a potential direct impact on the health of the current population from past LANL operations. Finally, residues from environmentally persistent pesticides used in the surrounding forests and agricultural land can be detected in various media, as can organic contaminants of natural (such as wildland fires) or undetermined origin. These substances and others have been monitored, either regularly or episodically as part of the LANL Environmental Surveillance Program.

Groundwater Ingestion

To estimate human health impacts to the public, only contaminants that could be ingested by the postulated receptors were included in the impact calculations. For the groundwater component of the ingestion pathway, only analysis results from the water supply wells were used to calculate the 95 percent upper confidence limit concentration.

Groundwater at LANL occurs as a regional aquifer at depths ranging from 600 to 1,200 feet (180 to 370 meters) and as perched groundwater of limited thickness and horizontal extent, either in canyon alluvium or at intermediate depths of a few hundred feet. All water produced by the Los Alamos County water supply system comes from the regional aquifer and meets Federal and state drinking water standards. No drinking water is supplied from the alluvial and intermediate groundwater sources. Water supply wells are present in Guaje Canyon, Pueblo Canyon, upper Los Alamos Canyon, Mortandad Canyon, Pajarito Canyon, and White Rock Canyon.

Liquid effluent disposal is the primary means by which LANL contaminants have had an effect, albeit limited, on the regional aquifer. Liquid effluent disposal at LANL has significantly degraded the quality of alluvial groundwater in some canyons. Because flow through the underlying approximately 900-foot-thick (270-meter-thick) zone of unsaturated rock is slow, the impact of effluent disposal is seen to a lesser degree in intermediate-depth perched groundwater and is only seen in a few wells that draw from the regional aquifer. In general, groundwater quality would improve as outfalls are eliminated, the volume of liquid discharges is reduced, and the water quality (concentrations of contaminants) of the discharges is improved.

During the last decade, EPA has recognized the potential for perchlorate toxicity at concentrations in the parts per billion range. No EPA regulatory limit exists for perchlorate in drinking water, though several states have set limits in the range of 10 to 20 parts per billion. EPA Region VI has established a level of 3.7 parts per billion.

LANL and the New Mexico Environment Department DOE Oversight Bureau have found perchlorate in most groundwater samples analyzed from across northern New Mexico at concentrations below 1 part per billion. At LANL, perchlorate was the byproduct of the perchloric acid used in nuclear chemistry research. Water samples from most LANL locations show low perchlorate concentrations, but samples taken downstream from inactive perchlorate release sites show distinctly higher values.

As indicated by the LANL environmental surveillance program (LANL 2005b), the presence of high metal values (compared with regulatory standards) in groundwater samples is believed to be due to ubiquitous well-sampling-related issues rather than to contamination resulting from LANL operations. Well-drilling fluids; the metal in well casings, fittings, and pump housings; dissolved surface minerals from the aquifer's rock framework; and alterations to aquifer water chemistry due to the presence of a well all may contribute to increases of some metal values.

Arsenic was detected in measurable amounts in some water supply wells. As noted in Appendix D of the *1999 SWEIS*, the primary sources of arsenic in food and water sources in the LANL area are naturally-occurring soil and basalt. The concentrations of arsenic in groundwater supply wells are not significantly different between Los Alamos and San Ildefonso. The main use of arsenic in the United States is pesticide formulation, and LANL does not use large amounts of arsenic in any of its research and development or processing activities.

Some supply wells have shown elevated levels of nitrate. LANL environmental surveillance program results (LANL 2005b) indicate that a possible source of these contaminants is effluent from a local sewage treatment plant. In addition, some past effluent discharges from the Radioactive Liquid Waste Treatment Facility contained high levels of nitrates (LANL 2004b).

The LANL environmental surveillance program analyzed samples from selected springs and wells for organic constituents. Samples were analyzed for some or all of the following types of organics: volatile organic compounds, semivolatile organic compounds, polychlorinated biphenyls, pesticides, diesel-range organics, and high explosives (HMX, RDX, TNT). Certain organic compounds used in analytical laboratories are frequently detected in samples, probably as a result of contamination introduced by the laboratory process. These compounds include acetone, methylene chloride, 2-butanone, and bis(2-ethylhexyl)phthalate. Since there was no definitive evidence that these compounds were introduced as part of the laboratory process, they were conservatively retained as part of the group of organics considered as contributing to risk from ingestion of groundwater.

Volatile and semi-volatile organic compounds were not found in any of the water supply wells in significant concentrations; therefore, they were not included in the group of compounds that contribute to risk from groundwater consumption.

High-explosive compounds also were not found in statistically significant quantities in the water supply wells. They have been found in other regional aquifer wells, however, and are a known contaminant in surface waters and sediments. As a result, any supply well sample results containing high-explosive compounds were conservatively retained for consideration.

In August 2004, the LANL environmental surveillance program identified several positive pesticide results, notably results for 4,4'-DDT and 4,4'-DDE, in LANL samples. These results were not supported by previous data or by process knowledge at the sample locations. Subsequent examination of the data revealed that some glassware used in the process was only rinsed, without further cleaning, between uses. This finding meant that pesticide contamination could be transferred from one sample to another during the sample preparation. As a result, all pesticide results for 2004 are considered unusable (LANL 2005b).

Table C–43 shows the contribution to health risk to the offsite resident receptor from ingestion of trace metals, nitrates, perchlorate, and organic compounds in groundwater. Arsenic, the contaminant with the highest Hazard Index and cancer risk, occurs naturally at relatively high concentrations in soil and groundwater throughout northern New Mexico. Arsenic is not known to have been used in significant quantities at LANL and the elevated groundwater concentrations do not appear to be related to any past or current LANL operations or effluents. Vanadium, the contaminant with the second-highest Hazard Index, is also a naturally-occurring trace element in the region. Elevated concentrations of vanadium seen in surface water and groundwater samples do not appear to be related to any past or current LANL operations or effluents. See Section C.2 for additional information.

Surface Water and Sediment Ingestion

LANL personnel monitor surface water and stream sediments in northern New Mexico and southern Colorado to evaluate the potential environmental effects of LANL operations. LANL personnel analyze samples for radionuclides, high explosives, metals, a wide range of organic compounds, and (for surface water) general chemistry.

Watercourses that drain from LANL property are dry most of the year. No perennial surface water extends completely across LANL in any canyon. The canyons consist of over 85 miles (140 kilometers) of watercourses located within LANL and Los Alamos Canyon upstream of the site. Of the 85 (140 kilometers) miles of watercourse, approximately 2 miles (3.2 kilometers) are naturally perennial, and approximately 3 miles (4.8 kilometers) are perennial waters created by effluent. The remaining 80 or more miles (130 kilometers) of watercourse dry out for varying lengths of time. The driest segments may flow only in response to local precipitation or snowmelt. Although most of the watercourses are dry throughout the year, occasional floods can redistribute sediment in a streambed to locations far downstream from where a release or spill occurs.

Table C–43 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Groundwater

Groundwater Consumption: 1.51 Liters per Day Average, 2.44 Liters per Day High Intake

Analytes	*95% UCL Concentration (µg/L)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	1.08	0.0000227	0.0000367	0.005		0.00454	0.00735		
Aluminum	176	0.0037	0.00599	1.00		0.0037	0.00599		
Arsenic	13	0.00027	0.000443	0.0003	1.5	0.912	1.48	0.00041	0.000664
Boron	1,350	0.0283	0.0459	0.2		0.142	0.229		
Barium	182	0.00383	0.0062	0.2		0.0192	0.0310		
Beryllium	0.229	4.80×10^{-6}	7.77×10^{-6}	0.002	4.3	0.0024	0.0039	0.0000206	0.0000334
Cadmium	0.164	3.43×10^{-6}	5.56×10^{-6}	0.0005	0.0018	0.00687	0.0111	6.18×10^{-9}	1.00×10^{-8}
Perchlorate	2.88	0.00006	0.0000987	0.0007		0.0863	0.140		
Cobalt	2.95	0.0000619	0.0001	0.02		0.00309	0.00501		
Chromium	8.48	0.000178	0.00029	1.5		0.000119	0.000192		
Copper	22.9	0.000481	0.00079	0.037		0.013	0.021		
Mercury	0.248	5.21×10^{-6}	8.43×10^{-6}	0.0003		0.0174	0.0281		
Manganese	12.6	0.000265	0.000429	0.047		0.00564	0.00912		
Molybdenum	33.3	0.0007	0.00113	0.005		0.14	0.227		
Nickel	4.45	0.0000935	0.00015	0.02		0.00468	0.00757		
Nitrate	1,910	0.0402	0.065	1.6		0.0251	0.0406		
Lead	5.21	0.00011	0.000177	0.0014		0.0781	0.126		
Antimony	0.419	8.79×10^{-6}	0.0000142	0.0004		0.022	0.0356		
Selenium	6.55	0.00014	0.000223	0.005		0.0275	0.0446		
Tin	5.46	0.00012	0.000186	0.6		0.000191	0.00031		
Strontium	835	0.0175	0.0284	0.6		0.0292	0.0473		
Thallium	0.318	6.68×10^{-6}	0.0000108	0.00008		0.0835	0.135		
Uranium	0.875	0.0000184	0.0000298	0.0006		0.0306	0.0496		
Vanadium	3.65	0.00077	0.00124	0.001		0.766	1.24		
Zinc	189	0.00397	0.00643	0.3		0.0132	0.0214		

Analytes	***95% UCL Concentration (µg/L)***	***Average Chronic Daily Intake (mg/kg-day)***	***High Chronic Daily Intake (mg/kg-day)***	***Oral RfD (mg/kg-day)***	***Oral Slope Factor (per mg/kg-day)***	***Average Case Hazard Index***	***High Intake Hazard Index***	***Average Case Cancer Risk***	***High Intake Cancer Risk***
Acetone	10.6	0.00022	0.00036	0.9		0.000246	0.00399		
Bis(2-ethylhexyl)phthalate	1.59	0.0000334	0.0000541	0.02	0.014	0.00167	0.0027	4.67×10^{-7}	7.57×10^{-7}
Butanone(2)	0.36	7.56×10^{-6}	0.0000122	0.6		0.0000126	0.0000204		
Chloromethane	1.22	0.0000256	0.0000415	0.026	0.0063	0.000985	0.0016	1.61×10^{-7}	2.61×10^{-7}
Heptachlor epoxide	0.01	2.10×10^{-7}	3.40×10^{-7}	0.0000130	9.1	0.0162	0.0262	1.91×10^{-6}	3.09×10^{-6}
Methylene chloride	3.7	0.0000777	0.000126	0.06	0.0075	0.0013	0.0021	5.83×10^{-7}	9.44×10^{-7}
RDX	0.25	5.25×10^{-6}	8.50×10^{-6}	0.003	0.11	0.00175	0.00283	5.78×10^{-7}	9.35×10^{-7}
Styrene	0.78	0.0000164	0.0000265	0.2		0.0000819	0.000133		
Tetrachloroethene	0.92	0.0000193	0.0000313	0.06	0.2	0.000322	0.000521	3.86×10^{-6}	6.26×10^{-6}
Tetryl	0.04	8.40×10^{-7}	1.36×10^{-6}	0.004		0.000210	0.000340		

kg = kilogram, L = liter, mg = milligram, µg = microgram, RDx = hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Water Concentration (µg/L) × Consumption rate (L/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

The overall quality of most surface water in the Los Alamos area is very good, with very low levels of dissolved solutes. Of the more than 100 analytes tested in sediment and surface water within LANL, most are at concentrations far below regulatory standards or risk-based advisory levels. Nearly every major watershed, however, shows indications of some effect from LANL operations, often for just a few analytes.

Although many of the above-background results in sediment and surface water are from the major liquid effluent discharges, other possible sources include isolated spills, former photographic-processing facilities, highway runoff, and residual ash from the Cerro Grande Fire. At monitoring locations below other industrial or residential areas, particularly in the Los Alamos and Pueblo Canyon watersheds, above-background contaminant levels reflect contributions from non-LANL sources such as urban runoff.

Guaje Canyon is a major tributary in the Los Alamos Canyon watershed that heads in the Sierra de los Valles and lies north of LANL. The canyon has not received any effluent from LANL activities. Concentrations of metals, organics, and radionuclides in Guaje Canyon base flow and sediments were below regulatory limits or screening levels. Active channel sediments contained background ranges of metals and radionuclides.

Los Alamos Canyon, including Bayo, Acid, Pueblo, and DP Canyons, has a large drainage that heads in the Sierra de los Valles. Land in the Los Alamos Canyon watershed has been continuously used since the mid-1940s, with operations conducted at some time in all of the subdrainages. Each of the canyons draining the watershed also receives urban runoff from the Los Alamos town site.

Nonradiological contaminants detected at significant concentrations in the Los Alamos Canyon watershed include polychlorinated biphenyls, benzo(a)pyrene, mercury, copper, lead, and zinc. Analysis detected benzo(a)pyrene in sediment samples from Acid Canyon above Pueblo; the LANL environmental surveillance staff concluded that the major source of benzo(a)pyrene in the drainage was urban runoff rather than a LANL-related source (LANL 2005b).

Mercury was detected in Los Alamos Canyon above DP Canyon. LANL sources of mercury and polychlorinated biphenyls are known to exist in the drainage system, and erosion control features have been installed near the sources to minimize downstream movement. Elevated concentrations of copper, lead, and zinc were detected in DP Canyon above LANL facilities and are likely derived from urban runoff sources rather than LANL operations.

Sandia Canyon begins on the Pajarito Plateau within TA-3 and has a total drainage area of about 5.5 square miles. This relatively small drainage extends eastward across the central part of LANL and crosses San Ildefonso Pueblo land before joining the Rio Grande. Effluent discharges primarily from power plant blowdown support perennial flow conditions along a 2-mile (3.2-kilometer) reach. The upper portion of the canyon contains some of the highest polychlorinated biphenyl concentrations of any watercourse within LANL boundaries. Downstream sediment concentrations of polychlorinated biphenyls decline quickly and are near background ranges at the LANL downstream boundary. Along an approximately 2-mile (3.2-kilometer) segment are found above-background concentrations of chromium, copper, mercury, and zinc in surface water and sediments. Measurements in 2004 also found concentrations of dissolved copper and lead above regulatory standards.

Mortandad Canyon begins on the Pajarito Plateau near the main complex at TA-3. The canyon crosses San Ildefonso Pueblo land before joining the Rio Grande. Analysis detected dissolved copper concentrations and benzo(a)pyrene above screening levels; potential sources are many and include road runoff, ash from the Cerro Grande Fire, and industrial sources.

Pajarito Canyon begins on the flanks of the Sierra de los Valles on U.S. Forest Service lands. The canyon crosses the south-central part of LANL before entering Los Alamos County lands in White Rock. Dissolved copper concentrations greater than the regulatory standards were detected in channels throughout the Pajarito Canyon watershed. A review of sediment data from the drainage did not indicate a LANL source for the copper. In 2004, a sediment sample from Pajarito Canyon contained many metals and radionuclides at concentrations two to five times above background levels (LANL 2005b). Concentrations of organic compounds in sediments from Pajarito Canyon are far below EPA residential soil screening levels, with the exception of benzo(a)pyrene. Low levels of polychlorinated biphenyls were detected in sediments. Polychlorinated biphenyls were not detected in stormwater runoff samples.

Water Canyon heads on the flanks of the Sierra de los Valles on U.S. Forest Service land and extends across LANL to the Rio Grande. Water Canyon and its tributary Cañon de Valle pass through the southern portion of LANL where explosives development and testing has been conducted in the past and continues to take place. Elevated concentrations of barium, HMX, and RDX have been measured in sediment and surface water.

Tables C–44 and **C–45** show the contribution to health risk to the recreational user receptor from ingestion of metals, nitrates, perchlorate, and organic compounds in surface water and sediment. **Table C–46** shows the health risk to the offsite resident receptor from ingestion of contaminants in sediment that may be transported offsite by streams and seasonal runoff.

Soil Ingestion

In the past, soils within and around LANL were analyzed for 22 light, heavy, and nonmetal trace elements (occurrence in amounts less than 1,000 micrograms per gram in soil) and 3 light and heavy abundant elements (occurrence in amounts greater than 1,000 micrograms per gram in soil). Most of these elements, with the exception of barium, beryllium, mercury, and lead, were either below the limits of detection or within the regional statistical reporting limits. Therefore, recent analyses only address the four metals that were consistently detected above the limit of detection in past years (barium, beryllium, mercury, and lead). In general, very few individual sites from either perimeter or onsite areas had barium, beryllium, mercury, or lead concentrations above the regional statistical reporting limits, and these concentrations were far below the screening action levels.

Table C–44 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Surface Water

Surface Water Consumption: 5.34 Liters per Year Average, 8.64 Liters per Year High Intake

Analytes	*95% UCL Concentration (μg/L)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	5.19	1.06×10^{-6}	1.71×10^{-6}	0.005		0.000212	0.0003		
Aluminum	129,000	0.0263	0.0426	1.00		0.0263	0.0426		
Arsenic	2.89	5.89×10^{-6}	9.53×10^{-6}	0.0003	1.50	0.0196	0.0318	8.84×10^{-6}	0.0000143
Boron	231	0.0000471	0.0000762	0.2		0.000236	0.0004		
Barium	3,270	0.000666	0.00108	0.2		0.00333	0.00539		
Beryllium	13.4	2.72×10^{-6}	4.41×10^{-6}	0.002	4.30	0.00136	0.0022	0.0000117	0.0000189
Cadmium	10.4	2.11×10^{-6}	3.42×10^{-6}	0.0005	0.0018	0.00423	0.00684	3.80×10^{-9}	6.15×10^{-9}
Perchlorate	16.8	3.42×10^{-6}	5.53×10^{-6}	0.0007		0.00489	0.00791		
Cobalt	54.2	0.0000111	0.0000179	0.02		0.000553	0.00089		
Chromium	117	0.0000238	0.0000385	1.5		0.0000159	0.0000257		
Copper	115	0.0000234	0.0000378	0.037		0.000632	0.00102		
Mercury	0.389	7.94×10^{-8}	1.28×10^{-7}	0.0003		0.000265	0.000428		
Manganese	11,200	0.0029	0.00371	0.047		0.0488	0.0789		
Molybdenum	23.5	4.80×10^{-6}	7.76×10^{-6}	0.005		0.000959	0.00155		
Nickel	73.8	0.0000151	0.0000243	0.02		0.000753	0.00122		
Nitrate	21,200	0.0043	0.007	1.60		0.0027	0.00437		
Lead	191	0.0000390	0.0000631	0.0014		0.0278	0.045		
Antimony	72	0.0000147	0.0000238	0.0004		0.0367	0.0594		
Selenium	9.36	1.91×10^{-6}	3.09×10^{-6}	0.005		0.000382	0.0006		
Tin	8.98	1.83×10^{-6}	2.96×10^{-6}	0.6		3.05×10^{-6}	4.94×10^{-6}		
Strontium	711	0.000145	0.0002	0.6		0.000242	0.0004		
Thallium	9.20	1.88×10^{-6}	3.04×10^{-6}	0.00008		0.0235	0.0379		
Uranium	79.3	0.0000162	0.0000262	0.0006		0.0270	0.0436		
Vanadium	150	0.0000306	0.0000496	0.001		0.0306	0.0496		

Analytes	*95% UCL Concentration (µg/L)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Zinc	862	0.000176	0.000284	0.3		0.00586	0.000948		
Acetone	78.3	0.000016	0.0000258	0.9		0.0000177	0.0000287		
AROCLOR 1260	0.5	1.02×10^{-7}	1.65×10^{-7}		2.00			2.04×10^{-7}	3.30×10^{-7}
Benzo(a)pyrene	3.85	7.85×10^{-7}	1.27×10^{-6}		7.30			5.73×10^{-6}	9.27×10^{-6}
Bis(2-ethylhexyl)phthalate	10.9	2.23×10^{-6}	3.61×10^{-6}	0.02	0.014	0.000111	0.00018	3.12×10^{-8}	5.05×10^{-8}
HMX	150	0.0000307	0.0000496	0.05		0.000613	0.000992		
RDX	7.78	1.59×10^{-6}	2.57×10^{-6}	0.003	0.11	0.000529	0.000856	1.75×10^{-7}	2.82×10^{-7}
Trinitrotoluene	0.35	7.14×10^{-8}	1.16×10^{-7}	0.0005	0.03	0.000143	0.000231	2.14×10^{-9}	3.47×10^{-9}

HMx = octahydro-1, 3, 5, 7-tetranitro-3, 5, 7-tetrazocine, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Water Concentration (µg/L) × Consumption rate (L/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–45 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Sediment

Sediment Consumption: 1.07 g per Year Average, 4.27 g per Year High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	1.95	7.97×10^{-8}	3.18×10^{-7}	0.005		0.0000159	0.0000636		
Aluminum	16,400	0.00067	0.00268	1		0.00067	0.00268		
Arsenic	3.75	1.53×10^{-7}	6.11×10^{-7}	0.0003	1.5	0.00059	0.00204	2.29×10^{-7}	9.16×10^{-7}
Boron	5.9	2.41×10^{-7}	9.61×10^{-7}	0.2		1.20×10^{-6}	4.81×10^{-6}		
Barium	244	9.95×10^{-6}	0.0000398	0.2		0.0000498	0.000199		
Beryllium	1.1	4.49×10^{-8}	1.79×10^{-7}	0.002	4.3	0.0000225	0.0000897	1.93×10^{-7}	7.72×10^{-7}
Cadmium	0.841	3.43×10^{-8}	1.37×10^{-7}	0.0005	0.0018	0.0000686	0.00274	6.17×10^{-11}	2.47×10^{-10}
Cobalt	5.37	2.19×10^{-7}	8.75×10^{-7}	0.02		0.0000110	0.0000438		
Chromium	30.7	1.25×10^{-6}	5.01×10^{-6}	1.5		8.35×10^{-7}	3.34×10^{-6}		
Copper	19.4	7.92×10^{-7}	3.16×10^{-6}	0.037		0.0000214	0.0000855		

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Mercury	0.103	4.21×10^{-9}	1.68×10^{-8}	0.0003		0.0000140	0.0000561		
Manganese	824	0.0000336	0.000134	0.047		0.000715	0.00286		
Molybdenum	1.88	7.69×10^{-8}	3.07×10^{-7}	0.005		0.0000154	0.0000614		
Nickel	10.8	4.41×10^{-7}	1.76×10^{-6}	0.02		0.0000221	0.0000882		
Lead	24.9	1.02×10^{-6}	4.06×10^{-6}	0.00140		0.000726	0.0029		
Antimony	0.197	8.04×10^{-9}	3.21×10^{-8}	0.0004		0.0000201	0.0000803		
Selenium	3.80	1.55×10^{-7}	6.20×10^{-7}	0.005		0.0000310	0.000124		
Tin	8.89	3.63×10^{-7}	1.45×10^{-6}	0.6		6.04×10^{-7}	2.41×10^{-6}		
Strontium	51.9	2.12×10^{-6}	8.45×10^{-6}	0.6		3.53×10^{-6}	0.0000141		
Thallium	0.232	9.48×10^{-9}	3.79×10^{-8}	8.00×10^{-5}		0.000118	0.000473		
Vanadium	23.9	9.77×10^{-7}	3.90×10^{-6}	0.001		0.000977	0.0039		
Zinc	148	6.04×10^{-6}	0.0000241	0.3		0.0000201	0.0000804		
AROCLOR 1260	165	6.72×10^{-6}	0.0000268		2.00			0.0000134	0.0000537
Benzo(a)anthracene	1,010	0.0000413	0.000165		0.73			0.0000302	0.000121
Benzo(a)pyrene	741	0.0000303	0.000121		7.3			0.000221	0.000882
Benzo(b)fluoranthene	982	0.0000401	0.000160		0.73			0.0000293	0.000117
Bis(2-ethylhexyl)phthalate	2,310	0.0000945	0.000377	0.02	0.014	0.00472	0.0189	1.32×10^{-6}	5.28×10^{-6}
HMX	1,100	0.0000448	0.000179	0.05		0.000896	0.00358		
RDX	1,130	0.0000460	0.000184	0.003	0.11	0.0153	0.0612	5.06×10^{-6}	0.0000202
Trinitrotoluene	199	8.14×10^{-6}	0.0000325	0.0005	0.03	0.0163	0.065	2.44×10^{-7}	9.75×10^{-7}

g = grams, HMx = octahydro-1, 3, 5, 7-tetranitro-3, 5, 7-tetrazocine, kg = kilogram, L = liter, mg = milligram, µg = microgram, RDx = hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Sediment Concentration (µg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–46 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Sediment

Sediment Consumption: 36.5 g per Year Average, 146 g per Year High Intake

Analytes	*95% UCL Concentration (μg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Case Cancer Risk*
Silver	0.921	1.28×10^{-6}	5.13×10^{-6}	0.005		0.000256	0.00103		
Aluminum	40,000	0.0556	0.223	1		0.056	0.223		
Arsenic	6.28	8.73×10^{-6}	0.0000350	0.0003	1.5	0.0291	0.117	0.0000131	0.0000525
Boron	15.3	0.0000212	0.0000851	0.2		0.000106	0.000426		
Barium	371	0.0005	0.00207	0.2		0.00258	0.0103		
Beryllium	2.00	2.78×10^{-6}	0.0000111	0.002	4.3	0.00139	0.0056	0.0000119	0.0000478
Cadmium	1.08	1.50×10^{-6}	6.03×10^{-6}	0.0005	0.0018	0.00301	0.0121	2.71×10^{-9}	1.08×10^{-8}
Cobalt	11.5	0.0000160	0.0000643	0.02		0.000802	0.00321		
Chromium	24.7	0.0000343	0.000138	1.5		0.0000229	0.0000917		
Copper	26.0	0.0000361	0.000145	0.037		0.000976	0.00391		
Mercury	0.143	1.99×10^{-7}	7.96×10^{-7}	0.0003		0.000662	0.00265		
Manganese	1,370	0.0019	0.00761	0.047		0.0404	0.162		
Molybdenum	0.809	1.13×10^{-6}	4.51×10^{-6}	0.005		0.000225	0.000902		
Nickel	22.8	0.0000316	0.000127	0.02		0.00158	0.00634		
Lead	26.8	0.0000372	0.000149	0.0014		0.0266	0.106		
Antimony	0.14	1.94×10^{-7}	7.79×10^{-7}	0.0004		0.000486	0.00195		
Selenium	1.55	2.15×10^{-6}	8.63×10^{-6}	0.005		0.000431	0.00173		
Tin	2.74	3.81×10^{-6}	0.0000153	0.6		6.35×10^{-6}	0.0000254		
Strontium	212	0.000294	0.00118	0.6		0.000490	0.00196		
Thallium	0.400	5.57×10^{-7}	2.23×10^{-6}	0.00008		0.00696	0.0279		
Vanadium	51.1	0.000071	0.000285	0.001		0.071	0.285		
Zinc	96.6	0.000134	0.000538	0.3		0.000447	0.00179		
AROCLOR 1260	12.0	0.0000167	0.0000668		2.00			0.0000334	0.000134
Bis(2-ethylhexyl)phthalate	198	0.000275	0.0011	0.02	0.014	0.00138	0.055	3.85×10^{-6}	0.0000154

g = grams, kg = kilogram, L = liter, mg = milligram, μg = microgram, RfD = Reference Dose, UCL = upper confidence limit.

Notes: Chronic Intake (mg/kg-day) = Sediment Concentration (μg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/μg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

A comparison of the means of these elements collected in soils from perimeter and onsite areas with those from regional areas shows that the concentrations of beryllium, mercury, and lead in soils collected from onsite areas were significantly higher than concentrations from regional soils. Although beryllium, mercury, and lead concentrations in soils from onsite areas were statistically higher than in regional soils, the differences were very small.

Tables C–47 and **C–48** show the contribution to health risk to the offsite resident and the recreational user receptors from the ingestion of trace metals in surface soil.

Produce and Fish Ingestion

A wide variety of wild and domestic edible vegetable, fruit, grain, and animal products are harvested in the area surrounding LANL. Ingestion of foodstuffs constitutes an important pathway by which nonradioactive contaminants can be transferred to humans. Therefore, foodstuff samples are routinely collected (fruits, vegetables, grains, fish, milk, eggs, honey, herbal teas, mushrooms, pinyon nuts, domestic animals, and large and small game animals) from the surrounding area and communities to determine the impacts of LANL operations on the human food chain.

The metal elements analyzed in food were either those that have been consistently detected above the limit of detection in past years, those that have a history of use at LANL, or those that have been detected in significantly higher concentrations in soils. Of the five metals analyzed in produce collected from perimeter and onsite areas, only three (barium, lead, and selenium) were found to be above their limits of detection; beryllium and mercury were below the limits of detection. Of the three elements that were found to be above their limits of detection, all were within regional statistical reporting limits. As a group, the levels of all of the metal elements analyzed in produce from all perimeter and onsite areas were not significantly higher than those in produce collected from regional areas. Of special note is that beryllium and lead were found at significantly higher levels in soils collected in perimeter and onsite areas, but were not found at significantly higher levels in produce collected from perimeter or onsite areas than in produce collected from around the region.

Monitoring results reported in 2002 (LANL 2004b) show trace elements in produce collected before and after the Cerro Grande Fire. From almost all sites, only selenium was present in higher concentrations in produce collected after the Cerro Grande Fire than in produce collected before the fire. It is hard to say that selenium concentrations in produce collected from these sites increased because of the Cerro Grande Fire because (1) no other trace elements were elevated after the fire, and (2) selenium concentrations in soil samples collected from these same sites in 2000 and 2002 were not significantly higher than in soils collected in 1999.

The 2003 Environmental Surveillance Report presents the results of a special study on perchlorates found in vegetables and irrigation waters (LANL 2004d). Perchlorates are used at LANL in explosive and actinide research and were released into the environment as treated and untreated effluent discharges. They are highly soluble, mobile, and long-lived, and they have migrated from shallow depths to deeper groundwater levels within LANL lands. Perchlorates are

Table C–47 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Soil

Soil Consumption: 36.5 g per Year Average, 146 g per Year High Intake

Analytes	*95% UCL Concentration (μg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Barium	164	0.000229	0.001	0.2		0.00114	0.00458		
Beryllium	0.924	1.28×10^{-6}	5.15×10^{-6}	0.002	4.3	0.000642	0.00257	5.52×10^{-6}	0.0000221
Mercury	0.0222	3.08×10^{-8}	1.24×10^{-7}	0.0003		0.000103	0.000412		
Lead	23.5	0.0000326	0.000131	0.0014		0.0233	0.0934		
Selenium	0.13	1.81×10^{-7}	7.24×10^{-7}	0.005		0.0000361	0.000145		

g = grams, kg = kilogram, L = liter, mg = milligram, μg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Soil Concentration (μg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/μg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–48 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Soil

Soil Consumption: 1.07 g per Year Average, 4.27 g per Year High Intake

Analytes	*95% UCL Concentration (μg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Barium	184	7.52×10^{-6}	0.0000301	0.2		0.0000376	0.000150		
Beryllium	0.932	3.80×10^{-8}	1.52×10^{-7}	0.002	4.3	0.0000190	0.0000760	1.64×10^{-7}	6.53×10^{-7}
Mercury	0.0242	9.87×10^{-10}	3.94×10^{-9}	0.0003		3.29×10^{-6}	0.0000131		
Lead	18.3	7.48×10^{-7}	2.99×10^{-6}	0.0014		0.000534	0.00213		

g = grams, kg = kilogram, L = liter, mg = milligram, μg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Soil Concentration (μg/g) × Consumption rate (g/day) × 1×10^{-3} (mg/μg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

readily taken up by plants, and the major source of water for home garden irrigation in the Los Alamos vicinity is from deep groundwater sources. Perchlorates inhibit thyroid function, but there is no current Federal standard for protection of human health. Therefore, a special study was conducted to evaluate the possible existence of perchlorates in locally grown foods. Results showed no perchlorate concentrations in any of the vegetable samples or water samples above the minimum reporting level or the minimum detection level.

The 2004 Environmental Surveillance Report (LANL 2005b) discussed the results of a special monitoring study to identify polychlorinated biphenyls in the Rio Grande. Polychlorinated biphenyls are extensively distributed worldwide and are ubiquitous in the environment. Concern has existed for years that LANL has released polychlorinated biphenyls into the environment that may have reached the Rio Grande. From 1997 to 2002, studies were conducted on polychlorinated biphenyls in fish taken from the Rio Grande and from Cochiti and Abiquiu reservoirs. One of the goals of the studies was to determine whether LANL has contributed to the polychlorinated biphenyl burdens. Results showed only a small amount of similarity between the type of aroclors indicated in the Rio Grande below LANL and aroclors known to exist at LANL. In addition, the studies concluded that, for the particular time period studied, LANL was not likely contributing polychlorinated biphenyls to the Rio Grande as indicated by the statistically similar total polychlorinated biphenyls concentrations at the two stations above LANL and the station immediately below LANL. This same conclusion was made in reports on the previous fish studies.

Fish normally collected each year include two types: predators and bottom-feeders. In any given year, predator fish may include the following: northern pike (*Esox lucius*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), white crappie (*Pomoxis annularis*), brown trout (*Salmo trutta*), white bass (*Morone chrysops*), and walleye (*Stizostedion vitreum*). Similarly, bottom-feeding fish may include the following: white sucker (*Catostomus commersoni*), channel catfish (*Ictalurus punctatus*), carp (*Cyprinus carpio*), and carp sucker (*Carpiodes carpio*). Bottom-feeding fish are better indicators of environmental contamination than predator game fish because the bottom-feeding fish forage on the bottom where contaminants readily bind to sediments.

In general, most of the trace elements in both predator and bottom-feeding fish collected upstream and downstream of LANL were below the limit of detection. Concentrations of the elements that were above the limit of detection (barium, mercury, and selenium) were within historical regional background concentrations and were statistically similar to concentrations in fish from other bodies of water in the region. Mercury concentrations, a major problem in New Mexico fisheries, were statistically significant in most fish collected. The levels of mercury in predator and bottom-feeding fish muscle (fillets) collected were still below the U.S. Food and Drug Administration's ingestion limit.

Tables C–49 and **C–50** show the contributions to health risk to the offsite resident from the ingestion of trace metals in produce and predator fish. **Table C–51** shows the contribution to health risk to the special pathways receptor from ingestion of trace metals in non-predator (bottom-feeding) fish.

Table C–49 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Produce

Produce Consumption: 8.2 g/kg-day Average, 25.5 g/kg-day High Intake

Analytes	*95% UCL Concentration (µg/g wet weight)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Barium	4.48	0.0367	0.114	0.2		0.184	0.571		
Beryllium	0.03	0.000246	0.000765	0.002	4.3	0.123	0.383	0.00106	0.00329
Mercury	0.0117	0.0000957	0.000297	0.0003		0.319	0.992		
Lead	0.658	0.00540	0.0168	0.00140		3.86	12		
Selenium	0.103	0.000844	0.00263	0.005		0.169	0.525		

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Produce Concentration (µg/g) × Consumption rate (g/day) × 1 × 10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–50 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Fish

Fish Consumption: 20.1 g/day Average, 53 g/day High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	1.42	0.000399	0.00105	0.005		0.0797	0.21		
Arsenic	0.5	0.00014	0.000369	0.0003	1.5	0.467	3.5	0.00021	0.00158
Barium	0.536	0.00015	0.000396	0.2		0.000751	0.00198		
Beryllium	0.264	0.0000738	0.000195	0.002	4.3	0.0369	0.0973	0.000317	0.000837
Cadmium	0.25	0.0000700	0.000185	0.0005	0.0018	0.14	0.369	1.26×10^{-7}	3.32×10^{-7}
Chromium	0.5	0.00014	0.000369	1.5		0.0000933	0.00246		
Mercury	0.6	0.000168	0.000443	0.00003		0.56	1.48		
Nickel	1	0.00028	0.000738	0.02		0.014	0.0369		
Lead	0.15	0.0000420	0.000111	0.001		0.03	0.0791		
Antimony	0.4	0.000112	0.000295	0.0004		0.28	0.738		
Selenium	1.10	0.000309	0.000814	0.005		0.0617	0.163		

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Fish Concentration (µg/g wet weight) × Consumption rate (g/day) × 1 × 10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–51 Hazard Index and Cancer Risk to the Special Pathways Receptor from the Ingestion of Nonradioactive Contaminants in Fish

Fish Consumption: 70 g per Day Average, 170 g per Day High Intake

Analytes	*95% UCL Concentration (µg/g)*	*Average Chronic Daily Intake (mg/kg-day)*	*High Chronic Daily Intake (mg/kg-day)*	*Oral RfD (mg/kg-day)*	*Oral Slope Factor (per mg/kg-day)*	*Average Case Hazard Index*	*High Intake Hazard Index*	*Average Case Cancer Risk*	*High Intake Cancer Risk*
Silver	0.5	0.000488	0.00119	0.005		0.0975	0.237		
Arsenic	0.526	0.000513	0.00125	0.0003	1.50	1.71	4.16	0.000770	0.00187
Barium	1.20	0.00117	0.00285	0.2		0.00587	0.0143		
Beryllium	0.264	0.000257	0.0006	0.002	4.30	0.129	0.312	0.0011	0.00269
Cadmium	0.25	0.000244	0.000593	0.0005	0.0018	0.488	1.19	4.39×10^{-7}	1.07×10^{-6}
Chromium	0.5	0.000488	0.00119	1.5		0.000325	0.000790		
Mercury	0.398	0.000388	0.000944	0.003		1.29	3.15		
Nickel	1.00	0.000975	0.00237	0.02		0.0488	0.119		
Lead	0.168	0.000163	0.000397	0.0014		0.117	0.284		
Antimony	0.4	0.00039	0.000948	0.0004		0.975	2.37		
Selenium	0.866	0.000844	0.00205	0.005		0.169	0.41		

g = grams, kg = kilogram, L = liter, mg = milligram, µg = microgram, RfD = Reference Dose, UCL = upper confidence limit.
Notes: Chronic Intake (mg/kg-day) = Fish Concentration (µg/g wet weight) × Consumption rate (g/day) × 1×10^{-3} (mg/µg) × 1/Body Weight (1/71.8 kg). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

C.3 Impacts on Human Health from Biological Agents

C.3.1 Introduction

The research capacity of LANL deals with a multitude of world-class scientific topics and is focused on advancing environmental and biomedical knowledge and supporting both the DOE mission and the national bio-defense mission. Current biological research covers a range of topics including, but not limited to, genomic (or genetic) and proteomic (the study of proteins generated by the genes of a particular cell) science, measurement science and diagnostics, molecular synthesis, structural biology, cell biology, computational biology, and environmental microbiology. All of these divisions are focused on understanding the interaction between humans, the microbial world, and the environment. This task is accomplished by the detailed study of microorganisms and their characteristics using technology specific to each of the groups mentioned above. Microorganisms are found naturally in the environment; they are living things that have or can develop the ability to act or function independently. There are different categories of microorganisms, including bacteria, viruses, and fungi. Bacteria are single-celled organisms that can multiply rapidly and live anywhere in the environment. Only a very small percentage of these can cause infection and mild-to-severe disease in humans. Bacteria are also capable of producing toxins that can be harmful to humans, animals, and plants. A virus is an acellular organism (that is, a single particle) that depends on the host cell's metabolic functions to multiply. Most but not all viruses can infect humans. Fungi are plant-like organisms that lack chlorophyll; a small number of these organisms are capable of causing disease in humans.

C.3.2 Principles of Biosafety

All laboratories within the United States, including LANL, follow a specific set of guidelines for all laboratory practices that is issued by the Centers for Disease Control and Prevention and the National Institutes of Health. These guidelines are safety protocols that provide a baseline for all laboratory work.

The term "containment" is used to describe safe methods of managing infectious materials in the laboratory environment where they are being handled or maintained. The purpose of containment is to reduce or eliminate exposure of laboratory workers, other persons, and the outside environment to potentially hazardous agents (HHS 2007).

Primary containment, the protection of personnel and the immediate laboratory environment from exposure to infectious agents, is provided by both good microbiological technique and the use of appropriate safety equipment. Secondary containment, the protection of the environment external to the laboratory from exposure to infectious materials, is provided by a combination of facility design and operational practices. Therefore, the three elements of containment include laboratory practice and technique, safety equipment, and facility design. The risk assessment of the work to be performed with a specific agent will determine the appropriate combination of these elements (HHS 2007).

C.3.2.1 Safety Equipment (Primary Barriers)

Safety equipment includes biological safety cabinets, enclosed containers, and other engineering controls designed to remove or minimize exposures to hazardous biological materials. The biological safety cabinet is the principal device used to provide containment of infectious splashes or aerosols generated by many microbiological procedures. Three types of biological safety cabinets (Class I, II, and III) are used in microbiological laboratories. Open-fronted Class I and Class II biological safety cabinets are primary barriers that offer significant levels of protection to laboratory personnel and the environment when used with good microbiological techniques. The Class II biological safety cabinet also provides protection from external contamination of the materials (for example, cell cultures, microbiological stocks) being manipulated inside the cabinet. The gas-tight Class III biological safety cabinet provides the highest attainable level of protection to personnel and the environment. Safety equipment also may include items for personal protection such as gloves, coats, gowns, shoe covers, boots, respirators, face shields, safety glasses, or goggles. Personal protective equipment is often used in combination with biological safety cabinets and other devices that contain the agents, animals, or materials being handled (HHS 2007).

C.3.2.2 Facility Design and Construction (Secondary Barriers)

The design and construction of the facility contributes to laboratory workers' protection, provides a barrier to protect persons outside the laboratory, and protects persons or animals in the community from infectious agents that may be accidentally released from the laboratory. Laboratory management is responsible for providing facilities commensurate with the laboratory's function and the recommended biosafety level for the agents being manipulated.

The recommended secondary barrier(s) will depend on the risk of transmission of specific agents. For example, the exposure risks for most laboratory work in Biosafety Level 1 and 2 facilities will be direct contact with the agents or inadvertent contact exposures through contaminated work environments. Secondary barriers in these laboratories may include separation of the laboratory work area from public access, availability of a decontamination facility, and handwashing facilities. When the risk of infection by exposure to an infectious aerosol is present, higher levels of primary containment and multiple secondary barriers may be necessary to prevent infectious agents from escaping into the environment. Such design features include specialized ventilation systems to ensure directional airflow, air treatment systems to decontaminate or remove agents from exhaust air, controlled access zones, airlocks at laboratory entrances, or separate buildings or modules to isolate the laboratory. Design engineers for laboratories may refer to specific ventilation recommendations such as those found in the Applications Handbook for Heating, Ventilation, and Air-Conditioning published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (HHS 2007).

C.3.2.3 Waste

Biological waste being removed from a laboratory is disinfected with a 10 percent Clorox solution or by autoclaving (a process using temperature and pressure to produce steam) regardless of the safety level. These processes, when implemented correctly, ensure that all waste is decontaminated before it leaves the confinement of the facility (HHS 2007). Normal laboratory waste is handled in an appropriate manner in accordance with the type of waste being discarded via the LANL Safety Plan.

C.3.2.4 Biological Release

LANL operates Biosafety Level 1 and 2 (see the discussion of Biosafety Levels in Section C.3.3) facilities as discussed in Chapter 3, Section 3.1.3.11, of this SWEIS. If released into the environment, Biosafety Level 1 material at LANL would pose little to no risk to the workers, public, or environment in general because this biological material is not known to consistently cause disease and is not contagious. Biosafety Level 2 facilities use an extensive set of procedures, safety equipment, and containment facilities that prevent any releases of Biosafety Level 2 agents that would affect workers or the public. Laboratory personnel are still subject to non-biological hazards that are associated with all workplaces and are subject to Occupational Safety and Health Administration regulations.

C.3.3 Biosafety Levels

Four biosafety levels represent combinations of laboratory practices and techniques, safety equipment, and laboratory facilities. Each combination is specifically appropriate for the operations performed, the documented or suspected routes of transmission of the infectious agents, and the laboratory function or activity. The recommended biosafety level(s) for specific organisms represent those conditions under which the agent(s) ordinarily can be safely handled. When specific information is available to suggest that the human body's ability to resist the type, strength, and rate of infection is insufficient, or that antibiotic resistance patterns, vaccine and treatment availability, or other factors are significantly altered, more (or less) stringent practices may be specified (HHS 2007).

C.3.3.1 Biosafety Level 1

Biosafety Level 1 practices, safety equipment, and facility design and construction are appropriate for undergraduate and secondary educational training and teaching laboratories, as well as other laboratories in which work is performed with defined and characterized strains of viable microorganisms that are not known to consistently cause disease in healthy adult humans. *Bacillus subtilis, Naegleria gruberi,* infectious canine hepatitis virus, and exempt organisms under the National Institutes of Health Recombinant DNA Guidelines represent microorganisms that meet these criteria. Vaccine strains that have undergone multiple in vivo (that is, within a living organism) passages should not be considered infectious simply because they are vaccine strains. Biosafety Level 1 represents a basic level of containment that relies on standard microbiological practices with no special primary or secondary barriers recommended, other than a sink for handwashing (HHS 2007).

C.3.3.2 Biosafety Level 2

Biosafety Level 2 practices, equipment, and facility design and construction are applicable to clinical, diagnostic, teaching, and other laboratories in which work is performed with the broad spectrum of naturally occurring moderate-risk agents that are present in the community and associated with human disease of varying severity. With good microbiological techniques, these agents can be used safely in activities conducted on the open bench, provided the potential for producing splashes or aerosols is low. Hepatitis B virus, HIV, *salmonellae*, and *Toxoplasma spp.* (a parasite that spreads from animals to humans) are representative of microorganisms assigned to this containment level. Biosafety Level 2 is appropriate when work is performed with any human-derived blood, body fluids, tissues, or primary human cell lines where the presence of an infectious agent may be unknown. (Laboratory personnel working with human-derived materials should refer to the Occupational Safety and Health Administration Bloodborne Pathogen Standard for specific required precautions.) Primary hazards to personnel working with these agents relate to accidental skin absorption, mucous membrane exposures, or ingestion of infectious materials. Extreme caution should be taken with contaminated needles or sharp instruments. Even though organisms routinely manipulated at Biosafety Level 2 are not known to be transmissible by the aerosol route, procedures with aerosol or high splash potential that may increase the risk of such personnel exposure must be conducted in primary containment equipment or in devices such as a biological safety cabinet. Other primary barriers should be used as appropriate, such as splash shields, face protection, gowns, and gloves. Secondary barriers such as handwashing sinks and waste decontamination facilities must be available to reduce potential environmental contamination (HHS 2007).

C.3.3.3 Biosafety Level 3

Biosafety Level 3 practices, safety equipment, and facility design and construction are applicable to clinical, diagnostic, teaching, research, or production facilities in which work is performed with indigenous or exotic agents with a potential for respiratory transmission, and thus may cause serious and potentially lethal infection. *Mycobacterium tuberculosis*, St. Louis encephalitis virus, and *Coxiella burnetii* are representative of the microorganisms assigned to this level. Primary hazards to personnel working with these agents relate to autoinoculation (that is, inoculation with a vaccine made from microorganisms obtained from the recipient's own body), ingestion, and exposure to infectious aerosols. At Biosafety Level 3, more emphasis is placed on primary and secondary barriers to protect personnel in contiguous areas, the community, and the environment from exposure to potentially infectious aerosols. For example, all laboratory manipulations should be performed in a biological safety cabinet or other enclosed equipment such as a gas-tight aerosol generation chamber. Secondary barriers for this level include controlled access to the laboratory and ventilation requirements that minimize the release of infectious aerosols from the laboratory (HHS 2007). The Biosafety Level 3 work being proposed for LANL is being addressed in a separate environmental impact statement and is not addressed in this SWEIS.

C.3.3.4 Biosafety Level 4

Biosafety Level 4 practices, safety equipment, and facility design and construction are applicable to work with dangerous and exotic agents that pose a high individual risk of life-threatening disease, may be transmitted via the aerosol route, and have no available vaccine or therapy. Agents with similar genetics to Biosafety Level 4 agents also should be handled at this level. When sufficient data are obtained, work with these agents may continue at this level or at a lower level. Viruses such as Marburg or Congo-Crimean hemorrhagic fever are manipulated at Biosafety Level 4 (HHS 2007). No Biosafety Level 4 work is currently performed or proposed to be performed at LANL. **Table C–52** delineates containment design practices and levels of biological agents for each Biosafety Level Facility.

Table C–52 Containment Design Practices and Levels of Biological Agents for Each Biosafety Level Facility

Biosafety Level	*Agents*	*Practices*	*Safety Equipment (Primary Barriers)*	*Facilities (Secondary Barriers)*
1	Not known to consistently cause disease in healthy adults.	Standard Microbiological Practices	None required.	Open bench top sink required.
2	Associated with human disease; hazard = percutaneous injury (that is, injury obtained through the skin or skin puncture), ingestion, and mucous membrane exposure.	Biosafety Level 1 practices plus: - Limited access, - Biohazard warning signs, - "Sharps" precautions, and - Biosafety manual defining any needed waste decontamination or medical surveillance policies	Primary barriers = Class I or II biological safety cabinets or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials; personal protective equipment: laboratory coats; gloves; and face protection as needed.	Biosafety Level 1 plus: - Autoclave (a strong, pressurized, steam-heated vessel, used for sterilization).
3	Indigenous or exotic agents with potential for aerosol transmission; disease may have serious or lethal consequences.	Biosafety Level 2 practices plus: - Controlled access, - Decontamination of all waste, - Decontamination of lab clothing before laundering, and - Baseline serum.	Primary barriers = Class I or II biological safety cabinets or other physical containment devices used for all open manipulations of agents; personal protective equipment: protective lab clothing; gloves; and respiratory protection as needed.	Biosafety Level 2 plus: - Physical separation from access corridors; - Self-closing, double-door access; - Exhausted air not recirculated; and - Negative airflow into laboratory.
4	Dangerous or exotic agents which pose high risk of life-threatening disease from aerosol-transmitted lab infections or related agents with unknown risk of transmission.	Biosafety Level 3 practices plus: - Clothing change before entering, - Shower on exit, and - All material decontaminated on exit from facility.	Primary barriers = All procedures conducted in Class III biological safety cabinets or Class I or II biological safety cabinets in combination with full-body, air-supplied, positive pressure personnel suit.	Biosafety Level 3 plus: - Separate building or isolated zone; - Dedicated supply and exhaust, vacuum, and decontamination systems; and - Other requirements outlined in Section C.3.3.3.

Source: HHS 2007.

C.3.4 Detection

Unlike chemical or radiological hazards, biological organisms cannot be recognized instantaneously due to the complexity of differentiating normal background organisms from potentially deadly organisms. Therefore, the scientific community has been working diligently to develop methods and assays that will allow collection and identification of an organism within any sample within an acceptable time. The detection of a biological agent starts with being able to collect samples from surfaces, air, water, soil, or bodily fluids that contain the potentially harmful organism. The next step in detection is identifying the presence of a harmful organism and its identification. These assays must be capable of utilizing specificity, time, and accuracy to identify the unknown agent; the more specific assays take a longer period of time. The methods that are most commonly used are Polymerase Chain Reaction, Enzyme-Linked Immunosorbent Assay, and Culturing. Polymerase Chain Reaction is a method in which specific DNA sequences are amplified to identify the presence or absence of a given organism. Enzyme-Linked Immunosorbent Assay is a method that determines the presence of antibodies to a foreign substance. Culturing, the gold standard method for many reference laboratories, is a method in which a given sample is spread on a nutrient culture plate containing the appropriate media for the organism of interest and allowed to grow for a given length of time at a given temperature. This method allows investigators to identify all living organisms within a sample, unlike the previous methods that cannot distinguish between living or dead organisms. All of these methods together are being developed to help protect the public from a biological attack.

C.3.5 Select Biological Agents

Select agents are specifically regulated pathogens and toxins as defined in 42 CFR Part 73, including pathogens and toxins regulated by both the U.S. Department of Health and Human Services and U.S. Department of Agriculture (specifically overlapping agents or toxins). These agents are select agents because they have been or could be used by a nation state or terrorist group to attack the United States in the form of biological warfare; therefore they are a risk to national security. These select agents are a concern because:

- They can be easily or moderately disseminated or transmitted from person to person;
- They result in high mortality rates, moderate morbidity rates, and have the potential for a major public health impact;
- They might cause public panic and social disruption;
- They require special action for public health preparedness;
- They require specific enhancements of the Center for Disease Control and Prevention’s diagnostic capacity and enhanced disease surveillance;
- Their ease of production and dissemination; and
- They can be engineered for mass dissemination in the future.

C.3.6 Transmission

These different types of agents are also categorized by route of infection or transmission; that is, how they are passed via an animal (zoonotic), a host – mosquito (vector-borne), or a human. A “zoonotic disease is a disease caused by infectious agents that can be transmitted between (or are shared by) animals and humans” (Olsen 2000). These categories of agents also can be described by whether or not they just cause infection in the person that had contact with that organism (infectious) and whether the infection is passed from person to person (contagious).

C.4 Key Differences Between Biological, Radiological, and Chemical Agents

Although each is always present in our environment and can be both beneficial and detrimental to human health, there are several important distinctions between biological, radiological, and chemical agents, including those listed below:

- Biological organisms have the capability to survive and replicate within a given environment, whereas both radiological and chemical agents will decay or remain constant over time.
- Detection time for chemicals and ionizing radiation is faster than for biological materials (minutes versus hours).
- Only biological materials are capable of contagious spread from person to person.
- There are levels of radiation and concentrations of chemicals below which there are no discernible health effects; but even at minute concentrations, certain biological agents may cause health effects ranging from mild illness (morbidity) to fatal illness (mortality).
- All chemical agents and some biological agents can be neutralized by the use of other chemicals, but radiation cannot be neutralized; it can only be shielded or contained.

C.5 References

CIRRPC (Committee on Interagency Radiation Research and Policy Coordination), 1992, *Use of BEIR V and UNSCEAR 1988 in Radiation Risk Assessment, Lifetime Total Cancer Mortality Risk Estimates at Low Doses and Low Dose Rates for Low-LET Radiation*, ORAU 92/F-64, Science Panel Report No. 9, Office of Science and Technology Policy, Executive Office of the President, Washington, DC, December.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 2003a, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE), ISCORS Technical Report No. 1*, DOE/EH-412/0015/0802, Rev. 1, Office of Environmental Policy and Guidance, Washington, DC, January.

DOE (U.S. Department of Energy), 2003b, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0350, Los Alamos, New Mexico, November.

EPA (U.S. Environmental Protection Agency), 1994, *Estimating Radiogenic Cancer Risks,* EPA 402-R-93-076, Office of Radiation and Indoor Air, Washington, DC, June.

EPA (U.S. Environmental Protection Agency), 1997, *Exposure Factors Handbook*, National Center for Environmental Assessment, Office of Research and Development, Washington, DC, August.

EPA (U.S. Environmental Protection Agency), 1999, *Cancer Risk Coefficients for Environmental Exposure To Radionuclides,* Federal Guidance Report, No. 13, EPA 402-R-99-001, Office of Radiation and Indoor Air, Washington, DC, September.

EPA (U.S. Environmental Protection Agency), 2001, *Office of Radiation and Indoor Air, Health Effects Assessment Summary Tables (HEAST) - Radionuclides Table*, April 16.

EPA (U.S. Environmental Protection Agency), 2002, *CAP88-PC Version 3.0 User Guide, Draft Revision 1*, Office of Radiation and Indoor Air, Washington, DC, August.

EPA (U.S. Environmental Protection Agency), 2003, *CSFII Analysis of Food Intake Distributions,* EPA/600/R-03/029, National Center for Environmental Assessment–Washington Office, Office of Research and Development, Washington, DC, March.

EPA (U.S. Environmental Protection Agency), 2005a, *Integrated Risk Information System, IRIS Substance List,* (accessed at www.epa.gov/IRIS).

EPA (U.S. Environmental Protection Agency), 2005b, *Region 6 Human Health Medium-Specific Screening Levels 2006*, (accessed at *www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm)*, EPA Region 6, Dallas, TX, December.

HHS (U.S. Department of Health and Human Services), 2007, *Biosafety in Microbiological and Biomedical Laboratories*, Centers for Disease Control and Prevention, National Institutes of Health, Health and Human Services, Fifth Edition, February.

ICRP (International Commission on Radiological Protection), 1991, *1990 Recommendations of the International Commission on Radiological Protection*, Annals of the ICRP, ICRP Publication 60, Vol. 21, No. 1-3, Pergamon Press, New York, New York, November.

LANL (Los Alamos National Laboratory), 2000, *U.S. Department of Energy Report, 1999 LANL Radionuclide Air Emissions*, LA-13732-ENV, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2001, *U.S. Department of Energy Report*, *2000 LANL Radionuclide Air Emissions*, LA-13839-MS, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2002a, *U.S. Department of Energy Report*, *2001 LANL Radionuclide Air Emissions*, LA-13957-PS, Office of Los Alamos Site Operations, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2002b, *Environmental Surveillance at Los Alamos during 2001*, LA-13979-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003a, *U.S. Department of Energy Report, 2002 LANL Radionuclide Air Emissions*, LA-14058-PR, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003b, *Dose Assessment Using CAP88*, RRES-MAQ-501, R6, Meteorology and Air Quality, August 26.

LANL (Los Alamos National Laboratory), 2004a, *Air-Sampling Data from Area G: A Radioactive-Waste Management Site*, LA-14090, January.

LANL (Los Alamos National Laboratory), 2004b, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2004c, *U.S. Department of Energy Report, 2003 LANL Radionuclide Air Emissions*, LA-14155-PR, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2004d, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *U.S. Department of Energy Report, 2004 LANL Radionuclide Air Emissions*, LA-14233, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

National Research Council, 2005, Free Executive Summary, *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation,* (accessed February 28, 2006 at www.nap.edu/catalog/11340.html).

NCRP (National Council on Radiation Protection and Measurements), 1987, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 93, Bethesda, Maryland, September 1.

NCRP (National Council on Radiation Protection and Measurements), 1993, *Risk Estimates for Radiation Protection,* NCRP Report No. 115, Bethesda, Maryland, December 31.

NRC (U.S. Nuclear Regulatory Commission), 2003, *SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program*, NUREG/CR-6525, Rev. 1, Washington, DC, August.

NutritionData, 2006, "Nutritional Summary for Nuts, pine nuts, pinyon, dried," (accessed at www.nutritiondata.com/ facts-001-02s02f2.html), Nutrition Facts and Calorie Counter, New York, New York.

Olsen, C., 2000, "Zoonotic Diseases Tutorial," (accessed February 28, 2006, www.vetmed.wisc.edu/pbs/zoonoses), Department of Pathobiological Sciences, School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin.

APPENDIX D
EVALUATION OF HUMAN HEALTH IMPACTS FROM FACILITY ACCIDENTS

APPENDIX D
EVALUATION OF HUMAN HEALTH IMPACTS FROM FACILITY ACCIDENTS

D.1 Introduction

This appendix provides additional information and details to support the analysis of the impacts of potential facility accidents presented in Chapter 5. It includes, in Section D.2, an evaluation of the present applicability of the methodology and accident data that were reported in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a) to inform the public of the differences in analyses between that document and the current site-wide environmental impact statement (SWEIS) for continued operation of Los Alamos National Laboratory (LANL). This is followed in Section D.3 with a discussion of the postulated radiological and chemical accident scenarios and their estimated impacts to workers and the public. Section D.4 discusses site-wide seismic impacts. Wildfires in the LANL vicinity and their potential for causing the release of hazardous radiological and chemical materials are a subject of public concern. A wildfire accident scenario was analyzed and its potential impacts to workers and the public are discussed in Section D.5. The impact discussions in Sections D.3 through D.5 address the general population and specific bounding individuals (the noninvolved worker and the maximally exposed individual [MEI]). Section D.6 discusses the impacts to the worker directly involved in the operation being analyzed, that is, the involved worker. Section D.7 presents impacts on individuals at various distances up to 3,281 yards (3,000 meters) from each hypothesized accident source. Two computer codes were used to analyze the postulated accidents and to estimate their impacts: (1) MACCS for radiological releases; and (2) ALOHA for chemical releases. These codes are described in Sections D.8 and D.9, respectively.

D.2 Data and Analysis Changes from the *1999 SWEIS*

Accident scenarios are generally chosen for analysis in an environmental impact statement to represent the range of possible initiating events and impacts. Accidents resulting in severe (often bounding) consequences and risks are typically presented as well. In the case of the current SWEIS, scenarios from the *1999 SWEIS* were considered. Changes to LANL operations since 1999 and any new information that could change the scenarios evaluated in 1999 were incorporated. In addition, operations that are planned or have been initiated since 1999 were included. Scenarios for these changed and new operations were chosen to demonstrate the range of possible accidents and to describe the bounding impacts.

The differences between accidents analyzed in the *1999 SWEIS* and this SWEIS are provided in **Table D–1**. Most of the differences are the result of updated environmental information (such as population and meteorology data) and changes in facility operations (facilities added, deleted, or material at risk [MAR] changes). Additional, relevant aspects of the overall study that pertain to other environmental resource areas are addressed elsewhere in this SWEIS.

The first column of Table D–1 refers to an accident topic or issue discovered during the review of documented information. Designations such as RAD-01, CHEM-01, and SITE-01 refer to specific accidents that were postulated and analyzed in the *1999 SWEIS*. The relevant facilities are also identified in the column, where applicable. The second column contains a qualitative description to reflect any changes in scenarios since the *1999 SWEIS* was issued. The third column is an evaluation of the current information on the listed topic or issue. The information contained in Table D–1 played a dominant role in directing the course of the facility accident analyses performed for this SWEIS.

Much of the background data, such as meteorology or plume characteristics, and its use in the present analysis are described in **Table D–2**. As indicated in the table, an offsite population distribution based on the 2000 census was determined for each LANL technical area (TA); this distribution was then applied to any releases from that area. Populations were considered to a distance of 50 miles (80 kilometers) from the TA.

D.3 Radiological and Chemical Accidents

This section provides information and data that supports the analysis of radiological and chemical impacts of facility accidents for each alternative presented in Chapter 5. It includes the accident frequency of occurrence and impacts, scenarios, material at risk, source terms, and factors used in the calculation of source terms.

These scenarios represent potential accidents at individual facilities. Earthquakes and wildfires that could impact multiple facilities are considered in Sections D.4 and D.5, respectively.

D.3.1 Radiological and Chemical Scenarios and Source Terms

The accident scenarios and source terms used to calculate the radiological and chemical accident impacts are shown in **Table D–3**. The evolution of choosing these scenarios is described in Table D–1. As described there, most of these scenarios evolved from those analyzed in the *1999 SWEIS*.

The Decontamination and Volume Reduction System (DVRS) is a new operation that was not considered in the *1999 SWEIS*. The impacts from an operational spill at DVRS are presented to depict the consequences of a relatively high probability operational accident. The forklift collision and spill associated with the building fire scenario are included because they represent high consequence and high risk (relative to other DVRS scenarios) impacts to the general public and workers.

Table D–1 Evaluation of Accident Data from the *1999 SWEIS*

Topic/Issue	*Scenario Notes*	*Evaluation*
Offsite population	None	Offsite population has increased in magnitude by 20 to 30 percent.
Modeling Methodology		Dose-to-LCF factor has increased by 20 percent (public) and 50 percent (worker). Other SWEIS modeling parameters that were not specified in the *1999 SWEIS* can affect MEI and population doses.
Meteorological Data		Post-*1999 SWEIS* meteorological data are available through 2003. Sensitivity analysis using more recent data show increases in population dose of up to 20 percent. Chemical accident impacts would also increase.
RAD-01 TA-54, RANT	Increased source term	Reanalyzed based on scenario changes including increased source term from 2006 BIO. Now noted as RANT Lightning Strike Fire.
RAD-02 TA-3, CMR	New CMR scenario	The *CMRR EIS* (DOE 2003a) was published after the *1999 SWEIS*. The maximum risk no action accident from that document was selected to represent CMR. The scenario is called CMR HEPA filter fire.
RAD-03 TA-18, GODIVA IV	No longer operating	Not analyzed because this TA-18 mission is being relocated to the Nevada Test Site. MAR that was formerly at TA-18 has been moved to the TA-55 SST Facility and is considered part of the site-wide seismic scenarios.
RAD-04 TA-15, DARHT	Nonnuclear	Not analyzed; now a nonnuclear facility.
RAD-05 TA-21, TSFF	MAR moved to WETF	Replaced with WETF Fire. Remaining MAR analyzed as part of site-wide seismic scenarios.
RAD-06 TA-50-37, RAMROD	Radiological facility	Not analyzed; facility is no longer a nuclear facility and thus would not impact offsite receptors.
RAD-07 TA-50-69, WCRR	Increased Source Term	Now called WCRR Lightning Strike Fire. New accident scenario from 2006 BIO.
RAD-08 TA-54, TWISP	New transuranic waste storage scenario	Replaced with Waste Storage Dome Fire. Major risk accident from the Safety Evaluation Report for TA-54 Area G (DOE 2003b).
RAD-09 TA-54, TWISP	New waste storage domes scenario	Replaced with Onsite Transuranic Waste Fire Accident. Major risk accident from the Safety Evaluation Report for TA-54 Area G (DOE 2003b).
RAD-10 TA-55-4, Plutonium Facility	Increased Source Term	Now called Plutonium Facility Materials Staging Area Fire.
RAD-11 TA-15, DARHT	Nonnuclear	Not analyzed; now a nonnuclear facility.
RAD-12 TA-16-411	Radiological facility	Not analyzed; facility is no longer a nuclear facility and thus would not impact offsite receptors. Remaining MAR analyzed as part of Site-wide Wildfire.
RAD-13 TA-18, Pajarito Site, Kiva #3	No longer operating	Replaced with scenario for only operating reactor, SHEBA Hydrogen Detonation. Scenario is major risk SHEBA accident scenario from the *TA-18 Relocation EIS* (DOE 2002a). MAR that was formerly at TA-18 has been moved to the TA-55 SST Facility and is considered part of the site-wide seismic scenarios.
RAD-14 TA-55-4, Plutonium Facility	Deleted	Replaced by Materials Staging Area Fire Accident Scenario.

Topic/Issue	***Scenario Notes***	***Evaluation***
RAD-15 TA-3-29 CMR	New CMR scenario	See RAD02. Wing Fire now considered part of Radiological Sciences Institute.
RAD-16 TA-3-29, CMR	New CMR scenario	See RAD02.
SITE-01 (Rad) Site-wide Earthquake	Change in source term and components	Renamed Seismic 1. CMR source term replaced based on CMR EIS (DOE 2003a). TA-18 source term changed based on TA-18 Relocation EIS (DOE 2002a), plus movement of material from TA-18 to TA-55 (see Seismic 02). RAMROD deleted because it is no longer a nuclear facility. Decrease in TA-21 source term. Change in scenario and increase in RANT source term. No release from waste storage domes during this event (DOE 2003b). DVRS glovebox processing campaign added (DOE 2004b). Nominally PC-2.
SITE-02 (Rad) Site-wide Earthquake	Change in source term and components	Renamed Seismic 2. Seismic 1 changes (above) carry to this scenario. Increase in WETF source term. TWISP (now Domes) scenario revised; source term increase based on all domes (DOE 2003b). Plutonium Facility releases based on 2002 BIO. Added SST Facility (material moved from TA-18 and awaiting shipment to the Nevada Test Site). Nominally PC-3. All else unchanged from *1999 SWEIS* with exception of new higher source term for TA-50-69 and TA-55-4.
SITE-03 (Rad) Site-wide Earthquake	Deleted	No significant scenarios beyond those of Seismic 2. Surface rupture not considered in source document (DOE 2003a).
SITE-04 (Rad) Site-wide Wildfire	Change in source term and components	Renamed Wildfire. TA-21 source terms decreased. Sigma Complex, Radiochemistry Laboratory, waste storage domes added.
CHEM-01 TA-00-1109	Deleted	Accident is no longer applicable because MAR has been moved offsite (LANL 2004).
CHEM-02 TA-3-476	Deleted	Chlorine no longer stored for water treatment (LANL 2004).
CHEM-03 TA-3-476	Deleted	Chlorine no longer stored for water treatment (LANL 2004).
CHEM-04 TA-54-216	No change	Now labeled 75 liters selenium hexafluoride from waste cylinder storage at TA-54-216 (LANL 2004).
CHEM-05 TA-54-216	No change	Now labeled 300 pounds sulfur dioxide from waste cylinder storage at TA-54-216 (LANL 2004).
CHEM-06 TA-55-4	No change	Now labeled 150 pounds of chlorine gas released outside of Plutonium Facility (LANL 2004).
Helium at TA-55-41	New	Added to represent possible asphyxiant release accident.
SITE-01 (Chem) Site-wide Earthquake	Change in source term and components	Renamed Seismic 1. Chlorine at TA-00 and TA-3 deleted; no longer at site. Phosgene and formaldehyde sources decreased.
SITE-02 (Chem) Site-wide Earthquake	Change in source term and components	Renamed Seismic 2. Seismic 1 changes carry over to this scenario.
SITE-03 (Chem) Site-wide Earthquake		Same scenario as Seismic 2. SITE-03 was combined with SITE-02 to create Seismic 2.

Topic/Issue	*Scenario Notes*	*Evaluation*
SITE-04 (Chem) Site-wide Wildfire	Change in source term and components	Renamed Wildfire. Hydrogen cyanide from Sigma Complex added.
TA-54, DVRS	New	DVRS glovebox processing campaign scenarios are added (DOE 2004b).
Sealed Sources at CMR	New	Sealed source MAR at CMR added.
MDA G	New	Scenario (explosion) that could potentially affect offsite receptors chosen (see Appendix I).
Aircraft Crash	New	*1999 SWEIS* aircraft crash scenarios changed because either MAR moved (see RAD-05); facilities are no longer operating (see RAD-06); or a more bounding, non-aircraft crash scenario was chosen for analysis (see RAD-08 and RAD-16). Aircraft crash scenario analyzed in Appendix J (Human Health Impacts section) of this SWEIS for Sealed Sources in Waste Storage Domes at TA-54, Area G. Highest-risk sealed source scenario (Sealed Sources at CMR) brought forward to this appendix (see Sealed Sources at CMR above).
CMRR	Bounded by CMR	DOE 2003a considered accidents from both CMR (No Action) and the CMRR (Preferred Action). Results (Tables C–3 and C–5 of that document) show that CMRR accident risks are bounded by those of CMR. Therefore, the latter is analyzed here.
WORK-01 thru -05	Not included	Involved worker accident consequences were addressed qualitatively in the *1999 SWEIS*. Designations Work-01 through -05 were dropped and replaced with discussion in Section D.6.
Criticality Scenario	Involved worker issue	Considered in *1999 SWEIS* for TA-18 (facility not operating in the alternatives for this SWEIS) and qualitatively for involved workers (WORK-03). SHEBA (TA-18) criticality considered in the TA-18 Relocation EIS (DOE 2002a) and risks to the public and non-involved worker shown (Table C–6 of that document) to be inconsequential and bounded by the SHEBA Hydrogen Detonation scenario analyzed in this SWEIS. Criticality scenario impacts are short range and affect involved workers only. Involved worker impacts are discussed in Section D.6.
Detonation of High Explosives Scenario	Involved worker issue	Considered qualitatively in *1999 SWEIS* for involved workers (WORK-01). No potential for associated radionuclide or toxic chemical release consequences to public. High explosive detonation scenario impacts are short range and affect involved workers only. Involved worker impacts are discussed in Section D.6.

LCF = latent cancer fatality; MEI = maximally exposed individual; TA = technical area; RANT = Radioassay and Nondestructive Testing; BIO = basis of interim operation; CMR = Chemistry and Metallurgy Research Building; CMRR EIS = *Final Environmental Impact Statement for the Chemistry and Metallurgy Research and Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*; HEPA = high-efficiency particulate air; GODIVA = fast burst reactor formerly operating in TA-18; MAR = material at risk; SST = Safe Secure Transport; DARHT = Dual-Axis Radiographic Hydrodynamic Test; TSFF = Tritium Science and Fabrication Facility; WETF = Weapons Engineering Tritium Facility; RAMROD = Radioactive Materials Research, Operations, and Demonstration; WCRR = Waste Characterization, Reduction, and Repackaging Facility; TWISP = Transuranic Waste Inspectable Storage Project; SHEBA = Solution High-Energy Burst Assembly; DVRS = Decontamination and Volume Reduction System; PC = performance category; MDA = material disposal area; CMRR = Chemistry and Metallurgy Research Replacement Facility.

Table D–2 General Analysis Assumptions Independent of Scenario

Parameter	*General Population*	*MEI, Workers*	*Comments*
MACCS2			**Version 1.13.1**
Population	SECPOP2000 (NRC 2003) 2000 census. General population distribution centered at accident source facility.	Noninvolved worker at 100 meters from source.	Facility locations from LANL 2006. MEI and noninvolved worker using "peak dose at a distance" MACCS2 results.
Population Ring Boundaries	1, 2, 3, 4, 5, 10, 20, 30, 40, 50 miles	Not applicable	General population to 50 miles.
Inhalation and external exposure from plume	Yes	Yes	
Inhalation and external exposure from deposition and resuspension	Yes	No	MEI and noninvolved worker are short-term exposures.
Breathing rate	0.000347 cubic meters per second	0.000347 cubic meters per second	DOE 1992.
Exposure from agricultural pathway, except tritiated water, strontium-90 and cesium-137	No	No, due to short exposure time.	Plutonium and uranium chief inhalation risks.
Exposure from agricultural pathway, tritiated water, strontium-90, and cesium-137	Yes, HTO estimated using CAP88. Derived factor.	No, due to short exposure time.	Ratio of ingestion to inhalation as determined from unit release of HTO using CAP88 (EPA 2005). No worker or individual ingestion pathway.
Evacuation	No	No	Assume no protective actions taken.
Relocation	No	No	Assume no protective actions taken.
Cloud shielding factor	0.75	1	General population from Chanin and Young 1997.
Protection factor for inhalation	0.41	1	General population from Chanin and Young 1997.
Skin protection factor	0.41	1	General population from Chanin and Young 1997.
Ground shielding factor	0.33	1	General population from Chanin and Young 1997. No deposition for workers.
Groundshine weathering coefficients	0.5, 0.5	0.5, 0.5	Chanin and Young 1997. Not applicable to workers.
Groundshine weathering coefficient half-lives	1.6×10^{7}, 2.8×10^{9} seconds	1.6×10^{7}, 2.8×10^{9} seconds	Chanin and Young 1997. Not applicable to workers.
Resuspension concentration coefficient	10^{-5}, 10^{-7}, 10^{-9} per meter	10^{-20}, 10^{-20}, 10^{-20} per meter	General population from Chanin and Young 1997. No resuspension for workers.
Resuspension concentration coefficient half-lives	1.6×10^{7}, 1.6×10^{8}, 1.6×10^{9} seconds	1.6×10^{7}, 1.6×10^{8}, 1.6×10^{9} seconds	0.5, 5, and 50 years, respectively (Chanin and Young 1997). Not applicable to workers.
Wet deposition	Yes	No	No wet deposition for workers. No wet deposition of noble gases (Chanin and Young 1997).
Dry deposition	Yes	No	No dry deposition for workers (conservative). No dry deposition of noble gases (Chanin and Young 1997).

Parameter	***General Population***	***MEI, Workers***	***Comments***
Washout coefficient	0.000095, 0.8	0.000095, 0.8	Chanin and Young 1997. Not applicable to workers and MEI.
Deposition velocity	.01, .005, .001 meters per second	.01, .005, .001 meters per second	Unfiltered particulates, tritiated water, filtered particulates, respectively. Not applicable to workers and MEI.
Long-term exposure period (resuspension)	317 years (1×10^{10} sec)	317 years (1×10^{10} sec)	Maximum allowed by MACCS2. Not applicable to workers and MEI.
Sigma-y, Sigma-z (dispersion parameters)	Tadmor-Gur Tables	Tadmor-Gur Tables	Chanin and Young 1997.
Surface roughness length correction	1.27	1.66	Corresponds to z0=10 centimeters (rural) for general population and z0=38 centimeters (DOE 2004b) for workers.
Plume meander time base	600 seconds	600 seconds	Chanin and Young 1997.
xpfac1	0.2	0.01	Plume meander exponential factor for time less than break point (1 hour). General population from DOE 1992, workers set to .01 (minimum value allowed by MACCS), so no plume meander for 1 hour (conservative).
xpfac2	0.25	0.25	Chanin and Young 1997; plume meander exponential factor for times greater than 1 hour.
Plume segment reference time	0	0	Plume segment reference at leading edge of plume (for dispersion, deposition, decay calculations).
TA releases for which TA-6 Meteorological Tower data are used	[3], 6, 8, 9, [16], 22, 35, 40, 43, 48, [50], 52, [55], 59, 60, 61, 63, 64, 66, 69	[3], 6, 8, 9, [16], 22, 35, 40, 43, 48, [50], 52, [55], 59, 60, 61, 63, 64, 66, 69	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-49 Meteorological Tower data are used	11, [15], 33, 36, 39, 49	11, [15], 33, 36, 39, 49	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-53 Meteorological Tower data are used	0, [21], 46, 51, 53	0, [21], 46, 51, 53	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-54 Meteorological Tower data are used	[18], [54]	[18], [54]	Closest Meteorological Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].

Parameter	General Population	MEI, Workers	Comments
Meteorological dataset	2003	2003	Overall year of maximum worker and general population dose for the years 1995 through 2003 for unit ground level release of plutonium-239. All TA Meteorology data for 2003 within 11 percent of maximum year (1995 through 2003) except TA-46 (16 percent).
Atmospheric mixing height	350, 550, 500, 380; 1,500, 3,400, 4,000, 2,200 meters	350, 550, 500, 380; 1,500, 3,400, 4,000, 2,200 meters	Corresponding to the numbers in the previous two columns: morning-winter, spring, summer, fall; afternoon-winter, spring, summer, fall (Holzworth 1972).
Wind shift without rotation	Yes	Yes	Plume direction follows wind direction every hour.
metcod	5	5	Stratified random samples for each day of the year (see nsmpls below).
nsmpls	24	24	24 Meteorology samples per day (sample each hour).
Boundary conditions used in last ring	Yes	No	General population boundary conditions (rainfall) conservatively chosen so that releases are accounted for within modeled area. Sensitivity shows that not including boundary conditions (open boundary) results in decrease of 12 percent in median population dose and no change in extreme population dose for TA-6.
Model boundary mixing height	1,600 meters	1,600 meters	Average of seasonal mixing heights as given in Meteorology files.
Model boundary stability class and wind speed	D-2.2 meters per second	D-2.2 meters per second	50 percent MET conditions (see average Meteorology conditions below). Not applicable to workers.
Model boundary rain fall rate	23 millimeters per hour	0 millimeters per hour	Conservative maximum hourly rate from all 2003 Meteorology files (noted at TA-53 and 54). Not applicable to workers.
Dose conversion factors	FGR 11,12	FGR 11,12	Increase tritiated water inhalation by 50 percent to account for skin absorption (EPA 1988, EPA 1993).
Presented dose results	TEDE-mean	TEDE-mean	
Health risk	0.0006	0.0006	Fatal cancers per rem (total effective dose equivalent) (DOE 2003c).
ALOHA			**Version 5.3.1.**
Ground roughness length	38 centimeters	38 centimeters	DOE 2004b. ALOHA defaults to vertical dispersion parameter (Sigma-z) values consistent with urban environment for the indicated roughness length, z0, of 38 centimeters. For z0 less than 20 centimeters,

Parameter	General Population	MEI, Workers	Comments
			ALOHA defaults to a rural environment. Distances of interest expected to be close to release. General population uses same parameters as workers.
Meteorological measurement height	10 meters	10 meters	Consistent with MACCS MET data files.
Humidity	50 percent	50 percent	DOE 2004c. Within range for LANL (LANL 2006).
Median MET conditions	D-2.2	D-2.2	Stability class and wind speed in meters per second. 50 percent x/q at 2,000 meters, typical distance of interest. Minimum median wind speed from any MET Tower for 2003 (noted at TA-6). Other areas range up to D-2.8.
Median MET conditions (Wildfire)	D-3.5	D-3.5	Stability class and wind speed in meters per second. 50 percent x/q at 2,000 meters, typical distance of interest. Minimum median wind speed from any MET Tower for cumulative period 2000 through 2003 (noted at TA-49) for months of April through June. Other areas range up to D-4.0 (for TA-53).
Date and time, median MET conditions	June 22 - 1 p.m.	June 22 - 1 p.m.	DOE 2004c (summer, midday). Consistent with hours of average MET conditions from 2003 TA-6 MET tower data.
Air temperature, median MET conditions	81 degrees Fahrenheit	81 degrees Fahrenheit	LANL 2006.
Cloud cover, median MET conditions	10 tenths	10 tenths	Complete cloud cover; chosen to be consistent with other median meteorological conditions and stability class D.
Inversion height (mixing height), median MET conditions	4,000	4,000	(Meters) Summer afternoon mixing height (see "Atmospheric Mixing Height" above) consistent with date and time.
Presented effects	Distance to ERPG-2 and 3	Distance to ERPG-2 and 3	DOE 2004c.

MEI = maximally exposed individual, MET = meteorological, HTO = tritiated water, TA = technical area, FGR = Federal Guidance Report, TEDE = total effective dose equivalent, ERPG = Emergency Response Planning Guideline.
Note: To convert meters to feet, multiply by 3.2808; from miles to kilometers, multiply by 1.609.

Table D–3 Facility Accident Source Term Data

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: RANTLIT. **Scenario:** Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38).													
Spilled and expelled	Plutonium Equivalent	curies	–	–	–	–	–	–	0.18	1	0	0	Yes
Burning			–	–	–	–	–	–	18.36	60	0.1	0	Yes
Identifier: WETF. **Scenario:** Weapons Engineering Tritium Facility Fire (TA-16-205).													
Fire	Tritiated Water	grams	1,000	1	1	1	–	1	1,000	60	0	23	Yes
Fire	Plutonium-238		5.00	1	0.0005	1	–	1	0.0025	60	0	23	Yes
Suspension	Plutonium-238		5.00	1	–	1	0.00004	1	0.0048	1,440	0	0	Yes
Identifier: WCRLITN. **Scenario:** Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69).													
Spill inside building	Plutonium Equivalent	curies	800	1	0.001	1	–	1	0.8000	1	0	0	Yes
Spill outside building			1,000	1	0.001	0.1	–	1	0.1000	1	0	0	Yes
Fire inside building			799.2	1	0.01	1	–	1	7.992	60	0.1	0	Yes
Resuspension outside building			999.9	1	–	0.1	0.00004	1	0.09599	1,440	0	0	Yes
Identifier: DOMEF. **Scenario:** Waste Storage Dome Fire (TA-54).													
Combustible													
Burning expelled in lid loss	Plutonium Equivalent	curies	3,380	0.123	0.01	1	–	1	4.15	60	0	0	No
Burning (in drums)			3,380	0.877	0.0005	1	–	1	1.48	60	0	0	No
Noncombustible													
Burning	Plutonium Equivalent	curies	9,210	1	0.006	0.01	–	1	0.553	60	0	0	No
Total													
Burning	Plutonium Equivalent	curies	–	–	–	–	–	–	6.18	60	0	0	No
Impact release			12,600	0.123	0.001	1	–	1	1.55	1	0	0	No
Identifier: DOMET **Scenario:** Onsite Transuranic Waste Fire (TA-54).													
Initial (expelled)	Plutonium Equivalent	curies	1,100	1	0.001	0.3	–	1	0.33	1	0	0	No
Uncontained burn (high heat)			1,100	1	0.01	1	–	0.5	5.49	60	15.3	0	No

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Uncontained burn (smoldering)			1,100	1	0.01	1	–	0.5	5.49	60	0.1	0	No
Suspension			1,090	1	–	1	0.00004	1	1.04	1,440	0	0	No
Identifier: PF4MFIR. **Scenario:** Plutonium Facility Materials Staging Area Fire (TA-55-4).													
Fire	Plutonium-238	curies	–	–	–	–	–	–	0.229	60	0.1	0	No
	Plutonium-239		–	–	–	–	–	–	8.015	60	0.1	0	No
	Plutonium-240		–	–	–	–	–	–	1.857	60	0.1	0	No
	Plutonium-241		–	–	–	–	–	–	26.85	60	0.1	0	No
	Plutonium-242		–	–	–	–	–	–	0.0001083	60	0.1	0	No
	Americium-241		–	–	–	–	–	–	0.747	60	0.1	0	No
Resuspension	Plutonium-238	curies	–	–	–	–	–	–	0.06428	1,440	0	0	No
	Plutonium-239		–	–	–	–	–	–	2.25	1,440	0	0	No
	Plutonium-240		–	–	–	–	–	–	0.5213	1,440	0	0	No
	Plutonium-241		–	–	–	–	–	–	7.537	1,440	0	0	No
	Plutonium-242		–	–	–	–	–	–	0.0000304	1,440	0	0	No
	Americium-241		–	–	–	–	–	–	0.2097	1,440	0	0	No
Identifier: DVRS01. **Scenario:** Decontamination and Volume Reduction System Operational Spill (TA-54-412).													
	Plutonium Equivalent	curies	1,100	1	0.001	0.3	–	1	0.33	10	0	0	Yes
Identifier: DVRS05. **Scenario:** Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412).													
	Plutonium Equivalent	curies	1,100	1	0.01	1	–	1	11.0	120	0.1	0	Yes

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: SHEBA. **Scenario:** SHEBA Hydrogen Detonation (TA-18-168) No Action Alternative Only.													
Metal	Plutonium Equivalent	grams	9,020	1	0.0005	0.5	–	1	2.25	–	–	–	No
Ceramic			924	1	0.005	0.4	–	1	1.85	–	–	–	No
Liquid			9.00	1	0.00005	0.8	–	1	0.00036	–	–	–	No
Powder			0.06	1	0.005	0.4	–	1	0.00012	–	–	–	No
Gas			0.00	1	1.0	1	–	1	0	–	–	–	No
Total													
High Heat	Plutonium Equivalent	grams	–	–	–	–	–	–	2.05	60	2.1	1.5	No
Smoldering			–	–	–	–	–	–	2.05	60	0.1	0	No
Identifier: CMR02. **Scenario:** Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29).													
Fire (high heat)	Plutonium Equivalent	curies	0.613	1	0.4	1	–	0.5	0.123	26.7	1.696	1.5	Yes
Fire (smoldering)			0.613	1	0.4	1	–	0.5	0.123	26.7	0.1	1.5	Yes
Identifier: SEAL2CF. **Scenario:** Chemistry and Metallurgy Research Building Fire Impacting Sealed Sources, Wing 9 (Expanded Operations Only).													
Impact	Cobalt-60	curies	3,420,000	0.05	0.001	0.3	–	1	51.3	30	2.04	0	No
	Strontium-90		580,000	0.05	0.001	0.3	–	1	8.70	30	2.04	0	No
	Cesium-137		23,500,000	0.05	0.001	0.3	–	1	353	30	2.04	0	No
	Iridium-192		26,400,000	0.05	0.001	0.3	–	1	396	30	2.04	0	No
	Radium-226		87,400	0.05	0.001	0.3	–	1	1.31	30	2.04	0	No
	Curium-244		2,850	0.05	0.001	0.3	–	1	0.0428	30	2.04	0	No
	Californium-252		6,100	0.05	0.001	0.3	–	1	0.0915	30	2.04	0	No
Fire (high heat)	Cobalt-60	curies	3,420,000	0.05	0.006	0.01	–	0.5	5.13	30	2.04	0	No
	Strontium-90		580,000	0.05	0.006	0.01	–	0.5	0.870	30	2.04	0	No
	Cesium-137		23,500,000	0.05	0.006	0.01	–	0.5	35.2	30	2.04	0	No
	Iridium-192		26,400,000	0.05	0.006	0.01	–	0.5	39.6	30	2.04	0	No
	Radium-226		87,400	0.05	0.006	0.01	–	0.5	0.131	30	2.04	0	No
	Curium-244		2,850	0.05	0.006	0.01	–	0.5	0.00427	30	2.04	0	No
	Californium-252		6,100	0.05	0.006	0.01	–	0.5	0.00915	30	2.04	0	No

Accident Phase	***Nuclide***	***MAR (curies or grams)***	***MAR***	***Damage Ratio***	***Airborne Release Fraction***	***Respirable Fractions***	***Airborne Release Rate (per hour)***	***Leak Path Factor***	***Source Term (units of MAR)***	***Release Duration (minutes)***	***Plume Heat (mega-watts)***	***Release Height (meters)***	***Wake?***
Subtotal (impact plus high heat fire)	Cobalt-60	curies	–	–	–	–	–	–	56.4	30	2.04	0	No
	Strontium-90		–	–	–	–	–	–	9.57	30	2.04	0	No
	Cesium-137		–	–	–	–	–	–	388	30	2.04	0	No
	Iridium-192		–	–	–	–	–	–	436	30	2.04	0	No
	Radium-226		–	–	–	–	–	–	1.44	30	2.04	0	No
	Curium-244		–	–	–	–	–	–	0.0470	30	2.04	0	No
	Californium-252		–	–	–	–	–	–	0.101	30	2.04	0	No
Fire (smoldering)	Cobalt-60	curies	3,420,000	0.05	0.006	0.01	–	0.5	5.13	60	0.1	0	No
	Strontium-90		580,000	0.05	0.006	0.01	–	0.5	0.870	60	0.1	0	No
	Cesium-137		23,500,000	0.05	0.006	0.01	–	0.5	35.2	60	0.1	0	No
	Iridium-192		26,400,000	0.05	0.006	0.01	–	0.5	39.6	60	0.1	0	No
	Radium-226		87,400	0.05	0.006	0.01	–	0.5	0.131	60	0.1	0	No
	Curium-244		2,850	0.05	0.006	0.01	–	0.5	0.00427	60	0.1	0	No
	Californium-252		6,100	0.05	0.006	0.01	–	0.5	0.00915	60	0.1	0	No
Identifier: MDAGEXP. **Scenario:** Explosion at a Pit at Material Disposal Area G (Expanded Operations Only).													
Explosion	Americium-241	curies	352	0.02 [a]	0.005	0.3	–	1	0.0104	1	0	0	No
	Gadolinium-148	curies	0.466	1	0.005	0.3	–	1	0.000699	1	0	0	No
	Thorium-230	curies	2.67	1	0.005	0.3	–	1	0.00401	1	0	0	No
	Actinium-227	curies	0.0430	1	0.005	0.3	–	1	0.0000645	1	0	0	No
	Plutonium-238	curies	591	0.88 [a]	0.005	0.3	–	1	0.780	1	0	0	No
	Plutonium-239	curies	319	0.96 [a]	0.005	0.3	–	1	0.459	1	0	0	No
	Plutonium-240	curies	74.7	1	0.005	0.3	–	1	0.112	1	0	0	No
	Plutonium-241	curies	219	1	0.005	0.3	–	1	0.329	1	0	0	No
	Uranium-233	curies	1.03	0	0.005	0.3	–	1	0	1	0	0	No
	Uranium-234	curies	0.392	1	0.005	0.3	–	1	0.000588	1	0	0	No
	Uranium-238	curies	1.72	1	0.005	0.3	–	1	0.00258	1	0	0	No

Accident Phase	Nuclide	MAR (curies or grams)	MAR	Damage Ratio	Airborne Release Fraction	Respirable Fractions	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (units of MAR)	Release Duration (minutes)	Plume Heat (mega-watts)	Release Height (meters)	Wake?
Suspension	Americium-241	curies	352	0.02 [a]	–	1	0.000004	1	0.000659	1,440	0	0	No
	Gadolinium-148	curies	0.464	1	–	1	0.000004	1	0.0000445	1,440	0	0	No
	Thorium-230	curies	2.66	1	–	1	0.000004	1	0.0002550	1,440	0	0	No
	Actinium-227	curies	0.0428	1	–	1	0.000004	1	0.00000411	1,440	0	0	No
	Plutonium-238	curies	588	0.88 [a]	–	1	0.000004	1	0.0497	1,440	0	0	No
	Plutonium-239	curies	318	0.96 [a]	–	1	0.000004	1	0.0292	1,440	0	0	No
	Plutonium-240	curies	74.3	1	–	1	0.000004	1	0.00714	1,440	0	0	No
	Plutonium-241	curies	218	1	–	1	0.000004	1	0.0209	1,440	0	0	No
	Uranium-233	curies	1.03	0 [a]	–	1	0.000004	1	0	1,440	0	0	No
	Uranium-234	curies	0.390	1	–	1	0.000004	1	0.0000374	1,440	0	0	No
	Uranium-238	curies	1.71	1	–	1	0.000004	1	0.000164	1,440	0	0	No

MAR = material at risk, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Damage ratios less than 1 indicate that all or part of the inventory is in a waste form such as concrete that would not release respirable particles in this accident scenario.

Storage of sealed sources represents a potential source of radionuclides that were not included in the earlier *1999 SWEIS*. These radionuclides (for example, cobalt-60 and cesium-137) represent external gamma radiation dose risks that are unlike those in most other scenarios (for example, tritium, uranium, and transuranics), which represent chiefly internal dose risks. A scenario that results in the largest risk from these sources, seismic event and fire at the Chemistry and Metallurgy Research Building impacting sealed sources, is included. Doses to individuals located close to the sources (for example, the noninvolved worker) include a component from direct (external) exposure to exposed source material. Appendix J describes the calculation of direct exposure to sealed sources in an accident and includes additional sealed source scenarios.

Material Disposal Area (MDA) cleanup was not considered in the *1999 SWEIS*. Appendix I of the current SWEIS describes proposed environmental remediation of MDAs and contains estimated impacts to offsite and worker receptors from severe accidents (relative to other MDA scenarios) at MDA G (maximum inventory MDA) and MDA B (close proximity to offsite receptors). The consequences and risks from the greater of the two are included in the discussion of the Expanded Operations Alternative in Section D.3.2.3.

D.3.2 Radiological Accident Impacts

Estimated facility accident impacts are represented in terms of consequences and risks. All consequences assume that the accident has occurred; therefore, the probability or frequency of the accident occurring is not taken into account. The risk of an accident does reflect the probability or frequency of occurrence and is calculated by multiplying the accident's frequency of occurrence by its consequences. Dose consequences are estimated for the MEI (reported in rem) located at the nearest site boundary, a noninvolved worker (reported in rem) located 328 feet (100 meters) from the accident, and the offsite population (reported in person-rem) out to a distance of 50 miles (80 kilometers). The MACCS offsite population dose calculation for radiological accidents includes an assumption that forces a conservatively large amount of radioactive material to be deposited in the last 10 miles (16 kilometers) of the 50-mile (80-kilometer) distance. This assumption results in a significantly higher calculated population dose than would be calculated if the real meteorology was used in this area. For the largest population dose radiological accident, the TA-54 waste storage dome wildfire, this MACCS methodology results in a 15 percent higher dose as compared to using real meteorology. Applying this conservative MACCS methodology to the population within 100 miles (160 kilometers) resulted in an increase of only 3 percent in the population dose even though the population increased by 194 percent. This comparison demonstrates the conservative nature of the methodology used in calculating the population dose, which encompasses radiological consequences for the population out to greater distances. Impacts at locations of public access closer than the nearest site boundary are also discussed.

Consequences are also expressed in terms of the likelihood of a latent cancer fatality (LCF) for the MEI and noninvolved worker and in terms of the number of additional LCFs for the offsite population. A conversion factor, 0.0006 LCFs (or the number of LCFs) per rem (or person-rem), is used to convert rem (or person-rem) to the likelihood of an LCF (or number of LCFs); this factor is doubled for doses to an individual in excess of 20 rem. The calculated doses and associated LCFs do not take into account any medical intervention that could be taken to lower the consequences of exposure.

D.3.2.1 No Action Alternative

The estimated consequences and annual risks of postulated accidents for the No Action Alternative are shown in **Tables D–4** through **D–6**. The maximum consequences and risks from facility accidents are chiefly a result of Plutonium Facility Operations at TA-55-4 and TA-54 operations (Radioassay and Nondestructive Testing [RANT], waste storage domes, DVRS).

The nearest public access to the Chemistry and Metallurgy Research Building, located on Diamond Drive approximately 170 feet (50 meters) from the CMR Building, is closer than the nearest site boundary to this facility. Doses were calculated for an individual at Diamond Drive during the duration of the high-efficiency particulate air (HEPA) filter fire at the Chemistry and Metallurgy Research Building. The same assumptions used to calculate the dose to the MEI were applied to this individual. The dose to an individual at Diamond Drive would be 8.1 rem, more than 10 times the value indicated in Table D–4. The consequences and risks at this location also would be 10 times the value indicated in Tables D–4 and D–6 for this scenario.

The relatively large RANT and Waste Characterization, Reduction, and Repackaging Facility (WCRR) lightning strike fire accident annual frequency is based on the conservative assumption that any lightning strike on these facilities, regardless of lightning energy or strike location on the facility, would result in a fire with the same source term as the largest building fire from the facility accident analysis.

D.3.2.2 Reduced Operations Alternative

Accident impacts under the Reduced Operations Alternative are similar to those under the No Action Alternative, as shown in Tables D–4 through D–6. Solution High-Energy Burst Assembly (SHEBA) operations at LANL would cease. The tables show that SHEBA operations are a small component of the facility impacts at LANL; its elimination would not significantly alter the overall risk profile from individual facility operations. All other impacts in the No Action Alternative tables are equally applicable for this alternative.

D.3.2.3 Expanded Operations Alternative

Accident impacts under the Expanded Operations Alternative are shown in **Tables D–7** through **D–9**. SHEBA operations at LANL would cease under the Expanded Operations Alternative, so its relatively small impacts, have been eliminated from the tables. Additional or replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste at DVRS and the waste storage domes would be moved offsite or to a new facility, the TRU (Transuranic) Waste Facility (formerly the Transuranic Waste Consolidation Facility), which would be located in a TA along the Pajarito Road Corridor. The impacts to the public of this new facility would be less than those of the existing facilities because of the new location and because less material would be stored while the rest would be moved offsite. Tables D–7 through D–9 reflect the present DVRS and waste storage domes operations because they would be active for most of the time period of interest and would bound the impacts of the new TRU Waste Facility. Accident impacts for the new facility are described in Appendix H.

Table D–4 Radiological Accident Offsite Population Consequences for the No Action and Reduced Operations Alternatives

Accident Scenario	MEI		Population to 50 Miles (80 kilometers)	
	Dose (rem) [a]	LCF [b]	Dose (person-rem)	LCF [c, d]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	410	0.49	11,000	6 (6.3)
Weapons Engineering Tritium Facility Fire (TA-16-205)	5.9	0.0036	190	0 (0.11)
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	46	0.055	4,800	3 (2.9)
Waste Storage Dome Fire (TA-54)	420	0.50	4,200	3 (2.5)
Onsite Transuranic Waste Fire (TA-54)	190	0.22	5,700	3 (3.4)
Plutonium Facility Materials Staging Area Fire (TA-55-4)	73	0.087	9,000	5 (5.4)
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	20	0.012	190	0 (0.11)
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	320	0.39	6,100	4 (3.7)
SHEBA Hydrogen Detonation (TA-18-168) [e]	0.88	0.00053	69	0 (0.041)
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.77	0.00046	200	0 (0.12)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, and TA-21-209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations Alternative.

Table D–5 Radiological Accident Onsite Worker Consequences for the No Action and Reduced Operations Alternatives

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	LCF [b]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	1,900	2.2 [c]
Weapons Engineering Tritium Facility Fire (TA-16-205)	8.9	0.0054
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	1,100	1.3 [c]
Waste Storage Dome Fire (TA-54)	2,000	2.3 [c]
Onsite Transuranic Waste Fire (TA-54)	760	0.91
Plutonium Facility Materials Staging Area Fire (TA-55-4)	1,600	1.9 [c]
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	51	0.062
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	890	1.1 [c]
SHEBA Hydrogen Detonation (TA-18-168) [d]	15	0.0092
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	5.4	0.0032

LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, because the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations Alternative.

Table D–6 Radiological Accident Offsite Population and Worker Risks for the No Action and Reduced Operations Alternatives

Accident Scenario	*Frequency (per year)*	*Onsite Worker*	*Offsite Population*	
		Noninvolved Worker at 110 Yards (100 meters) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	0.12 [d]	0.12	0.059	0.76
Weapons Engineering Tritium Facility Fire (TA-16-205)	1.1×10^{-5}	6.0×10^{-8}	4.0×10^{-8}	1.3×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	0.14 [d]	0.14	0.0077	0.4
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.0005	0.0025
Onsite Transuranic Waste Fire (TA-54)	0.001	0.00091	0.00022	0.0034
Plutonium Facility Materials Staging Area Fire (TA-55-4)	0.01	0.01	0.00087	0.054
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	0.02	0.0012	0.00024	0.0022
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	0.001	0.001	0.00039	0.0037
SHEBA Hydrogen Detonation (TA-18-168) [e]	0.0054	0.00005	2.8×10^{-6}	0.00022
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.01	0.000032	4.6×10^{-6}	0.0012

MEI = maximally exposed individual, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, HEPA = high-efficiency particulate air filter.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs in the offsite population per year; value in parentheses is the calculated result.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[d] The lightning strike fire accident scenarios conservatively assumes that any lightning strike on the facility will result in a source term equivalent to a structure fire.

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations Alternative.

Table D–7 Radiological Accident Offsite Population Consequences for the Expanded Operations Alternative

Accident Scenario	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem) [a]	*LCF* [b]	*Dose (person-rem)*	*LCF* [c, d]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	410	0.49	11,000	6 (6.3)
Weapons Engineering Tritium Facility Fire (TA-16-205)	5.9	0.0036	190	0 (0.11)
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	46	0.055	4,800	3 (2.9)
Waste Storage Dome Fire (TA-54)	420	0.50	4,200	3 (2.5)
Onsite Transuranic Waste Fire (TA-54)	190	0.22	5,700	3 (3.4)
Plutonium Facility Materials Staging Area Fire (TA-55-4)	73	0.087	9,000	5 (5.4)
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	20	0.012	190	0 (0.11)
Explosion at Material Disposal Area G (TA-54)	55	0.066	770	0 (0.46)
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	320	0.39	6,100	4 (3.7)
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	0.099	0.000059	12,000	7.0
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.77	0.00046	200	0 (0.12)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

Table D–8 Radiological Accident Onsite Worker Consequences for the Expanded Operations Alternative

Accident Scenario	***Noninvolved Worker at 110 Yards (100 meters)***	
	Dose (rem) [a]	***LCF*** [b]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	1,900	2.2 [c]
Weapons Engineering Tritium Facility Fire (TA-16-205)	8.9	0.0054
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	1,100	1.3 [c]
Waste Storage Dome Fire (TA-54)	2,000	2.3 [c]
Onsite Transuranic Waste Fire (TA-54)	760	0.91
Plutonium Facility Materials Staging Area Fire (TA-55-4)	1,600	1.9 [c]
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	51	0.062
Explosion at Material Disposal Area G (TA-54)	410	0.49
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	890	1.1 [c]
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	1.2	0.00073
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	5.4	0.0032

LCF = latent cancer fatality, TA = technical area, HEPA = high-efficiency particulate air filter.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, because the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12, show an LCF of 1.0.

Table D–9 Radiological Accident Offsite Population and Worker Risks for the Expanded Operations Alternative

Accident Scenario	*Frequency (per year)*	*Onsite Worker*	*Offsite Population*	
		Noninvolved Worker at 110 Yards (100 meters) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Radioassay and Nondestructive Testing Facility Lightning Strike Fire (TA-54-38)	0.12 [d]	0.12	0.059	0.76
Weapons Engineering Tritium Facility Fire (TA-16-205)	1.1×10^{-5}	6.0×10^{-8}	4.0×10^{-8}	1.3×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility Lightning Strike Fire (TA-50-69)	0.14 [d]	0.14	0.0077	0.4
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.0005	0.0025
Onsite Transuranic Waste Fire (TA-54)	0.001	0.00091	0.00022	0.0034
Plutonium Facility Materials Staging Area Fire (TA-55-4)	0.01	0.01	0.00087	0.054
Decontamination and Volume Reduction System Operational Spill (TA-54-412)	0.02	0.0012	0.00024	0.0022
Explosion at Material Disposal Area G (TA-54)	0.01	0.0049	0.00066	0.0046
Decontamination and Volume Reduction System Building Fire and Spill due to Forklift Collision (TA-54-412)	0.001	0.001	0.00039	0.0037
Chemistry and Metallurgy Research Building Fire Involving Sealed Sources (TA-3-29)	0.00024	1.7×10^{-7}	1.4×10^{-8}	0.0017
Chemistry and Metallurgy Research Building HEPA Filter Fire (TA-3-29)	0.01	0.000032	4.6×10^{-6}	0.0012

MEI = maximally exposed individual, TA = technical area, HEPA = high-efficiency particulate air filter.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4).

[d] The lightning strike fire accident scenarios conservatively assumes that any lightning strike on the facility will result in a source term equivalent to a structure fire.

MDA cleanup is a component of the Expanded Operations Alternative. A number of scenarios were considered for this activity, and an explosion during cleanup operations that breaches the MDA enclosure and bypasses the HEPA filtration was chosen for analysis. MDA G, because of its relatively large inventory, was found to bound the accident impacts from MDA cleanup. The consequences and risks from this scenario are included in Tables D–7 through Table D–9. As with the No Action Alternative, TA-54 operations generally dominate the accident risks from Expanded Operations. Cleanup of MDA G, although not bounding, adds a component to this risk. Appendix I includes more details about MDA cleanup accident impacts.

Another component of the Expanded Operations Alternative (but not of the No Action Alternative) is the onsite storage of sealed sources. The important exposure pathways are different for some of the radionuclides that might be released from the sealed sources. Previously, sources received for management at LANL consisted chiefly of alpha emitters such as americium and plutonium that are chiefly internal risks with doses to the body that are delivered over an extended time period. The nuclides associated with other sealed sources now being considered for management at LANL can be strong gamma emitters and thus may result in significant prompt external as well as internal exposure in the event of an accident.

A number of different radionuclides are present in the sealed sources, as shown in Table D–3. The MARs shown there represent the maximum allowable inventory of each of the nuclides if that individual nuclide only were present. Each of the nuclides was separately analyzed. It was found that cobalt-60 would lead to maximum exposure of the individuals closest to the release, such as the noninvolved worker, from exposure to source material as well as plume exposure. Transuranics such as californium-252 would lead to maximum exposure of individuals further from the release, such as the MEI at the Chemistry and Metallurgy Research Building, from plume exposure. Cesium-137 would lead to maximum exposure of the general public from ground exposure to deposited material, internal exposure from ingestion of foodstuffs, and exposure to the release plume. The dose to an individual outside at Diamond Drive during the hypothetical fire at the Chemistry and Metallurgy Research Building involving sealed sources scenario would be 4.3 rem, 42 percent of which would be from external exposure to gamma radiation. Such a dose would result in an increased chance of a fatal cancer during the lifetime of the individual of 0.0026, or approximately 1 chance in 385.

The accident analysis for sealed sources conservatively assumes that the maximum allowable limit of one single radioisotope is present instead of a more realistic expected mix of several radioisotopes at lower activity levels. This assumption provides a bounding consequence in the event of a postulated accident that releases sealed source inventory or exposes gamma or neutron emitters so that direct radiation affects the dose to individuals close to the source. The analysis also assumes that the shipping containers that hold the source and the building within which the containers are stored both fail, resulting in external exposure and release of these radionuclides. Appendix J, Section J.3.3.2, contains further discussion of sealed source accident scenarios and risks.

D.3.3 Chemical Accident Impacts

This section provides data that support the impacts of facility accidents presented in Chapter 5, including estimated accident frequencies of occurrence, scenarios, and materials released.

The chemicals of concern at LANL facilities and their potential impacts under the No Action, Reduced, and Expanded Operations Alternatives are shown in **Table D–10**. These were selected from a complete set of chemicals used onsite based on their quantities, chemical properties, and human health effects. The tables show the impact of each postulated chemical release and the applicable concentration guidelines. The first guideline is the concentration of a substance in air at a level that generally requires action to prevent or mitigate exposures. The second guideline is the concentration above which severe irreversible health effects or a fatality may occur. Emergency Response Planning Guideline (ERPG) -2 and -3 values published by the American Industrial Hygiene Association (AIHA 2005) are used in this analysis to represent those levels of impact, consistent with DOE emergency management hazards assessment and planning practices (DOE 2005a, DOE 1997).[1] ERPG-2 and ERPG-3 are defined in terms of the expected health impacts from a 1-hour exposure, as follows:

> *ERPG-2: The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.*
>
> *ERPG-3: The maximum concentration in air below which it is believed nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.*

ERPGs are used throughout industry and government to assess chemical hazards and plan for emergencies; however, ERPGs have been issued for fewer than 120 chemicals as of 2005. To provide its sites and facilities with impact criteria for other chemicals, DOE commissions the development of alternative values, termed Temporary Emergency Exposure Limits (TEELs). As of late 2005, TEEL values have been issued for nearly 3,000 chemicals (DOE 2005b). The TEEL levels of TEEL-2 and TEEL-3 are defined in the same words as the corresponding ERPGs, but without reference to any duration of exposure. When no ERPGs have been published for a substance, the TEEL-2 and -3 values are used in this analysis to represent the ERPG-2 and ERPG-3 levels of health impact.

---

[1] *Beginning with the recent issuance of DOE Order 151.1C (November 2005) Acute Exposure Guideline Levels published by the U.S. Environmental Protection Agency (EPA) are specified as the chemical impact criteria of first choice, and these values are being incorporated into hazards assessments and emergency plans throughout DOE. Acute Exposure Guideline Levels are defined in terms of several different exposure times ranging from 10 minutes to 8 hours. In general, the Acute Exposure Guideline Levels-2 and -3 values for a 60-minute exposure are about the same as the ERPGs used in this analysis.*

Table D–10 Chemical Accident Impacts

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]		Concentration	
			Value	Distance to Value (meters)	Value	Distance to Value (meters)	Noninvolved Worker at 100 Meters	MEI at Site Boundary
Selenium hexafluoride from waste cylinder storage at TA-54-216	0.0041	75 liters (20 gallons)	0.6 ppm [c]	2,800	5 ppm [c]	880	140 ppm	12 ppm at 491 meters
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (136 kilograms)	3 ppm	1,650	15 ppm	690	310 ppm	27 ppm at 491 meters
Chlorine gas released outside of Plutonium Facility (TA-55-4)	0.063	150 pounds (68 kilograms)	3 ppm	1,080	20 ppm	380	170 ppm	3.4 ppm at 1,016 meters
Helium at TA-55-41	0.063	9,230,000 cubic feet (261,366 cubic meters) (at STP)	280,000 ppm [c]	186	500,000 ppm [c]	139	greater than ERPG-3	10,000 ppm at 1,048 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million, STP = standard temperature and pressure, TEEL = Temporary Emergency Exposure Limits.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] The TEEL value is used. ERPGs have not been issued for this substance.

Note: To convert meters to yards, multiply by 1.0936.

D.3.3.1 No Action Alternative

The chemicals of concern at LANL facilities under the No Action Alternative are shown in Table D–10. Selenium hexafluoride, sulfur dioxide, and chlorine are all toxic gases that, at elevated levels, can cause respiratory dysfunction as well as other health effects. Helium is an asphyxiant that can cause health effects by displacing breathable oxygen.

Table D–10 shows the concentrations of each chemical, if released, at specified distances. The inventory of each chemical is assumed to be released from a break in a line over a 10-minute interval. The cause of the break could be mechanical failure, corrosion, mechanical impact, or natural phenomena. The noninvolved worker, if directly downwind from the release and unable to take evasive action, would be exposed to levels in excess of ERPG-3 for these releases. Under the same circumstances, the MEI located at the LANL and San Ildefonso Pueblo boundary would be exposed to selenium hexafluoride and sulfur dioxide in excess of ERPG-3 levels.

D.3.3.2 Reduced Operations Alternative

The chemicals of concern that could be released in a facility accident are the same for the Reduced Operations Alternative as for the No Action Alternative. None of the chemicals identified for the latter are eliminated in this alternative. The information in Table D–10, then, is applicable to the Reduced Operations Alternative.

D.3.3.3 Expanded Operations Alternative

The chemicals of concern that could be released in a facility accident for the No Action Alternative apply equally to the Expanded Operations Alternative. In addition, MDA cleanup is a component of the Expanded Operations Alternative that has a potential for accidental releases of toxic chemicals. A fire during excavation that breaches the MDA enclosure and bypasses the HEPA filtration was chosen as a severe scenario. There is a great deal of uncertainty regarding which chemicals and quantities were disposed of in the MDAs. MDA B, the MDA closest to the public (and thus with the potential for the greatest impact on the public), was chosen to bound the chemical accident impacts for MDA cleanup. Two chemicals, sulfur dioxide (a gas) and beryllium (assumed in powder form), were chosen based on their restrictive ERPG values to bound the impacts of an extensive list of possible chemicals disposed of in the MDAs. **Table D–11** shows that both of these chemicals, if present in MDA B at the quantities assumed, would dissipate to below ERPG-3 levels very close to the release. Appendix I includes more details about MDA cleanup chemical accident impacts.

Table D–11 Chemical Accident Impacts for the Expanded Operations Alternative

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]		Concentration	
			Value	Distance to Value (meters)	Value	Distance to Value (meters)	Noninvolved Worker at 100 Meters	MEI at Site Boundary
Selenium hexafluoride from waste cylinder storage at TA-54-216	0.0041	75 liters (20 gallons)	0.6 ppm [c]	2,800	5 ppm [c]	880	140 ppm	12 ppm at 491 meters
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (136 kilograms)	3 ppm	1,650	15 ppm	690	310 ppm	27 ppm at 491 meters
Chlorine gas released outside of Plutonium Facility (TA-55-4)	0.063	150 pounds (68 kilograms)	3 ppm	1,080	20 ppm	380	170 ppm	3.4 ppm at 1,016 meters
Helium at TA-55-41	0.063	9,230,000 cubic feet (261,366 cubic meters) (at STP)	280,000 ppm [c]	186	500,000 ppm	139	> ERPG-3	10,000 ppm at 1,048 meters
Sulfur dioxide at MDA B	Unknown	1 pound (0.45 kilogram)	3 ppm	83	15 ppm	34	2.1 ppm	9.2 ppm at 45 meters
Beryllium powder at MDA B	Unknown	22 pounds [d] (10 kilograms)	0.025 mg/cu m	23	0.1 mg/cu m	9	0.0025 mg/cu m	0.0088 mg/cu m at 45 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million, STP = standard temperature and pressure, MDA = material disposal area, mg/cu m = milligrams per cubic meter.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] The TEEL value is used. ERPGs have not been issued for this substance.

[d] This quantity represents the total material at risk. A fraction (6×10^{-5}) of this solid would be released as respirable particles in the hypothesized scenario.

Note: To convert meters to yards, multiply by 1.0936.

D.4 Site-Wide Seismic Impacts

Two site-wide seismic events, Seismic 1 and Seismic 2, were postulated to estimate the effects of potential radiological and chemical releases. Seismic 1 is nominally represented by a Performance Category-2 (PC-2) earthquake. Such an event is characterized by a return period of 1,000 years (annual probability of exceedance of 1×10^{-3}) with a peak horizontal ground acceleration of 0.22 g (gravitational acceleration).[2] Seismic 2 is nominally represented by a PC-3 earthquake with a return period of 2,000 years (annual probability of exceedance of 5×10^{-4}) and a peak horizontal ground acceleration of 0.31 g (Cuesta 2004). Were such a seismic event to occur, simultaneous radiological and chemical releases from multiple locations could result. The rationale for choosing these scenarios is described in Table D–1. Most of these scenarios evolved from those analyzed in the *1999 SWEIS*. Revisions to the seismic releases in that earlier document (called site releases there) were based on information that became available subsequent to the writing of the *1999 SWEIS*. This new information was reviewed and significant scenarios were added as appropriate. One example is the addition of the Safe Secure Transport Facility (TA-55-355). That facility houses material that was at TA-18 at the time of the *1999 SWEIS*. The current document considers the new location and storage design, while deleting the TA-18 buildings that are no longer operating.

The health effects calculated for these two postulated seismic events should be considered within the context of the nonradiological human health impacts expected. These seismic events would cause widespread failures of both nonnuclear LANL structures and structures outside of LANL. A much larger number of fatalities and injuries from structure collapse would be expected for these seismic events.

Effects of Updated Probabilistic Seismic Hazards Analysis

An updated probabilistic seismic hazard analysis that uses new geotechnical, geologic, and geophysical data collected at the Chemistry and Metallurgy Research Replacement Facility location (particularly of the Bandelier Tuff) and current seismic hazard analysis methodology has been developed for the LANL site (LANL 2007a). Probabilistic seismic hazards were calculated for specific locations, the Chemistry and Metallurgy Research Replacement Facility, TA-3, TA-16, and TA-55. The envelope of these site-specific hazards can be applied in a generic fashion to other locations at the LANL site. The seismic accident scenarios (Seismic 1 and 2) analyzed in the SWEIS were developed based on the *Seismic Hazards Evaluation of the Los Alamos National Laboratory (February 24, 1995)*. LANL nuclear structures, systems, and components were evaluated specifically for peak horizontal ground accelerations of 0.22g and 0.31g corresponding to an annual earthquake return period of 1,000 and 2,000 years or annual probabilities of exceedance of 0.001 (1 in 1000) and 0.0005 (1 in 2000), respectively. The updated seismic hazards analysis (LANL 2007a) results indicate a site-wide peak horizontal ground acceleration of about 0.27g with a corresponding expected return period of 1,000 years and about 0.45g with an expected return period of 2,000 years. The expected return periods for the 0.22g and 0.31g peak horizontal ground acceleration are now established at about 700 and 1,250 years, respectively. The revised annual probabilities of exceedance are thus 0.0015 and

---

[2] *The term "g" stands for the acceleration of an object due to gravity at a rate of 32 feet per second (9.8 meters per second) and is used as a standard measure of ground movement associated with seismic events.*

0.0008, respectively. Using these larger probabilities, however, the seismic accident risks for the MEI, the noninvolved worker, and the population are less than 1 percent of accident risks for other types of accidents in the SWEIS such as fires at the Radioassay and Nondestructive Testing Facility, the Waste Characterization, Reduction, and Repackaging Facility, and the TA-54 waste storage domes.

For many facilities involved in the Seismic 1 and 2 accident scenarios, a conservative assumption is made that there is a complete failure of structures, systems, and components (given the Seismic 1 and 2 ground shaking) thereby resulting in the maximum possible radioisotope or chemical release to the environment. Higher seismic accelerations at the same annual frequency of exceedance based on the updated probabilistic seismic hazard analysis would result in identical consequences for these facilities. Therefore, larger seismic peak ground acceleration associated with the updated probabilistic seismic hazard analysis would not increase the consequence of these accident scenarios. The facilities for which the consequences would be the same include: the Chemistry and Metallurgy Research Building, the Weapons Engineering Test Facility, the Tritium Science and Fabrication Facility, the Tritium System Test Assembly, the Radioactive Liquid Waste Treatment Facility, Waste Characterization, Reduction, and Repackaging Facility, and the Radioassay and Nondestructive Testing Facility. Facilities for which the consequences of higher ground acceleration may be greater include: the Plutonium Facility, the TA-55 Storage Facility, the Decontamination and Volume Reduction System, Waste Storage Domes, and the Safe Secure Transport Facility.

Typically, structures are designed with considerable factors of safety against failure of the structure subjected to a variety of loads (including earthquake loads). These factors of safety produce reliable structures. For the LANL facilities that are not assumed to completely fail (given the Seismic 1 and Seismic 2 levels of ground shaking), it is not possible to state the impacts of different peak horizontal ground accelerations without detailed structural analysis of facilities using the updated probabilistic seismic hazard analysis results. A bounding approach was used to estimate the maximum expected effect of the updated seismic hazards on the SWEIS seismic accident risks. The revised annual probabilities of exceeding the peak ground horizontal accelerations used in the accident analysis of 0.22g and 0.31g are approximately 1.5×10^{-3} and 8×10^{-4}. Using the accident source terms that were developed for the Seismic 1 and Seismic 2 accident scenarios, the effect of the revised estimates of annual probability of exceedance would be an increase in the radiological risk of 50 percent for Seismic 1 scenarios and 60 percent for Seismic 2 scenarios. This results in a maximum risk of an LCF of 0.00012 for the MEI, 0.0015 for the noninvolved worker and 0.0077 for the total population for the Seismic 1 accident scenario. The comparable MEI, noninvolved worker, and population risks for the Seismic 2 accident scenario are: 0.00045, 0.0008, and 0.0144, respectively. These estimated higher seismic accident risks do not take credit for facilities in which complete failure has already been assumed and therefore no larger accident source term would be expected at higher seismic ground accelerations. Although these seismic risks have increased due to the results of the updated seismic analysis, they remain less than 1 percent of the highest MEI, noninvolved worker, and population risks for other types of accidents that are analyzed in the SWEIS.

Just as the updated probabilistic seismic hazards analysis used new data and advanced methods to calculate LANL seismic hazards, revised structural analysis methods tied to damage states credited in the safety assessments will be used to update the seismic structural integrity evaluation of LANL facilities. The effect of the higher values of peak horizontal ground acceleration on calculated seismic accident consequences and risks will be analyzed in future facility safety analyses and incorporated as appropriate into future National Environmental Policy Act (NEPA) documents. The LANL management and operating contractor has developed and NNSA has accepted a site-wide justification for continued operation as a result of the estimates of increased seismic event frequency and acceleration associated with the updated probabilistic seismic hazards analysis. The justification for continued operation presents a qualitative evaluation of the effect of this increased seismic hazard on site-wide transportation and on the following LANL facilities: Chemistry and Metallurgy Research Building, Beryllium Technology Facility, Dual-Axis Radiographic Hydrodynamic Test Facility, Weapons Engineering Test Facility, Radioactive Liquid Waste Treatment Facility, Waste Characterization, Reduction, and Repackaging Facility, TA-53 underground spent resin tank, LANSCE, Area G waste operations, Radioassay and Nondestructive Testing Facility, Plutonium Facility, Safe and Secure Transport Facility, and the nuclear environmental sites (MDA A, MDA B, MDA C, MDA H, MDA T, MDA W, TA-35 Wastewater Treatment Plant, TA-35 Pratt Canyon, and MDA AB). The justification for continued operation determined that existing bounding seismic accident analyses; new facility safety analyses; compensatory measures of limiting radioactive material inventory, new programs, and procedures; and the low probability of a seismic event during the anticipated time period for detailed quantitative analysis of each facility's safety documentation provide the basis for an acceptable risk for continued operation of LANL (LANL 2007b, NNSA 2007).

The Los Alamos Site Office directed the LANL management and operating contractor to develop a project execution plan to perform specific detailed facility seismic analyses; incorporate necessary changes to facility safety bases; and develop a list of potential facility modifications to address deficiencies identified in the seismic analyses (NNSA 2007c). If necessary, facility-specific justifications for continued operation will be developed as part of this process. This project will provide for the evaluation of each LANL facility using the updated probabilistic seismic hazard analysis seismic accelerations and frequencies and in accordance with appropriate LANL structural engineering standards for seismic events using all applicable industry, federal government, and international standards, codes, and criteria.

D.4.1 Source Term Data

Table D–12 shows the source term data used to calculate impacts to workers and the public that could result from a site-wide earthquake. A single table is presented for the two earthquake scenarios (Seismic 1 and 2); the scenario corresponding to each release is indicated under the facility name.

Table D–12 Site-Wide Earthquake Source Term Data

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Seismic													
Identifier: CMR08. **Facility Name:** Chemistry and Metallurgy Research Building (TA-3-29) *Seismic 1 and 2*													
Initial	Plutonium Equivalent	curies	1,240	1	0.01	0.5	–	1	6.19	10	0	0	No
Suspension			1,230	1	0	1	0.000004	1	0.118	1,440	0	0	No
Identifier: SIT02. **Facility Name:** Weapons Engineering Tritium Facility (TA-16-205) *Seismic 2*													
Tritium release	Tritiated Water	grams	1,000	1	1.0	1	–	1	1,000	10	0	0	No
Identifier: SIT08 **Facility Name:** SHEBA (TA-18-168) *Seismic 1 and 2*													
Metal	Plutonium Equivalent	grams	9,020	1	0.00	1	–	1	0	10	0	0	No
Ceramic			924	1	0.00006	1	–	1	0.0554	10	0	0	No
Liquid			9.00	1	0.0002	0.8	–	1	0.00144	10	0	0	No
Powder			0.06	1	0.002	0.3	–	1	0.000036	10	0	0	No
Gas			0	1	1.0	1	–	1	0	10	0	0	No
Total													
Initial	Plutonium Equivalent	grams	–	–	–	–	–	–	0.0569	10	0	0	No
Suspension			0.0599	1	0.00	1	0.000004	1	0.00000575	1,440	0	0	No
Identifier: SIT09. **Facility Name:** Tritium System Test Assembly (TA-21-155) *Seismic 1 and 2*													
Tritium release	Tritiated Water	grams	0.1	1	1.0	1	–	1	0.1	10	0	0	No
Identifier: SIT10. **Facility Name:** Tritium Science and Fabrication Facility (TA-21-209) *Seismic 1 and 2*													
Tritium release	Tritiated Water	grams	0.88	1	1.0	1	–	1	0.88	10	0	0	No
Identifier: SIT11. **Facility Name:** Radioactive Liquid Waste Treatment Facility (TA-50-1) *Seismic 1 and 2*													
Initial	Plutonium-238	grams	–	–	–	–	–	–	0.000058	10	0	0	No
	Plutonium-239		–	–	–	–	–	–	0.27	10	0	0	No
	Americium-241		–	–	–	–	–	–	0.005	10	0	0	No
Suspension	Plutonium-238		–	–	–	–	–	–	0.00013	1,440	0	0	No
	Plutonium-239		–	–	–	–	–	–	5.85	1,440	0	0	No
	Americium-241		–	–	–	–	–	–	0.11	1,440	0	0	No

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: WCRSEIS. **Facility Name:** Waste Characterization, Reduction, and Repackaging Facility (TA-50-69) *Seismic 2 and Fire*													
Spill inside building	Plutonium Equivalent	curies	800	1	0.001	1	–	1	0.8	1	0	0	No
Spill outside building			1,000	1	0.001	0.1	–	1	0.1	1	0	0	No
Fire inside building			799.2	1	0.01	1	–	1	7.992	60	0.1	0	No
Resuspension inside building			791.2	1	–	1	0.00004	1	0.7596	1,440	0	0	No
Resuspension outside building			999.9	1	–	0.1	0.00004	1	0.09599	1,440	0	0	No
Identifier: SIT14. **Facility Name:** Radioassay and Nondestructive Testing Facility (TA-54-38) *Seismic 1 and 2*													
Initial	Plutonium Equivalent	curies	1,860	1	0.001	1	–	1	1.86	10	0	0	No
Suspension			1,860	1	–	1	0.000004	1	0.178	1,440	0	0	No
Identifier: PF4SEIS. **Facility Name:** Plutonium Facility (TA-55-4) *Seismic 2 and Fire*													
Spill and Fire	Plutonium-238	curies	–	–	–	–	–	–	7.47	60	0.1	0	No
Spill and Fire	Plutonium-239		–	–	–	–	–	–	10.59	60	0.1	0	No
Spill and Fire	Plutonium-240		–	–	–	–	–	–	2.71	60	0.1	0	No
Spill and Fire	Plutonium-241		–	–	–	–	–	–	68.95	60	0.1	0	No
Spill and Fire	Plutonium-242		–	–	–	–	–	–	0.036	60	0.1	0	No
Spill and Fire	Americium-241		–	–	–	–	–	–	1.95	60	0.1	0	No
Identifier: SIT19. **Facility Name:** Safe, Secure Transport Facility (TA-55-355) *Seismic 2*													
Free fall spill	Plutonium-239	grams	50,000	0.093	0.002	0.3	–	1	2.80	10	0	0	Yes
Powder impacted by object			50,000	0.047	0.01	0.2	–	1	4.67	10	0	0	Yes
Identifier: DOMEP. **Facility Name:** Waste Storage Domes (TA-54) (for population [a]) *Seismic 2*													
Combustibles													o
Drums	Plutonium Equivalent	curies	25,800	0.333	0.001	0.3		1	2.58	10	0	0	No
Overpacks			11,300	0.167	0.001	0.3		1	0.566	10	0	0	No
Suspension			10,500	1	–	1	0.000004	1	1.01	1,440	0	0	N

Accident Phase	Nuclide	MAR (curies or grams)	MAR	Damage Ratio	Airborne Release Fraction	Respirable Fractions	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (in units of MAR)	Release Duration (minutes)	Plume Heat (mega-watts)	Release Height (meters)	Wake?
Noncombustibles													
Drums	Plutonium Equivalent	curies	70,400	0.333	0.000849	0.3		1	5.98	10	0	0	No
Overpacks			30,900	0.167	0.000762	0.3		1	1.18	10	0	0	No
Suspension			23,800	1	–	1	0.000004	1	2.29	1,440	0	0	No
Total													
Initial	Plutonium Equivalent	curies	–	–	–	–	–	–	10.3	10	0	0	No
Suspension			–	–	–	–	–	–	3.30	1,440	0	0	No
Identifier: DOMEM **Facility Name:** Waste Storage Domes (TA-54) (for MEI and Noninvolved Worker [a]) *Seismic 2*													
Combustibles											0	0	No
Drums	Plutonium Equivalent	curies	15,900	0.333	0.001	0.3	–	1	1.59	10	0	0	No
Overpacks			6,960	0.167	0.001	0.3	–	1	0.348	10	0	0	No
Suspension			6,440	1	–	1	0.000004	1	0.619	1,440	0	0	No
Noncombustibles													
Drums	Plutonium Equivalent	curies	44,100	0.333	0.000849	0.3	–	1	3.75	10	0	0	No
Overpacks			19,400	0.167	0.000762	0.3	–	1	0.737	10	0	0	No
Suspension			14,900	1	–	1	0.000004	1	1.43	1,440	0	0	No
Total													
Initial	Plutonium Equivalent	curies	–	–	–	–	–	–	6.42	10	0	0	No
Suspension			–	–	–	–	–	–	2.05	1,440	0	0	No
Identifier: SIT16. **Facility Name:** Storage Facility (TA-55-185) *Seismic 1 and 2*													
Initial	Plutonium Equivalent	grams	48,900	1	0.00021	1	–	1	10.3	10	0	0	No
Suspension			48,900	1	–	1	0.000004	1	4.69	1,440	0	0	No
Identifier: DVRS08. **Facility Name:** Decontamination and Volume Reduction System (TA-54-412) (PC-2) *Seismic 1*													
PC-2 Seismic Event	Plutonium Equivalent	curies	900	1	0.001	0.1	–	1	0.09	1,440	0	0	No
Identifier: DVRS12. **Facility Name:** Decontamination and Volume Reduction System (TA-54-412) (PC-3) *Seismic 2*													
PC-3 Seismic Event	Plutonium Equivalent	curies	1,100	1	0.001	1	–	1	1.10	1,440	0	0	No

MAR = material at risk, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, MEI = maximally exposed individual, PC = performance category.

[a] Separate analyses were performed for the population and for the MEI and noninvolved worker because releases from all of the doses would affect the population, but an individual would be affected by only a subset of doses that are close to each other.

D.4.2 No Action Alternative Impacts

D.4.2.1 Site-Wide Seismic 1 – Radiological Impacts

Site-wide Seismic 1 is associated with seismic events up to approximately PC-2 in severity. **Tables D–13** and **D–14** show the potential consequences (dose and probability of an LCF) should such an earthquake occur under the No Action Alternative. **Table D–15** shows the health risk (frequency multiplied by the LCF consequence) per year of operation. The largest risk from this event is from potential Chemistry and Metallurgy Research Building releases.

If a Seismic 1 event were to occur, all of the releases shown in Table D–15 could emanate simultaneously. Accordingly, the sum of the health risk from each facility to the general population is indicated at the bottom of that table. This sum can be thought of as the overall health risk to the general population from a Seismic 1 event. The overall risk is seen to be approximately 0.005 per year; that is, a mean of one cancer fatality in the entire general population (out to 50 miles [80 kilometers] from each release) every 200 years of LANL operation.

Table D–13 Site-Wide Seismic 1 Radiological Accident Offsite Population Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	MEI		Population to 50 Miles (80 kilometers)	
	Dose (rem)	LCF [a]	Dose (person-rem)	LCF [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	62	0.075	6,100	4 (3.7)
SHEBA (TA-18-168) [d]	0.03	0.000018	0.77	0 (0.00046)
Tritium System Test Assembly (TA-21-155)	0.0015	8.8×10^{-7}	0.049	0 (0.00003)
Tritium Science and Fabrication Facility (TA-21-209)	0.013	7.5×10^{-6}	0.43	0 (0.00026)
Radioactive Liquid Waste Treatment Facility (TA-50-1)	3	0.0018	520	0 (0.31)
Radioassay and Nondestructive Testing Facility (TA-54-38)	64	0.077	1,100	1 (0.67)
Storage Facility (TA-55-185)	6	0.0036	590	0 (0.35)
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	2.8	0.0017	49	0 (0.03)
	Max 64	Max 0.077	Sum 8,400	Sum 5 (5.1)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1), 343,100 (TA-54-38, TA-54-412).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–14 Site-Wide Seismic 1 Radiological Accident Onsite Worker Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	LCF [b]
Chemistry and Metallurgy Research Building (TA-3-29)	2,000	2.4 [c]
SHEBA (TA-18-168) [d]	1.1	0.00064
Tritium System Test Assembly (TA-21-155)	0.011	6.7×10^{-6}
Tritium Science and Fabrication Facility (TA-21-209)	0.097	0.000058
Radioactive Liquid Waste Treatment Facility (TA-50-1)	120	0.15
Radioassay and Nondestructive Testing Facility (TA-54-38)	580	0.69
Storage Facility (TA-55-185)	240	0.29
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	10	0.0061

LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, since the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12, show an LCF of 1.0.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–15 Site-Wide Seismic 1 Radiological Accident Offsite Population and Worker Risks for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 1 Event	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	MEI [a]	Population to 50 Miles (80 kilometers) [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	0.001	0.001	0.000075	0.0037
SHEBA (TA-18-168) [d]	0.001	6.4×10^{-7}	1.8×10^{-8}	4.6×10^{-7}
Tritium System Test Assembly (TA-21-155)	0.001	6.7×10^{-9}	8.8×10^{-10}	3×10^{-8}
Tritium Science and Fabrication Facility (TA-21-209)	0.001	5.8×10^{-8}	7.5×10^{-9}	2.6×10^{-7}
Radioactive Liquid Waste Treatment Facility (TA-50-1)	0.001	0.00015	1.8×10^{-6}	0.00031
Radioassay and Nondestructive Testing Facility (TA-54-38)	0.001	0.00069	0.000077	0.00067
Storage Facility (TA-55-185)	0.001	0.00029	3.6×10^{-6}	0.00035
Decontamination and Volume Reduction System (TA-54-412) (PC-2 Seismic)	0.001	6.1×10^{-6}	1.7×10^{-6}	0.00003
		Max 0.001 [e]	Max 0.000077 [e]	Sum 0.0051 [e]

MEI = maximally exposed individual, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1), 343,100 (TA-54-38, TA-54-412).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

[e] See the discussion in Section D.4 regarding the impacts of the 2007 update of the probabilistic seismic hazard analysis.

Risks to individuals, on the other hand, cannot be summed because a single individual likely would not be exposed to multiple facility releases. Instead, only releases upwind from the individual's location would result in exposure. Table D–15, therefore, indicates the maximum health risk to the MEI from a release at any facility.

There is a potential for an individual at publicly accessible Diamond Drive, approximately 55 yards (50 meters) from the Chemistry and Metallurgy Research Building, to receive an exposure from that facility in excess of the MEI exposure. MACCS2 dispersion calculations, the underlying basis for this result, are generally considered to be conservatively high within 330 feet (100 meters) of a release. The calculated dose at Diamond Drive is 6,400 rem, 100 times the Chemistry and Metallurgy Research Building MEI dose indicated in Table D–13. Depending on the specific radionuclides released and the route of human exposure, a radiation dose of this magnitude would result in near-term health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose to the exposed individual or mitigating any health impacts. The dose calculated for an individual on Diamond Drive is based on an assumption that no protective action is taken during the entire time of exposure and that no subsequent medical intervention occurs.

D.4.2.2 Site-Wide Seismic 2 – Radiological Impacts

Site-wide Seismic 2 is associated with events up to approximately PC-3 in severity. **Tables D–16** and **D–17** show the potential consequences (dose and probability of an LCF) should such an earthquake occur under the No Action Alternative. **Table D–18** shows the health risk (frequency multiplied by the LCF consequence) per year of operation. All of the releases from the Seismic 1 event would, of course, be released during this event as well. The waste storage domes would be among the facilities that would have no releases during a Seismic 1 event, but would have releases in the event of the larger Seismic 2 event. This facility, TA-55, and the Chemistry and Metallurgy Research Building represent the major sources of risk for this event. The overall health risk to the general population from this event is approximately 0.009 per year; that is, a mean of one LCF in the entire general population (out to 50 miles [80 kilometers] from each release) every 111 years of LANL operation. Therefore, the risk from a Seismic 1 or 2 event is roughly equivalent.

Table D–16 Site-Wide Seismic 2 Radiological Accident Offsite Population Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	*MEI* Dose (rem)[a]	*MEI* LCF[b]	*Population to 50 Miles (80 kilometers)* Dose (person-rem)	*Population to 50 Miles (80 kilometers)* LCF[c, d]
Chemistry and Metallurgy Research Building (TA-3-29)	62	0.075	6,100	4 (3.7)
Weapons Engineering Tritium Facility (TA-16-205)	17	0.01	110	0 (0.063)
SHEBA (TA-18-168)[e]	0.03	0.000018	0.77	0 (0.00046)
Tritium System Test Assembly (TA-21-155)	0.0015	8.8×10^{-7}	0.049	0 (0.00003)
Tritium Science and Fabrication Facility (TA-21-209)	0.013	7.5×10^{-6}	0.43	0 (0.00026)
Radioactive Liquid Waste Treatment Facility (TA-50-1)	3	0.0018	520	0 (0.31)
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	43	0.052	5,100	3 (3.1)
Radioassay and Nondestructive Testing Facility (TA-54-38)	64	0.077	1,100	1 (0.67)

Facility Impacted by Seismic 2 Event	***MEI***		***Population to 50 Miles (80 kilometers)***	
	Dose (rem) [a]	***LCF*** [b]	***Dose (person-rem)***	***LCF*** [c, d]
Plutonium Facility (TA-55-4)	150	0.17	14,000	9 (8.6)
Storage Facility (TA-55-185)	6	0.0036	590	0 (0.35)
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	34	0.04	600	0 (0.36)
Waste Storage Domes (TA-54)	460	0.55	7,400	5 (4.5)
Safe, Secure Transport Facility (TA-55-355)	3.9	0.0024	290	0 (0.18)
	Max 460	Max 0.55	Sum 36,000	Sum 22

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual per year.

[c] Increased number of LCFs for the offsite population per year; value in parentheses is the calculated result.

[d] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1, -69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4, -185, -355).

[e] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–17 Site-Wide Seismic 2 Radiological Accident Onsite Worker Consequences for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	***Noninvolved Worker at 110 Yards (100 meters)***	
	Dose (rem) [a]	***LCF*** [b]
Chemistry and Metallurgy Research Building (TA-3-29)	2,000	2.4 [c]
Weapons Engineering Tritium Facility (TA-16-205)	150	0.17
SHEBA (TA-18-168) [d]	1.1	0.00064
Tritium System Test Assembly (TA-21-155)	0.011	6.7×10^{-6}
Tritium Science and Fabrication Facility (TA-21-209)	0.097	0.000058
Radioactive Liquid Waste Treatment Facility (TA-50-1)	120	0.15
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	1,100	1.3 [c]
Radioassay and Nondestructive Testing Facility (TA-54-38)	580	0.69
Plutonium Facility (TA-55-4)	2,700	3.3 [c]
Storage Facility (TA-55-185)	240	0.29
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	120	0.15
Waste Storage Domes (TA-54)	2,200	2.6 [c]
Safe, Secure Transport Facility (TA-55-355)	130	0.16

LCF = latent cancer fatality, TA = technical area, SHEBA = Solution High-Energy Burst Assembly.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, since the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

Table D–18 Site-Wide Seismic 2 Radiological Accident Offsite Population and Worker Risks for the No Action, Reduced Operations, and Expanded Operations Alternatives

Facility Impacted by Seismic 2 Event	*Frequency (per year)*	*Onsite Worker*	*Offsite Population*	
		Noninvolved Worker at 110 Yards (100 meters) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Chemistry and Metallurgy Research Building (TA-3-29)	0.0005	0.0005	0.000037	0.0018
Weapons Engineering Tritium Facility (TA-16-205)	0.0005	8.7×10^{-5}	5×10^{-6}	0.000032
SHEBA (TA-18-168) [d]	0.0005	3.2×10^{-7}	9×10^{-9}	2.3×10^{-7}
Tritium System Test Assembly (TA-21-155)	0.0005	3.3×10^{-9}	4.4×10^{-10}	1.5×10^{-8}
Tritium Science and Fabrication Facility (TA-21-209)	0.0005	2.9×10^{-8}	3.8×10^{-9}	1.3×10^{-7}
Radioactive Liquid Waste Treatment Facility (TA-50-1)	0.0005	0.000073	9.1×10^{-7}	0.00016
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	0.0001 [e]	0.0001	5.2×10^{-6}	0.00031
Radioassay and Nondestructive Testing Facility (TA-54-38)	0.0005	0.00035	0.000039	0.00034
Plutonium Facility (TA-55-4)	0.0004 [e]	0.0004	7×10^{-5}	0.0035
Storage Facility (TA-55-185)	0.0005	0.00014	1.8×10^{-6}	0.00018
Decontamination and Volume Reduction System (TA-54-412) (PC-3 Seismic)	0.0005	0.000074	0.00002	0.00018
Waste Storage Domes (TA-54)	0.0005	0.0005	0.00028	0.0022
Safe, Secure Transport Facility (TA-55-355)	0.0005	0.000077	1.2×10^{-6}	0.000088
		Max 0.0005 [f]	Max 0.00028 [f]	Sum 0.009 [f]

MEI = maximally exposed individual, TA = technical area, SHEBA = Solution High-Energy Burst Assembly, PC = performance category.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the offsite population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 297,000 (TA-3-29), 404,900 (TA-16-205), 334,100 (TA-18-168), 271,600 (TA-21-155, -209), 302,000 (TA-50-1, -69), 343,100 (TA-54-38, TA-54-412, Domes), 301,900 (TA-55-4, -185, -355).

[d] The SHEBA accident scenario is applicable only to the No Action Alternative. Operation of SHEBA would cease under the Reduce Operations and Expanded Operations Alternatives.

[e] Different frequency than other seismic events due to assumption of other additional failures.

[f] See the discussion in Section D.4 regarding the impacts of the 2007 update of the probabilistic seismic hazard analysis.

The consequence to an individual at publicly accessible Diamond Drive from a Seismic 2 release from the Chemistry and Metallurgy Research Building could exceed that from the nearest site boundary. This consequence is the same as for the Seismic 1 event; the effects of the Chemistry and Metallurgy Research Building release are discussed in detail under that heading.

D.4.2.3 Site-Wide Seismic 1 – Chemical Impacts

The facilities and chemicals of concern under site-wide Seismic 1 conditions are shown in **Table D–19**. There are numerous chemicals in small quantities onsite that could be released under these conditions. The listed chemicals were selected from a complete set of chemicals used onsite based on their larger quantities, chemical properties, and human health effects.

Table D–19 shows the ERPG concentration values for which excess concentrations could have harmful health or life-threatening implications as defined in the table's footnotes. Hydrogen cyanide, phosgene, and formaldehyde are toxic gases that, at elevated levels, can cause respiratory or cardiovascular (in the case of hydrogen cyanide) dysfunction. The hypothetical MEI could be exposed to formaldehyde concentrations in excess of ERPG-3 values in the event of such an earthquake, depending on the meteorological conditions at the time. This high exposure is a result of the proximity of TA-43-1 to the site border with the Los Alamos townsite.

Table D–19 Chemical Accident Impacts Under Seismic 1 Conditions

Chemical	Frequency [c] (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]		Concentration	
			Value	Distance to Value (meters)	Value	Distance to Value (meters)	Noninvolved Worker at 100 Meters	MEI at Site Boundary
Hydrogen Cyanide at TA-3-66 (Sigma Complex)	0.001	13.5 pounds (6 kilograms)	10 ppm	140	25 ppm	86	19 ppm	0.25 ppm at 924 meters
Phosgene at TA-9-21	0.001	1 pound (0.45 kilogram)	0.2 ppm	280	1 ppm	120	1.4 ppm	0.025 ppm at 823 meters
Formaldehyde at TA-43-1 (Bioscience Facilities)	0.001	14.1 liters (3.7 gallons)	10 ppm	180	25 ppm	110	31 ppm	Exceeds ERPG-3 at 12 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million.
[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).
[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).
[c] Based on the updated 2007 update of the probabilistic seismic hazard analysis, the annual probability of exceedance for this earthquake is estimated to be 0.0015 (1 chance in 670). See discussion in Section D.4.
Note: To convert meters to yards, multiply by 1.0936.

The noninvolved worker could be exposed to phosgene or formaldehyde in excess of ERPG-3 values if located directly downwind of the releases and unable to take evasive action.

Table D–19 shows the concentration of each chemical, if it were released, at specified distances. The estimated frequency of this seismic event is shown in the table.

D.4.2.4 Site-Wide Seismic 2 – Chemical Impacts

The facilities and chemicals of concern under site-wide Seismic 2 conditions are shown in **Table D–20**. There are numerous chemicals in small quantities onsite that could be released under these conditions. The listed chemicals were selected from a complete set of chemicals used onsite based on their larger quantities, chemical properties, and human health effects. The table shows the ERPG concentration values for which excess concentrations could have harmful health or life-threatening implications, as defined in the table's footnotes.

Table D–20 Chemical Accident Impacts Under Seismic 2 Conditions

Chemical	Frequency [c] (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]		Concentration	
			Value	Distance to Value (meters)	Value	Distance to Value (meters)	Noninvolved Worker at 100 Meters	MEI at Site Boundary
Hydrogen cyanide at TA-3-66 (Sigma Complex)	0.0005	13.5 pounds (6.1 kilograms)	10 ppm	137	25 ppm	86	18.6 ppm	0.25 ppm at 924 meters
Phosgene at TA-9-21	0.0005	1 pound (0.45 kilogram)	0.2 ppm	276	1 ppm	118	1.38 ppm	0.025 ppm at 823 meters
Formaldehyde at TA 43-1 (Bioscience Facilities)	0.0005	14.1 liters (3.7 gallons)	10 ppm	178	25 ppm	112	31.3 ppm	Exceeds ERPG-3 at 12 meters
Chlorine gas released outside of TA-55-41 Plutonium Facility	0.0005	150 pounds (68 kilograms)	3 ppm	1,080	20 ppm	380	165 ppm	3.4 ppm at 1,016 meters
Nitric acid spill at TA-55-4 (Plutonium Facility)	0.0005	6,100 gallons (23,090 liters)	6 ppm	49	78 ppm	6.6	1.61 ppm	0.019 ppm at 1,016 meters
Hydrochloric acid spill at TA-55-249	0.0005	5,200 gallons (19,684 liters)	20 ppm	185	150 ppm	64.5	65.9 ppm	0.65 ppm at 1,117 meters
Beryllium at TA-3-141 (Beryllium Technology Facility)	0.0005	110 pounds (49 kilograms) (powder) [d]	0.025 milligrams per cubic meter	282	0.1 milligrams per cubic meter	116	0.126 ppm	0.0043 milligrams per cubic meter at 880 meters

ERPG = Emergency Response Planning Guideline, MEI = maximally exposed individual, TA = technical area, ppm = parts per million.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] Based on the updated 2007 update of the probabilistic seismic hazard analysis, the annual probability of exceedance for this earthquake is estimated to be 0.0008 (1 chance in 1,250). See discussion in Section D.4.

[d] This quantity represents the total material at risk. A fraction (0.0006) of this solid would be released for the hypothesized scenario.

Note: To convert meters to yards, multiply by 1.0936.

The Seismic 1 chemical releases would be repeated here. In addition, because of the increased severity of this event, beryllium, chlorine, nitric acid, and hydrochloric acid could be released in sufficient quantities to create plausible health effects near the release site. Exposure to beryllium can result in acute lung damage; elevated levels of chlorine and acids can cause respiratory dysfunction. The beryllium powder release could result from a Beryllium Technology Facility structural failure in a Seismic 2 earthquake with subsequent container breaching. Chlorine could be released as a result of line or tank failures. The integrity of the nitric and hydrochloric acid tanks could be compromised. It is assumed that their entire contents spill and are contained within the seismically qualified berms surrounding each tank. Release from these acid pools would be by evaporation.

Table D–20 shows the concentration of each chemical, if released, at specified distances. The estimated frequency of the Seismic 1 event is shown in the table. The hydrogen cyanide, phosgene, and formaldehyde releases projected during a Seismic 1 event also would occur during the more severe Seismic 2 event; the distances and environmental concentration levels would be unchanged from the former event. None of the additional releases would result in MEI exposure in excess of ERPG-3 levels. A noninvolved worker, if directly downwind from the release and unable to take evasive action, could be exposed to beryllium or chlorine in excess of ERPG-3 levels. The additional releases (except beryllium) are from TA-55, and its distance from the site boundary, together with the quantities potentially released, would prevent ERPG-3 exposure to the public. The inventory of beryllium kept at TA-3-141 is limited to minimize accident impacts.

D.4.3 Reduced Operations Alternative Impacts

The site-wide seismic radiological accident impacts from the Reduced Operations Alternative would be similar to those from the No Action Alternative, as given in Tables D–13 through D–18. SHEBA operations at LANL would cease under this alternative. Inspection of the tables shows that SHEBA operations are a small component of the site-wide seismic accident impacts at LANL; its elimination would not significantly alter the overall site risk profile from such an event. All other impacts in the tables are equally applicable for this alternative.

The chemicals of concern that could be released in a site-wide seismic event are the same for the Reduced Operations Alternative as for the No Action Alternative. None of the chemicals identified for the latter are eliminated in this alternative. The information in Tables D–19 and D–20, then, is applicable to the Reduced Operations Alternative.

D.4.4 Expanded Operations Alternative Impacts

D.4.4.1 Site-Wide Seismic 1 – Radiological Impacts

The Seismic 1 accident impacts from the Expanded Operations Alternative would be similar to those from the No Action Alternative. SHEBA operations at LANL would cease under the Expanded Operations Alternative. Its impacts are relatively small; deleting SHEBA impacts would not change the overall Seismic 1 risk profile of this alternative. Replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste managed at DVRS would be moved offsite or to a new facility, the TRU Waste Facility, which would be located in a TA along the Pajarito Road Corridor. The impacts from this new facility would be less than those of the existing facility because of the new location. The entries in Tables D–13 through D–15 reflect present DVRS operations because it could be active for most of the time period of interest. The accident impacts from DVRS bound the impacts of its replacement facility. Accident impacts for the new facility are described in Appendix H.

D.4.4.2 Site-Wide Seismic 2 – Radiological Impacts

The Seismic 2 accident impacts from the Expanded Operations Alternative would be similar to those from the No Action Alternative. SHEBA operations at LANL would cease under the Expanded Operations Alternative. Its impacts are relatively small; deleting its impacts would not change the overall Seismic 2 risk profile of this alternative. Replacement risks from accident impacts would result from expanded waste management activities. Transuranic waste managed at DVRS and the waste storage domes would be moved offsite or to a new facility, the TRU Waste Facility, located in a TA along the Pajarito Road Corridor. The impacts from this new facility would be less than those of the existing facility because of the new location and because less material would be stored, the rest being moved offsite. The entries in Tables D–16 through D–18 reflect present DVRS and the waste storage domes operations because they could be active for most of the time period of interest and because their accident impacts bound the impacts of the new facility. The TRU Waste Facility accident impacts are described in Appendix H.

D.4.4.3 Site-Wide Seismic 1 – Chemical Impacts

The chemicals of concern that could be released in a site-wide Seismic 1 event are the same under the Expanded Operations Alternative as under the No Action Alternative. No additional chemicals were identified in this alternative that would have impacts exceeding those for the No Action Alternative. The information in Table D–19, then, is applicable to the Expanded Operations Alternative.

D.4.4.4 Site-Wide Seismic 2 – Chemical Impacts

The chemicals of concern that could be released in a site-wide Seismic 2 event are the same under the Expanded Operations Alternative as under the No Action Alternative. No additional chemicals were associated with this alternative that would have impacts exceeding those under the No Action Alternative. The information in Table D–20, then, is applicable to the Expanded Operations Alternative.

D.5 Wildfire Accidents

This section discusses the potential for a wildfire at LANL (LANL 2004) that could cause the release of hazardous radioactive and chemical materials that would affect the health and safety of LANL workers and the public.

D.5.1 Background

Wildfires were evaluated in the *1999 SWEIS* and were studied further following the Cerro Grande Fire in May 2000. The following sections provide background information on the potential for LANL wildfires since the *1999 SWEIS* was prepared.

D.5.1.1 Consuming Combustible Structures and Vegetation

A theoretical wildfire resulting in the exposure of humans to airborne radiation was one of several operational site-wide accident scenarios analyzed and reported in the *1999 SWEIS*. The health impact of the wildfire accident was 0.34 LCFs, resulting from an estimated population dose of 675 person-rem. The dose to the MEI member of the public was less than 25 rem, and the estimated frequency of occurrence was approximately once every 10 years. While the estimated radiological dose consequence of a wildfire accident was small, the high frequency of occurrence resulted in a risk (the product of the frequency and consequence) that was surpassed by only one other postulated accident in the *1999 SWEIS*.

The wildfire accident analysis assumed multiple source releases, including radiological inventories from buildings, suspended soils with environmental (very low) levels of contamination, and ash from burned vegetation (this ash also had very low levels of contamination). Since the analysis in 1999, radiological inventories in buildings have changed; the vulnerability of buildings to ignition by wildfire has changed as a result of tree thinning; more accurate and more comprehensive data have been compiled on concentrations of radionuclides in vegetation; vegetation fuel loads have changed; and the frequency of occurrence has possibly changed.

The LANL site and surrounding vicinity are generally forested areas with high fuel loading (Balice, Oswald, and Martin 1999; Balice et al. 2000). Wildfires are frequent occurrences on nearby U.S. Forest Service land and have an obvious potential for encroaching on the LANL site, as demonstrated by recent events (Balice, Oswald, and Martin 1999, Balice et al. 2000). Recently, an analysis was completed to help determine areas of concern for continued wildfire risk at LANL that consider the extensive environmental changes since 1999. Based on the results of this analysis, areas of concern were determined that are consistent with those found in another recent wildfire risk analysis (Balice et al. 2005). A particular scenario, a wildfire starting southwest of LANL near the border of the Bandelier National Monument and the Dome Wilderness Area, was postulated. While there is a potential for initiation of a wildfire at many locations within and near the LANL site, this location was considered to have the greatest potential for widespread environmental impacts to LANL because continuous fuel is available from these offsite locations near the southwest corner of LANL.

D.5.1.2 Recent Widespread Environmental Changes

Since completion of the *1999 SWEIS* wildfire analysis, the Cerro Grande Fire occurred. On May 4, 2000, the National Park Service initiated a prescribed burn on the flanks of Cerro Grande Peak within the boundary of Bandelier National Monument. The intended burn was a meadow of about 300 acres (120 hectares), located 3.5 miles (5.6 kilometers) west of TA-16, near the southwest corner of LANL. The prescribed burn began in the evening; by 1:00 p.m. the following day, the burn was declared a wildfire.

LANL’s meteorological data showed above–average temperatures and low humidity for the first 10 days of the wildfire, with wind speeds averaging 6 to 17 miles per hour (10 to 27 kilometers per hour) and gusting from 27 to 54 miles per hour (44 to 87 kilometers per hour). Generally, winds tended to be from the southwest to west during this period. By May 8, day 5 of the wildfire, spot fires began to occur on LANL lands. By May 10, the fire moved into the Los Alamos townsite and proceeded north and east across the TA-16 mesa top. The fire moved eastward down Water Canyon, Cañon de Valle, Pajarito Canyon, and Cañada del Buey by May 11. Eventually the fire extended northward on LANL lands to Sandia Canyon and eastward down Mortandad Canyon into San Ildefonso Pueblo lands. The residential areas of Los Alamos and White Rock were in the fire’s path, and more than 18,000 residents were evacuated. By the end of the day on May 10, the fire had burned 18,000 acres (7,280 hectares), destroyed 235 homes, and damaged many other structures. The fire also spread toward LANL; although the fire moved onto LANL land, all major structures were secured and no releases of radiation occurred. The wildfire was declared fully contained on June 6, after burning nearly 43,000 acres (17,400 hectares) of land extending to Santa Clara Canyon on Santa Clara Pueblo lands to the north of the townsite. LANL had approximately 6,757 acres (2,734 hectares) of low-burn severity; 844 acres (342 hectares) of moderate-burn severity; and 50 acres (20 hectares) of high-burn severity (Balice, Bennett, and Wright 2004).[3]

[3] *The sum of these areas is approximately equal to 7,700 acres as cited elsewhere in this SWEIS.*

The Cerro Grande Fire had enormous adverse impacts on forests around LANL. Immediately there were concerns about increased erosion and flooding and the potential impacts on contaminated soil and sediment. Seventy-seven contaminant potential release sites and two nuclear facilities at LANL that contain hazardous and radioactively contaminated soils and materials are located within floodplain areas. Without DOE action, these potential release sites and nuclear facilities could have released contaminants and materials downstream during rainfall events. In addition, numerous cultural resource sites and traditional cultural properties are located in canyons or along drainage areas and were at increased risk of flood damage.

LANL conducted assessments and implemented on-the-ground rehabilitation efforts. Under the DOE Special Environmental Assessment (DOE 2000), LANL was to conduct mitigation measures and monitor the condition of the burned area annually. In all, LANL treated over 1,800 acres (728 hectares) with techniques similar to those used by the Burned Area Emergency Rehabilitation team. The project was successful, increasing vegetative cover on the severely burned units from around 0 percent to almost 45 percent. Most of the straw wattles that were installed held sediment onsite and allowed vegetation to grow. The LANL management and operating contractor developed best management practices for all potential release sites that were potentially impacted by the fire to eliminate contaminant transport.

The drought that began in 2000 in the southwestern United States, although not unprecedented, has been one of the more severe in 50 years (Breshears et al. 2005). Precipitation for this region was 25 percent below average during 2000 and 2001, and 65 percent below average through the summer months. The combined effects of prolonged drought and severe outbreak of bark beetles (*Ips confusus*) resulted in tens of millions of dead trees over thousands of square miles in Arizona, New Mexico, Colorado, and Utah (McHugh, Kolb, and Wilson 2003). Highest mortality levels have been seen in ponderosa pine (*Pinus ponderosa*), douglas-fir (*Pseudotsuga menziesii*) and pinyon (*Pinus edulis*) pine trees. In many areas of pinyon-juniper habitat, entire stands of pinyon have died, leaving only juniper (*Juniperus monosperma*). Bark beetle infestations in western North America has been documented to cause large areas of high tree mortality that has been linked to both drought and fire in the region (USDA 2002). The Pajarito Plateau, where LANL is located, had an average 85 percent tree mortality for trees over 5 feet (1.5 meters) tall from 2002 to 2003, leaving a mosaic of live and dead trees.

To decrease the risk from catastrophic environmental fire, LANL began a tree-thinning project in January 2002. The goals of this project were to reduce the threat of wildfire to forested areas and structures on LANL property, to enhance and maintain wildlife habitat and tree species diversity by ensuring vertical and horizontal heterogeneity of age class and structure throughout the forest, and to promote forest health. Tree thinning has been completed on 7,283 acres (2,947 hectares), including both ponderosa pine and pinyon–juniper habitats (LANL 2005). Tree thinning and environmental changes were incorporated into the wildfire risk analysis of this SWEIS.

D.5.1.3 Wildfire Occurrence

D.5.1.3.1 General Approach

The following analysis of the risk of wildfire initiation and spread was taken from the *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement* (LANL 2004).

This analysis was largely based on data produced during earlier studies and field monitoring activities. A dataset of lightning strike locations and intensities was used to represent wildfire ignitions. Polygons (multi-sided geometric shapes) of previously modeled fires were used to evaluate the relative potential for fires to burn within the study area. Fuels data and an existing land cover map were used to characterize the fuels and fire hazards in the study region. It was assumed that lightning, modeled fires, and fuels characterizations represent ignitions, fire spread, and flammability, respectively. These are all important components of wildfire risk. The three intermediate results were weighted and combined in the geographical information system (GIS) software to create a preliminary relative risk rating for each cell in the study region. All analyses were completed using ArcView 3.2a GIS software. Cell (a term used in ArcView for a specific bounded surface area) resolution was set at 49 feet by 49 feet (15 meters by 15 meters).

D.5.1.3.2 Region of Interest

The study region was based on an area used for previous analyses of wildfire behavior (Balice et al. 2000). This included most of LANL and all of its areas west of TA-18. To the west, north, and south, the region of interest extends to the crest of the Sierra de los Valles and the eastern portion of the Valles Caldera National Preserve, the northern extent of the Los Alamos townsite, and Frijoles Canyon, respectively. Typical vegetation in this area consists of pinyon-juniper woodlands, ponderosa pine forests, mixed conifer forests, aspen forests and grasslands. Occasional barren areas, shrub lands, and spruce-fir forests also are found in the study region. Numerous developed areas, including the Los Alamos townsite and the TAs at LANL, are also interspersed throughout the study region.

D.5.1.3.3 Lightning Strike Densities and Intensities

Lightning strikes that were less than 100,000 amps in intensity were removed from the dataset. Lightning strikes that were located outside of a test region were also removed from the dataset. The 131 remaining lightning strike locations and their relative intensities were analyzed in ArcView. From these point locations, a map of densities by relative strike intensities was created and scaled from 0 to 1, with 1 representing the greatest combined strike density and intensity. The cell-based output of scaled values represents the relative tendencies that fires would be ignited within the polygons.

D.5.1.3.4 Modeled Fire Polygons

To assess the potential for fires to burn within each ArcView cell, wildfires were simulated from each lightning strike location using scenarios that reflected conditions in the Los Alamos region for the 1999 time period (57 lightning strikes) and the 2002 time period (49 lightning strikes), respectively. FARSITE was used as the modeling software (USDA 1998). FARSITE was previously parameterized with locally collected data representing the fuels and fire hazards of the Los Alamos region. The parameterized fire behavior modeling system also was validated against the burn histories of known fires.

The databases representing the 1999 time period were derived from vegetation and fuels conditions that were present in the Los Alamos region before the Cerro Grande Fire, before the initiation of major thinning and fire hazard reduction activities, and before the initiation of drought-induced mortality. All other conditions for fire behavior simulations were assumed to be those that existed immediately before or during the Cerro Grande Fire. The databases representing the 2002 time period incorporated changes that resulted from the Cerro Grande Fire, large-scale forest thinning activities, and tree mortality.

Each simulation produced a polygon representing the potential area burned by a wildfire. These multiple theme layers or polygons were then superimposed in the GIS, and the total number of fire polygons that occurred in each cell was summed. For both the 1999 time period and the 2002 time period, the greatest number of simulated fires in any given cell was 11. Cell values were then scaled from 0 to 1 based on these values, with 1 representing those cells where 11 simulated fires occurred. The final scaled values represent the relative tendency of a fire to burn through a cell under the conditions of the simulation. Those cells with more fires were assumed to be at greater risk of a fire actually burning through that cell.

D.5.1.3.5 Fuel Conditions

The fuel model concept, canopy heights, and percent canopy cover were used to model the fuel conditions at each ArcView cell. Values for these parameters were established from previous field sampling conducted throughout the Los Alamos region from 1997 through 2004. The fuel models were ranked by their relative ability to support more intense fires. Similarly, 100 feet (30 meters) was assumed to be the maximum canopy height, and all other canopy heights were ranked proportionally to this maximum value and scaled from 0 to 1. For canopy cover, 100 percent cover was set as the maximum possible, and the actual percent canopy cover values were rated proportionately between 0 and 1.

Previously developed land cover classification systems for assignment of fuel model, canopy heights, and percent canopy cover values to each land cover class were used. This was performed for conditions that were typical of the 1999 and 2002 time period. These scaled class assignments were applied to ArcView versions of land cover maps that were developed before and after the Cerro Grande Fire.

D.5.1.3.6 Wildfire Model Development

The five data layers of lightning, modeled fires, and fuel conditions (three layers) for each time period were mathematically combined in the GIS to assess spatial trends of fire risk across the study region. Equal weight was given to each of these three major risk groups according to the following relationship:

> {Density of lightning strikes by their relative intensity + relative number of simulated fires + [relative canopy height + relative percent canopy cover + relative fuel model]/3}/3.

Finally, the values for these calculated fire risks were scaled from 0 to 1. The analysis was repeated for conditions that existed in approximately 1999. This was before the Cerro Grande Fire, before extensive thinning was initiated, before rehabilitation treatments were applied to the forests of the region, and before the onset of major mortality events. Then the process was repeated for the 2002 conditions, after the Cerro Grande Fire, after the thinning of approximately 7,000 additional acres (2,800 hectares), and after the onset of tree mortality.

D.5.1.3.7 Wildfire Model Results

Results indicate that the risk of wildfires within the study region is not homogeneous through space and time. With regard to time, the relative wildfire risks are seen to decrease from the 1999 time period (see **Figure D–1**) to the 2002 time period (see **Figure D–2**). The greatest decrease in the wildfire risk appears to have taken place in the mountainous regions on the western boundary of LANL and further to the west, as well as in the mesa and canyon regions of the western and central portions of LANL.

Spatial variations in wildfire risk for the 2002 time period show a general decrease in risk from the mountainous regions in the west to the lower elevations in the eastern portion of the study region. A general ranking of the specific areas for their relative risk is also possible.

First, the greatest fire risk occurs along the Pajarito Ridge from New Mexico (NM) 501 to the Pajarito Ski Area.

Second, the next greatest fire risk occurs in the southwest corner of LANL, adjacent to the Back Gate.

Third, relatively high fire risks occur in the intervening areas along NM 501 and the western boundary of LANL.

Fourth, relatively high fire risks occur along portions of the mesa-canyon areas between TA-40 and TA-21. This is particularly true for the north-facing slopes of the canyons, although some of the other topographic positions in this area resulted in lower fire risk levels.

Fifth, the remaining portions of LANL and its immediate surroundings are at relatively less risk from wildfires.

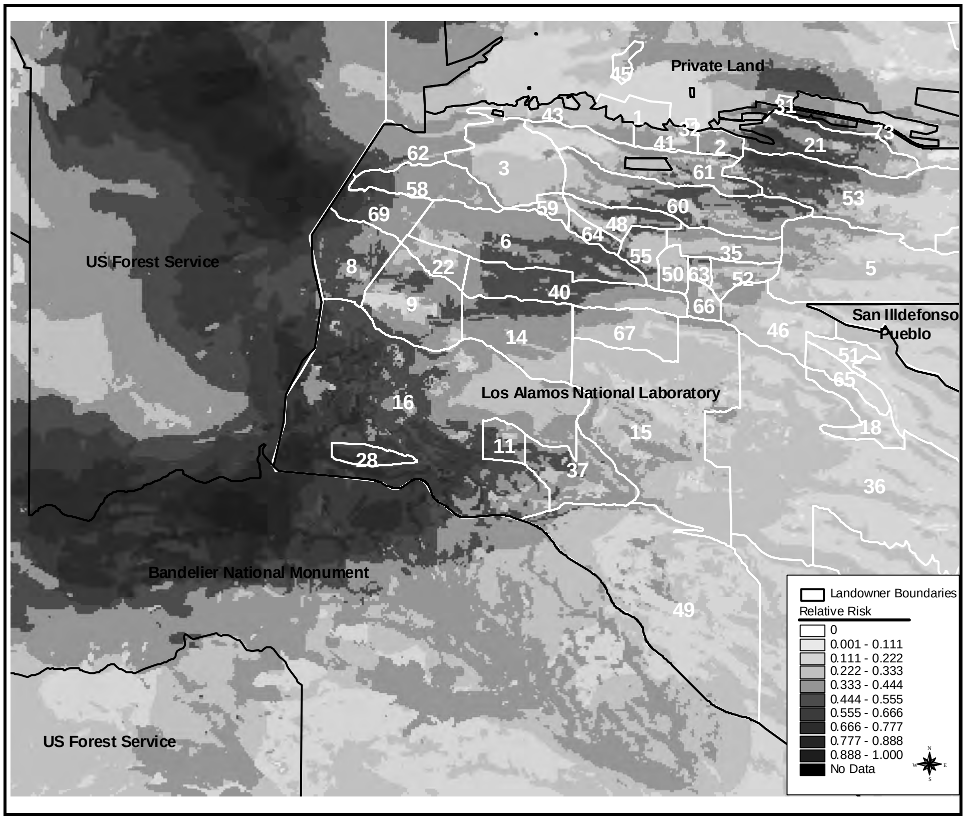


Figure D–1 Relative Risk of Wildfire in the Los Alamos Region (1999)

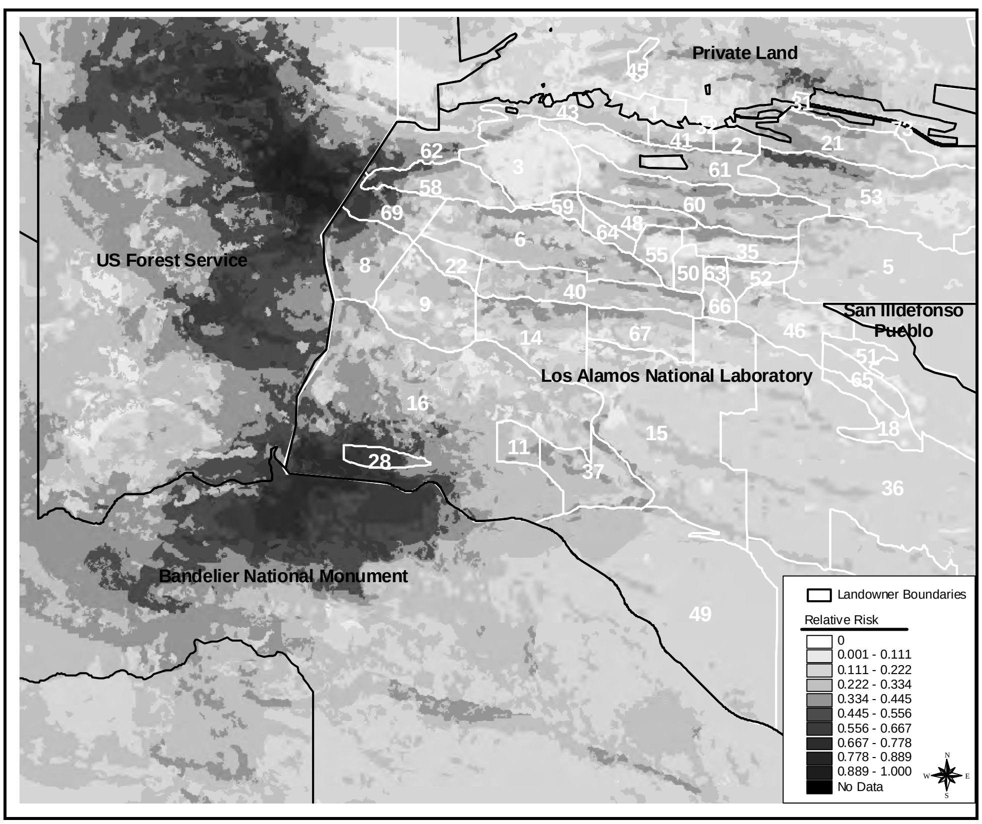


Figure D–2 Relative Risk of Wildfire in the Los Alamos Region (2002)

D.5.2 Current Wildfire Hazard Conditions

This section discusses the current wildfire hazard conditions and likelihood, reflecting changes that have occurred since the late 1990s. The analysis is taken from LANL 2004.

D.5.2.1 Changes to the Fuels and Fire Hazard Conditions in the Past 5 Years

Current fuels and fire hazard conditions in the Los Alamos region are not the same as those that existed in the late 1990s. This is reflected in the most credible wildfire scenario that would be expected in the present time period, which is considerably different from what would have been expected before 2000. In the wildfire scenario reported in the *1999 SWEIS* (DOE 1999a), fuels were heavy and continuous throughout most of the mixed conifer forests of the Sierra de los Valles and extended eastward to the ponderosa pine forests on most of the western portions of LANL property. As ponderosa pine forests transitioned to pinyon-juniper woodlands toward the eastern half of LANL, the canopy heights and the total fuel loads were reduced somewhat, but maintained the continuous nature of their overstory cover. These heavy and continuous fuels, especially in the mountainous environments, coupled with the southwest-to-northeast wind patterns that are typically prevalent during the fire season, suggested a general wildfire scenario that was validated by the Dome Fire and the Cerro Grande Fire.

In the general wildfire scenario of the 1990s, fire would be ignited by lightning or by humans in the mountains during high to extreme fire danger levels. A small fire of this type would burn lightly for a day or two until the combination of temperature, humidity, and wind worsened to the point that the fire extended from the ground surface through the fuel ladders into the forest overstory. At this time, the winds would carry the fire through the tree crowns from the mountains in a northeasterly direction toward LANL. The fire would continue to spread across LANL for up to 10 days. During this time, all unprotected buildings and facilities in its path would be destroyed. Suppression of the fire would be impossible until the weather conditions moderated sufficiently to allow the application of effective suppression measures.

Since the writing of the *1999 SWEIS*, several aspects of the wildfire conditions in the Los Alamos region have changed significantly; however, some aspects of the wildfire conditions in the region have not changed. For example, ignition sources have not changed since the *1999 SWEIS*. During both time periods, fires most likely would be ignited by lightning or by humans. Moreover, ignitions would typically occur most prevalently in the mountainous environments to the west of LANL. Topographic conditions in the Los Alamos region also have not changed since the *1999 SWEIS*. The mountainous environments to the west of LANL and the canyon-mesa environments at LANL present difficulties in managing and suppressing fires and create safety and management issues related to transportation and movements across these topographic barriers. In addition, the patchwork of land management agencies in the Los Alamos region has not changed since the *1999 SWEIS*, which creates unique problems for wildfire hazard management that can only be resolved through strong interaction and collaboration among the individual agencies.

Some aspects of weather have changed since the *1999 SWEIS* and some have not. Severe wildfire weather conditions tend to occur from mid-April to early July, and these have not been altered since 1999. Similarly, there is still a significantly strong tendency for intense winds to occur during this time period, and the direction of these winds tends to be from the southwest to the northeast. Moreover, the density of lightning strikes is high during the latter portions of the wildfire season, and this has altered since the writing of the *1999 SWEIS*. What has changed with respect to weather conditions since the *1999 SWEIS* is that the climate has grown significantly hotter and drier. Precipitation levels are somewhat similar to the 1950s drought; however, recent temperatures have been significantly higher (Breshears et al. 2005).

The wildfire hazard that changed extensively since the *1999 SWEIS* is fuel levels in the Los Alamos region. First, the Cerro Grande Fire greatly reduced fuels in more than 42,000 acres (17,000 hectares) of forested landscape at LANL and to the west of LANL. This was especially true in the severely burned areas where re-establishment of fuels has been limited to regrowth from sprouting shrubs and from seeded grasses. In contrast, regrowth of vegetation in the lightly burned and moderately burned sections of the Cerro Grande Fire has resulted in very little net change in fuel levels in these areas. Moreover, reseeding with grasses in the severely burned areas of the Cerro Grande Fire and other rehabilitation techniques have resulted in major changes to the post-fire fuel conditions. Immediately after the fire, severely burned forests were essentially unburnable; however, with the establishment of seeded grasses and with the addition of dead trees that have fallen to the ground, many of these areas can now support a surface fire.

In addition to past fires, fire hazard reduction activities in forests and adjacent to facilities at LANL have altered the fuel structures. Before 1997, the forests and woodlands at LANL were essentially unmanaged and severely overstocked with trees and shrubs. The result was a situation that was dangerously high in fuels and fire hazards throughout most of the forests and woodlands at LANL. Between 1997 and 1999, approximately 800 acres (324 hectares) of ponderosa pine forest on the western perimeter of LANL and near critical facilities were thinned from below. These fire hazard reduction activities increased dramatically after the Cerro Grande Fire. Between 2001 and 2003, approximately 6,000 acres (2,428 hectares) of ponderosa pine forests and pinyon-juniper woodlands were thinned. These fire hazard reduction activities focused on creating defensible space around critical buildings and facilities, underneath power lines and along transportation corridors, and in the surrounding forests and woodlands.

D.5.2.2 Potential Wildfire Scenarios

The results of the wildfire risk analysis incorporating altered fuel conditions that have occurred in the past few years suggest the heightened likelihood that some general wildfire scenarios will occur compared to other scenarios at LANL. Wildfires that occur today would still be ignited by lightning or by humans. These fires would tend to be ignited in the mountainous regions to the west of LANL, but fires also could be started on the LANL site. High winds during the fire season from mid-April to early July would still tend to carry actively burning wildfires from the southwest to the northeast. This general scenario is consistent with another recent wildfire risk analysis for LANL (Balice et al. 2005). Early suppression of wildfires is important to the successful protection of buildings and facilities. Once these fires enter the canopy of forests, they are difficult to control until weather conditions moderate.

The major impact of fire hazard reduction activities in recent years at LANL is that fires would tend to remain on the ground surface and would more readily drop from the canopies back to the ground surface. This, in combination with the creation of defensible space adjacent to LANL facilities, would facilitate management and suppression with the result that buildings and facilities would be easier to protect.

With the greatest modeled risk from wildfires occurring along the Pajarito Ridge and along the margins of the Frijoles Canyon, the risk to LANL would still largely arise from the west and the southwest. TA-16, TA-28, TA-58, TA-62, and TA-69 would be at the greatest risk from wildfires. The second greatest risk from wildfires would occur along the western borders of LANL; TA-8 and TA-9, and portions of TA-16 would be at risk from wildfires arising in this area. Secondarily, TA-3, TA-6, TA-11, TA-14, TA-22, TA-37, TA-40, and TA-59 also would be at risk from fires arising along the western boundary at LANL. In all of these cases, fires would enter the canyon environments on LANL property. This would create difficulties for control and management and increase the danger to adjacent buildings and facilities.

Fires that originate from within the boundaries of LANL likely would be ignited at firing sites at central locations of the site. These would primarily impact TA-14, TA-15, TA-40, and TA-67. Numerous canyons dissect this area, which would add to the difficulties of suppressing these fires as they spread across adjacent mesas from canyon to canyon. In addition, the canyon environments contain conditions (topographic barriers, heavy fuel loads on north-facing aspects, and modified canyon wind patterns) that would complicate the direction of wildfire spread. The result would be that fires would tend to spread readily in down-canyon and up-canyon directions and travel across mesas or via airborne embers to adjacent canyons.

D.5.2.3 Frequency of Wildfires

The probability component of the risk equation reported in the *1999 SWEIS* only considered the advancement of a large wildfire to the LANL boundary and assumed that this fire would continue on a path through LANL, reaching and igniting LANL buildings and causing a radiological release.

The frequency of a large fire encroaching on LANL (1 in 10 years) was estimated in 1999 as the joint probability of ignition in the adjacent forests, high to extreme fire danger, failure to promptly extinguish the fire, and fire-favorable weather. The frequency estimate for ignition in the adjacent forests was based on a 21-year period (1976 to 1996) and probably has not changed appreciably in the years since. Fire ignitions have continued to occur in adjacent forests. Periods of high to extreme fire danger have continued to occur frequently during the summer months, and fire-favorable conditions have continued as well. The estimated likelihood of a fire reaching a LANL boundary did not include the likelihood of a fire advancing across LANL to encroach on buildings containing radiological materials (in appreciable amounts), the likelihood of buildings igniting, and the likelihood of a release occurring once buildings are assumed to ignite. The likelihood of a fire encroaching on a building containing radioactive material depends on, among other factors, fuel load and continuity of fuel leading up to the space surrounding the buildings. The likelihood of a nuclear facility igniting depends on the joint probability of fuel load indices for fuel adjacent to buildings, the slope on which the adjacent fuel loads exist, and the combustibility of buildings. This factor was quantified in 1999 and has been updated recently. The likelihood of a release would be related to the damage ratio (likelihood that the material at risk was actually impacted by the accident) and the leak path factor (likelihood that confinement, if any, is breached). While the probability of a large fire encroaching on LANL remains moderate to high depending on location, probably still on the order of 1 in 10 years (0.1 per year), the probability of a LANL facility containing an appreciable radiological inventory being ignited by a wildfire and releasing some or all of the inventory has been reduced somewhat by the "defensible space" thinning and by the reductions in fuel caused by the Cerro Grande Fire.

Since the probability estimate for the *1999 SWEIS* stopped at the LANL boundary, there is no value for the probability of the fire advancing across LANL to nuclear facilities, igniting buildings, and causing a release. Without this value, an assessment of how this probability might have changed cannot be made. Gonzales, Ladino, and Valerio (2004) conservatively estimated that there is a 50 percent chance that the three factors just mentioned occur and combined this probability value (0.5) with the assumed probability for a wildfire reaching the LANL boundary (0.1). This resulted in a conservative estimate of the probability that a release would occur due to a wildfire and result in radiological exposures of 0.05 per year. This translates to a 5-in-100-year chance of occurrence, which is equal to 1 in 20 years. This estimate is in agreement with the draft Documented Safety Analysis for Area G. The fact that the Cerro Grande Fire did not result in the ignition of a LANL nuclear facility is evidence that thinning works and preventative maintenance will keep key facilities safer from wildfire than in the past.

D.5.2.4 Conditions that Favor Wildfire

In view of the present density and structure of fuel surrounding and within LANL and the occurrence of five major fires in the past 50 years it is evident that there is the potential for wildfire occurrence at LANL. Some protection is afforded LANL by the fire scars of the previous Dome and La Mesa Fires, but there is ample fuel continuity remaining to bring an offsite wildfire to the southwest and western boundary of LANL. The current analysis accounts for the environmental changes and fuel reduction mitigation that have occurred due to the Cerro Grande Fire.

The probability of high to extreme fire danger is determined by the frequency of meteorological conditions of low precipitation for 2 to 3 weeks preceding; low relative humidity for 3 consecutive days; and high temperatures. When the high to extreme fire danger exists in New Mexico in May through July, there are certain to be multiple ignition sources (from lightning and human causes). The high frequency of lightning and lightning-caused fires in the Jemez Mountains was used in the analysis of fire risk. The frequency of a large fire encroaching on LANL is estimated as the joint probability of ignition in the adjacent forests, high to extreme fire danger, failure to promptly extinguish the fire, and a 3-day spell of southwesterly to westerly wind over 11 miles per hour (5 meters per second), low humidity, and no precipitation.

D.5.2.5 Determining the Joint Probability of Occurrence of Weather and Fire Danger Conditions

The probability of occurrence of the weather and fire conditions needed for a wildfire were determined using wind and fire danger data for April through June, the months when fire risk and frequency are greatest, of 1980 through 1998. Note that site-wide fires also are possible, but less probable, in other months besides April through June; thus, the annual frequency of fire–favorable weather is somewhat greater than quantified for April through June.

In general, wind direction at any location varies and does not persist in a single direction for a few days. LANL is no exception. At LANL, persistent daytime winds are interrupted for a few hours when nighttime drainage winds occur; however, granting short interludes of drainage flow, there are many instances in which a dominant direction, such as southwesterly, westerly, northerly, can exist for 3 days without precipitation.

To determine a fire-favorable weather frequency, 15-minute average wind data from the lower level of the TA-6 and TA-59 meteorological towers was used. For each day in April through June of 1980 through 1998, an average afternoon wind was calculated from the 15-minute data to eliminate the local diurnal changes in wind speed and direction that are common to the area. Average afternoon wind speeds of greater than 10 miles per hour (4.5 meters per second) are chosen to represent strong winds. While this threshold may seem low for a strong wind, wind gusts of over 30 miles per hour (13 meters per second) and sometimes over 40 miles per hour (18 meters per second) are seen on most days when the afternoon average wind is above 10 miles (16 kilometers) per hour. The wind direction thresholds are set at 180 degrees (southerly) through 292.5 degrees (west-northwesterly). Three-day periods from the same dataset were then examined to determine whether the precipitation, wind speed, and wind direction fell above or within set limits. All 3-day periods falling within the set limits were then extracted.

The results show that it is not uncommon to see a 3-day period exhibiting the selected characteristics in a given year and that, when such a 3-day period appears, it is likely that more than one such period will occur within that year. Specifically, the resulting statistics show that, of the 19 years examined, 5 displayed at least one 3-day period within the limits, or one every 4 years. Of these 5 years, 4 had an average of 3.6 3-day periods (an instance of 5 days in a row is counted as three 3-day periods.) This comes to 15.4 instances in 19 springs.

In summary, fire-favorable weather conditions occur on the order of once per year; the ignition sources are prevalent; and firefighting is hampered by limited accessibility. Therefore, analysis concludes that a major fire moving up to the edge of LANL is not only credible but likely, probably on the order of 0.10 per year. This frequency is the same for all alternatives.

D.5.3 General Wildfire Scenario

D.5.3.1 Description

The SWEIS wildlife scenario used in 1999 predicted a path and outcome very similar to the Cerro Grande Fire. Due to the extent and size of the Cerro Grande Fire and subsequent fire mitigation actions completed since the *1999 SWEIS*, a new fire risk analysis was completed to incorporate the environmental changes and lessons learned from the Cerro Grande Fire.

The scenario fire begins midday in the late April through June timeframe, at a time of high or extreme fire danger, and is not extinguished in the first hour. The initial location is in an area populated with heavy ponderosa pine fuels that is found at between roughly 6,500 and 8,200 feet (1,980 and 2,500 meters) elevation. As the fire grows, local jurisdictions respond to the fire, but are not effective due to characteristics such as remoteness, travel time, lack of road access, and fire behavior. Resources from more distant jurisdictions are alerted, but cannot arrive in a short time because of distance, limited roads, and opposing evacuation traffic. It proves impossible to put out the fire with the available resources and existing forest access before it enters LANL. Unlike the Water Canyon Fire (greater than 3,000 acres [1,214 hectares] in June 1954), La Mesa Fire (15,300 acres [6,191 hectares] in June 1977), Dome Fire (16,500 acres [6,677 hectares] April 25 to May 5, 1996), and Oso Fire (greater than 5,000 acres [2,023 hectares] in June 1998), but very much like the Cerro Grande Fire in May 2000 (43,000 acres [17,401 hectares]), the weather does not change in time to prevent the fire from sweeping across the western part of LANL and into the townsite.

This specific analysis assumes a common meteorological situation that favors the fire. In this scenario, the fire begins about 10 a.m., reaches a size of 1,000 acres (400 hectares) in 3 hours, and becomes a well-developed crown fire on a broad fire front containing 6,000 acres (2,400 hectares) on the second day. Like the La Mesa Fire, at times it advances at a rate of 0.5 miles (0.7 kilometers) per hour. It starts spot fires 0.5 to 1.25 miles (0.8 to 2.0 kilometers) in advance, aided by prevailing southwest winds of 20 miles per hour (9 meters per second) and low daytime humidity. It easily jumps canyons and existing fuel break lines around LANL and the townsite, similar to the Cerro Grande Fire.

The daytime convection column reaches to 20,000 to 25,000 feet (6,000 to 7,600 meters). In the Oso Fire, the fire burned as actively at night as in the day, with flame heights on the order of 100 feet (30 meters). In this scenario, in order to have a conservative (low height) plume rise, at night the temperature drops and the relative humidity increases. The nighttime plume rise is then about 2,000 feet (600 meters). The fire regains its intensity at 10:00 a.m. each day. Following fire passage, the smoldering remains of vegetation and structures emit smoke and contaminants at the surface level.

The fire reaches NM 4 and NM 501, the southwest edge of LANL, at noon on the second day. Protective actions are already being undertaken by LANL management, such as relocating some radionuclides, barricading some windows, and releasing nonessential personnel following existing emergency plans. The fuel break along these roads proves inadequate. At this point, the fire has progressed in areas where access is limited, hampering fire suppression activities due to concern for the safety of the firefighters. A control line is established at Pajarito Road and resources are concentrated there. Consequently, Pajarito Road is closed and is not available for public evacuation. The fire burns forest to the west of and within LANL, but its eastern extent within LANL is constrained by pinyon-juniper woodlands and defined by fuel continuity and density.

From the completed specific analysis of fuel loads and prediction of fire risks, it is estimated the TAs most at risk include TA-8, TA-16, TA-28, TA-58, TA-62, and TA-69. This differs slightly from the previous wildfire scenario, in which TA-15, TA-37, and TA-66 were used. Following the continuous fuel lines and steered somewhat by southwesterly winds, the fire enters and crosses Pajarito Canyon and Twomile Canyon; by 1:00 a.m. on the third day, it burns up to the Pajarito Road control line just west of TA-66.

Although the control line would be expected to contain most fires, in this conservative accident scenario, an adverse meteorological situation exists where the wind picks up to 54 mph (24 meters per second), as it did in the Cerro Grande Fire, causing the fire to cross NM 501. On the LANL site, the fire is assumed to consume all combustible structures in its path that are evaluated to be at moderate or higher risk from wildfire under the LANL Building Appraisal Program. The fire also exposes the surface of contaminated earth that was previously protected by vegetation in the firing sites and canyons. This text separately discusses exposures from fire that burns the soil cover and suspends the underlying soil and exposures from burning structures. Exposures from the latter are calculated individually, enabling the assessment of fires of lesser extent than the site-wide fire.

This accident analysis does not consider offsite damage directly caused by the flames and smoke from LANL fires or the direct effects of the fire on the townsite. It is recognized that continuous fuel joins the National Forest and the residential areas, and that fires in the canyons at LANL also could propagate into the townsite.

D.5.3.2 Dispersion Meteorology, Thermal Energy, and Soil Resuspension Following the Fire

The wildfire radiological release exposure analysis was performed using MACCS2, the same computer code used on the other radiological release scenarios described in this appendix. That code was exercised stochastically, sampling each hour of an annual meteorological dataset and using that hour as the initial conditions for plume transport. The reported doses are the mean values of each of these trials. Because the wildfire is more likely to occur in April through June, the meteorology for those months was extracted from a recent 4-year dataset (2000 through 2003) of hourly meteorology to form a synthetic annual dataset consisting of April through June 2000 through 2003 (with meteorology from July 1, 2003, filling out the final day of the set). The MACCS2 wildfire analysis used this synthetic meteorology dataset.

The wildfire chemical release exposure analysis was performed using ALOHA, the same code used in the other chemical release scenarios described in this appendix. That code uses deterministic meteorology such as a single wind speed and stability class to calculate downwind dispersion. Table D-2 shows that stability class D and 7.8 mph (3.5 meters per second) wind speed represent median dispersion conditions for the synthetic dataset used in the MACCS2 analysis.

Exposures were calculated at 330 feet (100 meters) and the nearest public access to a release. These exposure locations are consistent with those chosen for the other scenarios included in this appendix. In the event of a wildfire scenario such as that considered here, the location of the public and onsite personnel such as firefighters might not correspond to those associated with the other scenarios considered. Chemical exposure at an additional location, 3,300 feet (1,000 meters) from each release, is therefore included. Radiological exposures at additional downwind distances, including 3,300 feet (1,000 meters), from each release are given in Section D.7.

The thermal energy of the contaminant plumes is a strong determinant of plume exposure; the greater the energy, the greater the plume buoyancy and the less impact on receptors along the ground. As described in the previous subsection, the daytime plume rise could reach up to 25,000 feet (7,600 meters), while the nighttime plume rise is conservatively assumed to be only 2,000 feet (600 meters). MACCS2 was run with the meteorological dataset described above and a plume heat input of 20 megawatts was found to result in a plume rise of approximately 2,000 feet (600 meters). That heat input was used for the fire phase of all radiological releases. ALOHA conservatively assumes no heat input; therefore, no buoyant rise due to heat is included in the chemical exposure calculations.

Following the fire release, a 24-hour wind suspension release period was assumed. It is thought that after the fire has passed, mitigation may not occur for this time period. An airborne release rate, 4×10^{-6} (4 parts per million) per hour, was chosen to reflect that contamination remaining at the source will likely be covered with fire debris.

D.5.3.3 Exposures from Burning Vegetation and Suspended Soil

Suspended ash from vegetation and suspended soil contributed about 7 percent (approximately 50 person-rem) of the total population radiological dose reported in the *1999 SWEIS*. Concentrations of radionuclides in vegetation at LANL were largely unavailable when that SWEIS analysis was performed in the late 1990s. Given plant and soil uptake coefficients for some radionuclides in the published literature, concentrations of radionuclides in plants were largely based on concentrations in soil. Since the *1999 SWEIS*, data have been compiled on concentrations of radionuclides in vegetation at LANL. Comparing data used in the *1999 SWEIS* with more recent data on concentrations of radionuclides in plants, perspective can be gained on the change in vegetation as a radiation source term for wildfire. One concentration used in the *1999 SWEIS* was 320 micrograms (μg) uranium per gram (g) of dry vegetation, which was taken from a sample collected in 1975 where uranium concentrations in surface soils were 20 to 3,500 times background levels. This compares to maximum concentrations of 0.65 μg/g-dry in the bark of shrubs that were rooted in transuranic waste material; 0.073[4] μg/g-dry in understory vegetation collected at one of 12 LANL Environmental Surveillance Program onsite locations in 1998; 0.066[3] μg/g-dry in overstory vegetation at one of the same 12 locations in the same year; 0.05[3] μg/g-dry in pine needles from TA-16 in 1985; 0.72[5] μg/g-dry in overstory vegetation at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility in 2002; and 1.5[6] μg/g-dry in pinyon tree bark at a firing site in 2001 (Gonzales et al. 2004). Other than total uranium, the *1999 SWEIS* does not identify the concentrations used in source term calculations. Ignoring the other radionuclides and based on comparison of the total uranium concentration assumed in the earlier SWEIS with other, more recent data on concentrations of total uranium in plants, the source term from vegetation used in the *1999 SWEIS* is still bounding of any that would be calculated using more recent concentration data. The predicted MEI dose from vegetation and soil in a site-wide fire remains less than 1 millirem. Although the Cerro Grande Fire burned only about 7,500 acres (3,040 hectares) of forest within LANL, the estimated inhalation dose to an MEI based on measurements of 0.2 millirem (LANL 2001) supports the hypothesis that vegetation and soil contribute very little radiation dose.

The effect of the existing radioisotope concentration in the soil in and around LANL on the calculated radiological consequences of a postulated wildfire was evaluated. Environmental

---

[4] *Computed using an ash/dry weight ratio of 0.1 from Fresquez and Ferenbaugh (1999).*
[5] *Computed using an ash/dry weight ratio of 0.08 from Fresquez and Ferenbaugh (1999).*
[6] *Computed by converting radioisotopic data to uranium mass data and using an ash/dry weight ratio of 0.029 for bark from Gonzales et al. (2004).*

surveillance data from the top 2 inches of soil measured in the 2001 through 2004 time period were used. These measurements were made for the following radioisotopes: tritium, strontium-90, cesium-137, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, plutonium-240, and americium-241. Assuming a wildfire occurred that burned the same 43,000 acres (17,400 hectares) as the Cerro Grande Fire and that the mean radioisotope soil concentration was the same as the mean measured for the onsite LANL areas, the airborne respirable source term was calculated to be approximately 10 curies of tritium and 0.2 curies of uranium and transuranic radioisotopes. The total released respirable source term for all of the buildings affected by the postulated wildfire accident in Appendix D is approximately 1.45×10^6 curies of tritium and 100 curies of uranium and transuranic radioisotopes. Therefore, the conservatively calculated soil-released source term from a Cerro Grande-size fire is a factor of about 500 to 100,000 times smaller than the source term released by buildings affected by the fire. This much smaller magnitude of source term, coupled with the fact that it would be released over a very large distributed area, shows that the radiological effect of releasing radioisotopes in the soil during a large fire at LANL is insignificant compared to the radiological consequence of the fire's effects on certain buildings at LANL.

D.5.4 Methodology

D.5.4.1 Evaluation of Building Fires

The *1999 SWEIS* analyzed potential individual and population radiological and chemical exposures from buildings burning as a result of wildfire initiation. Each building was first screened for its vulnerability to wildfire. Building vulnerabilities were updated in 2004 for this analysis. The building vulnerabilities at TA-54 and the Weapons Engineering Tritium Facility in TA-16 were validated in the field to incorporate the many fuel load mitigations that occurred in the recent past. Those buildings that were evaluated as vulnerable were then screened for chemical and radiological inventories that were updated in May 2004.

Criteria and Process for Determining Building Vulnerability to Wildfire

The evaluation of vulnerability to wildfire is based on building construction, materials and exposure, slope, and the quantity and structure of external fuel as described below. The total wild land fire vulnerability of over 500 buildings is frequently updated by the LANL Fire Protection Group. The vulnerability is the product of the structure hazard times the sum of the fuel hazard and slope hazard, as defined below.

Structure Hazard

The structure hazard rating considers the combustibility of the exterior structure:

- Underground – 0
- Noncombustible exterior (windowless) – 1
- Noncombustible exterior (window exposures) – 2
- Combustible exterior – 3

Fuel Hazard

The fuel hazard is the product of two components, fuel loading and distance factor. Fuel loading is taken as 0 for short grass and asphalt; for other conditions, it is determined by the fuel model type, as described in *Aids to Determining Fuel Models For Estimating Fire Behavior* (Anderson 1982).

The distance factor (DF) expresses the distance of the fuel from the structure:

- DF–0 – distance is greater than 4 times the height of the fuel.
- DF–1 – distance is greater than 2 times the height of the fuel.
- DF–2 – distance is the height of the fuel.
- DF–3 – distance is less than one-half the height of the fuel.

Slope Hazard

Exposing slopes are rated as follows:

Slope Hazard	***Slope***
5	Mild (0 to 5 percent)
10	Moderate (6 to 20 percent)
15	Steep (21 to 40 percent)
20	Extreme (41 percent and greater)

The total vulnerability is then calculated as the product of the structure hazard times the sum of the fuel hazard and slope hazard. This number is converted to a word description as follows:

Numerical Rating	***Vulnerability***
0 to 5	None
6 to 49	Very Low
50 to 79	Low
80 to 149	Moderate
150 to 259	High
260 and above	Extreme

Note that this method does not estimate the probability that a wildfire will consume the building. Rather, it quantifies the relative vulnerability of a building to wildfire on the basis of the conditions immediately surrounding a building and the construction type for each building. **Table D–21** lists the buildings that have a moderate or higher risk. Other buildings have no significant amounts of MAR and were not evaluated for this accident analysis.

Since 1999 when the results of this vulnerability assessment were first reported, a reduction in vulnerability from 51 to 21 buildings classified as moderate or higher has been achieved, largely as the result of clearing or thinning the forested areas (defensible space) immediately adjacent to the buildings. More importantly, buildings of concern that are located in the wildfire high-risk area, such as Weapons Engineering Tritium Facility in TA-16, have been downgraded to low vulnerability.

The *1999 SWEIS* analysis assumed that buildings with a moderate, high, or extreme wildfire vulnerability burned and released their entire content of radiological inventories. A reduction in the wildfire vulnerability of key buildings through reductions in the fuel load around the buildings could substantially reduce the likelihood of the buildings igniting and could also reduce the release of radiological materials by lowering the intensity of the fire. Since 1999, however, the wildfire vulnerabilities of two formerly high risk waste storage domes (Buildings 229 and 230) at TA-54 have been lowered to moderate. The Weapons Engineering Tritium Facility wildfire vulnerability has been reduced from moderate to very low.

Table D–21 Evaluation of Vulnerability of Los Alamos National Laboratory Buildings to Wildfire

Technical Area	*Building*	*Wildfire Risk*	*Nuclear Facility*	*Hazards*	*Construction Type* [a]
03	0016 and 0208	Moderate	No	Radiological	2
03	0040	Moderate	No	Radiological	2
03	0066 and 0451	High	No	Radiological, Chemical	2
03	0169	Moderate	No	Radiological	
08	0023	High	No	Radiological	2
21	0155	Moderate	No	Radiological	
21	0209	Extreme	No	Radiological, Chemical	2
36	0001	Moderate	No	Radiological	
41	0001 and 0004	Moderate	No	Radiological	
43	0001	Extreme	No	Radiological, Chemical	2
54	0033	High	Yes	Radiological	
54	0048	Moderate	Yes	Radiological	
54	0049	Moderate	Yes	Radiological	
54	0153	Moderate	Yes	Radiological	3
54	0215	Moderate	No	Radiological	3
54	0224	Moderate	No	Radiological	3
54	0226	Moderate	Yes	Radiological	3
54	0229	Moderate	Yes	Radiological	3
54	0230	Moderate	Yes	Radiological	3
54	0231	Moderate	Yes	Radiological	3
54	0232	Moderate	Yes	Radiological	3

[a] Construction type: 2 = noncombustible exterior with window exposures, 3 = combustible exterior.

Current sources of information were consulted for data on the relative quantities of radiological material at risk of potentially being impacted and released in an accident situation. By definition, only Hazard Category 1 and 2 nuclear facilities can have offsite impacts from their radiological material inventories when considered on an individual basis. However, because site-wide accidents can involve releases from several facilities, Hazard Category 3 nuclear facilities and nonnuclear (radiological) facilities were also considered. Nuclear facilities that are rated extreme, high, or moderate vulnerability in Table D–21 and were within relatively high wildfire risk areas were selected for quantitative contaminant risk assessment. Three additional facilities in TA-16, Building 205 (WETF), Building 411 (Device Assembly), and TA-50-69 (WCRR Transportainer) were also included because, even though individual facilities may have low vulnerabilities, TA-16 is among the TAs at greatest risk from a wildfire and TA-50 has an outside vulnerable transportainer.

D.5.4.2 Public Exposure from Burning Buildings

The individual exposures assume no sheltering inside buildings or vehicles and no protective actions taken by the individual at those locations. Although Area G is not in the direct path of the fire, it borders a canyon and could be susceptible to a canyon fire even in the absence of a site-wide fire. The results of the *1999 SWEIS* found that Area G contributed 75 percent of the total population exposure. Therefore, it was again included in the wildfire analysis.

D.5.4.3 Effects of Hazardous Chemicals

Vulnerable buildings and the outdoors in the fire path were screened for their chemical inventories and updated for 2004. Six of the 12 facilities included in the *1999 SWEIS* eliminated their chemical inventories. Only TA-3-66 increased its inventory from 11.5 pounds (5.2 kilograms) of hydrogen cyanide to 13.5 pounds (6.1 kilograms) of hydrogen cyanide. For fire-vulnerable facilities, the earthquake scenario chemical results are acceptable representations of the site-wide fire because the entire inventories are assumed to be released.

D.5.4.4 Onsite Workers and Offsite Population

In the event of a wildfire approaching from the south, LANL would begin evacuation of the southern area of LANL as soon as it was determined that the fire posed a threat and would proceed north with the evacuation. Personnel deemed essential to shutdown operations would remain until such actions were completed. Some emergency response personnel and security personnel would remain at all times in some areas. In 1999, there were 10,200 LANL employees (including contractors), of which approximately 4,000 lived outside of Los Alamos County and 6,200 within Los Alamos County. The *1999 SWEIS* reported that the Main Hill Road (New Mexico 502) could evacuate 800 cars per hour, and the combination of the East Jemez and Pajarito Roads could evacuate another 800 cars per hour.

During the Cerro Grande Fire, it was decided that, if the fire jumped Los Alamos Canyon, the entire town of Los Alamos would have to be evacuated. Shortly after noon on May 10, the fire jumped Los Alamos Canyon, which was the last natural barrier before the townsite. At 1:15 p.m., county emergency personnel broadcast the directive for all of the people of Los Alamos to evacuate their homes immediately. Although some projections indicated that it would take up to 12 hours to get all 12,000 Los Alamos residents down the mountain using the single road (New Mexico 502), the entire town evacuated in 4 hours, directed by the small police force. On May 10, 2000, the fire burned over 15,500 acres (62,700 hectares) in 9 hours—in other words, the Cerro Grande Fire consumed in 9 hours the same amount of acreage that the 1996 Dome Fire consumed in 9 days. By late afternoon, the wind-whipped 200-foot (60-meter) wall of flame reached the western edge of town; by 6:00 p.m., the first reports of loss of houses came in to the Emergency Operations Center.

In the aftermath of the Cerro Grande Fire, there was considerable interest in describing the potential radiological impacts of the fire itself and of the radionuclides of LANL origin that may have dispersed during the fire. Radiological dose calculations were performed based on air monitoring data collected by the LANL AIRNET system during the Cerro Grande Fire. The dose calculated was the committed effective dose equivalent, which is the dose received during the 50 years following the inhalation of radionuclides. The inhalation dose to an MEI in Los Alamos was 0.2 millirem (LANL 2001). A dose of similar magnitude was conservatively calculated for Rio Grande water use, chiefly from assumed irrigation during peak runoff from a storm event (LANL 2002). These doses can be considered in the context of exposure to naturally occurring radioactivity in the LANL area of at least 400 millirem per year (see Chapter 4, Section 4.6.1.2, of this SWEIS).

All workers in threatened areas would be evacuated prior to arrival of the fire front. Aircraft crashes with fatalities have occurred while dropping slurry on wildfires. Firefighters on the ground are at risk if they enter an area without an alternate escape route, and there have been historical fatalities from such events. However, because life safety is given priority over protection of property at LANL, it is not likely that there would be worker fatalities. Some firefighters and other emergency personnel could have significant, but transient, effects from smoke inhalation.

D.5.5 Wildfire Accident Impacts Analysis

There are no significant impact differences among the wildfire risks for the three alternatives, No Action, Reduced Operations, and Expanded Operations. Therefore, only a single set of wildfire impacts are presented. The radiological impact section, D.5.5.2, includes a discussion of the alternatives.

D.5.5.1 Facility Source Terms

A wildfire accident scenario was postulated for evaluation of impacts to onsite workers and the offsite population. Details of this scenario are given in the preceding sections. **Table D–22** shows the LANL buildings that could be affected by the wildfire, inventory of hazardous radiological materials, source term factors, and estimated source terms.

D.5.5.2 Radiological Impacts

The estimated consequences for the public and workers as a result of a wildfire are shown in **Tables D–23** and **D–24** for each listed facility. The values shown assume that a wildfire has occurred and therefore do no reflect any credit for the probability of a wildfire occurrence. The estimated annual risks for the wildfire scenario are shown in **Table D–25**. The values shown in that table take credit for the probability of a wildfire's occurrence. The risk from a wildfire is dominated by the TA-54 waste storage domes. The second largest risk (although significantly less than the domes) is also from TA-54, DVRS.

Table D–22 Wildfire Accident Source Term Data

Accident Phase	*Nuclide*	*MAR (curies or grams)*	*MAR*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fractions*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (in units of MAR)*	*Release Duration (Delta T) (minutes)*	*Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: WILDF01. **Facility Name:** Sigma Complex (TA-3-66/451).													
Fire	Depleted Uranium	grams	11,500,000	1	0.04	0.17	–	1	78,200	60	20	0	No
Suspension			11,000,000	1	–	1	0.00004	1	10,600	1,440	0.1	0	No
Identifier: WILDF02. **Facility Name:** Weapons Engineering Tritium Facility (TA-16-205).													
Fire	Tritiated Water	grams	1,000	1	1	1	–	1	1,000	60	20	0	No
Identifier: WILDF05. **Facility Name:** Radiochemistry Facility (TA-48-1).													
Fire	Plutonium Equivalent	grams	7.56	1	0.001	1	–	1	0.00756	60	20	0	No
Suspension			7.55	1	–	1	0.00004	1	0.00725	1,440	0.1	0	No
Identifier: DOMEP-Population. **Facility Name:** Waste Storage Domes (TA-54) (all domes).													
Combustibles													
Burning Expelled in Lid Loss	Plutonium Equivalent	curies	37,100	0.333	0.001	1	–	1	124	60	–	0	No
Burning (in drums)			37,100	0.667	0.0005	1	–	1	12.4	60	–	0	No
Noncombustibles													
Burning	Plutonium Equivalent	curies	101,000	1	0.006	0.01	–	1	6.08	60	–	0	No
Total													
Burning (high-heat)	Plutonium Equivalent	curies	–	–	–	–	–	–	71.1	60	20	0	No
Burning (smoldering)			–	–	–	–	–	–	71.1	60	0.1	0	No
Impact Release			138,000	0.33	0.001	1	–	1	45.7	1	0	0	No
Suspension			138,000	0.33	–	1	0.000004	1	43.6	1,440	0	0	No
Identifier: DOMEM-MEI. **Facility Name:** Waste Storage Domes (TA-54) (six western domes).													
Combustibles													
Burning Expelled in Lid Loss	Plutonium Equivalent	curies	22,800	0.333	0.01	1	–	1	76.1	60	–	0	No
Burning (in drums)			22,800	0.667	0.0005	1	–	1	7.61	60	–	0	No

Accident Phase	Nuclide	MAR (curies or grams)	MAR	Damage Ratio	Airborne Release Fraction	Respirable Fractions	Airborne Release Rate (per hour)	Leak Path Factor	Source Term (in units of MAR)	Release Duration (Delta T) (minutes)	Heat (mega-watts)	Release Height (meters)	Wake?
Noncombustibles													
Burning	Plutonium Equivalent	curies	63,500	1	0.006	0.01	–	1	3.81	60	–	0	No
Total													
Burning (high-heat)	Plutonium Equivalent	curies	–	–	–	–	–	–	43.8	60	20	0	No
Burning (smoldering)			–	–	–	–	–	–	43.8	60	0.1	0	No
Impact Release			86,300	0.33	0.001	1	–	1	28.5	1	0	0	No
Suspension			86,100	0.33	–	1	0.00004	1	27.2	1,440	0	0	No
Identifier: WILDF08. **Facility Name:** Device Assembly (TA-16-411).													
Fire	Uranium-238	grams	4,000	1	0.0005	1	–	1	2.00	60	20	0	No
Suspension			4,000	1	–	1	0.00004	1	3.84	1,440	0.1	0	No
Identifier: WDVRS06. **Facility Name:** Decontamination and Volume Reduction System (TA-54-412).													
Ejected (from drums)	Plutonium Equivalent	curies	1,100	0.333	0.001	0.3	–	1	0.11	60	20	0	No
Burning (ejected material)			366	1	0.01	1	–	1	3.66	60	20	0	No
Burning (in drums)			1,100	0.667	0.0005	1	–	1	0.367	60	20	0	No
Total													
Fire	Plutonium Equivalent	curies	–	–	–	–	–	–	4.14	60	20	0	No
Suspension			363	1	–	1	0.00004	1	0.348	1,440	0.1	0	No
Identifier: WILDF10. **New Name:** Radiography (TA-8-23).													
Fire	Plutonium Equivalent	curies	–	–	–	–	–	–	0.0026	60	20	0	No
Identifier: WCRWILD. **New Name:** Waste Characterization, Reduction, and Repackaging Facility (TA-50-69).													
Fire	Plutonium Equivalent	curies	1,800	1	0.01	1	–	1	18	60	1	0	No
Resuspension			1,782	1	–	1	0.00004	1	1.711	1,440	0	0	No

MAR = material at risk, TA = technical area, MEI = maximally exposed individual.

Table D–23 Radiological Accident Offsite Population Consequences for a Wildfire Accident

Facility Impacted by Wildfire	MEI		Population to 50 Miles (80 kilometers)	
	Dose (rem) [a]	LCF [b]	Dose (person-rem)	LCF [c, d]
Sigma Complex (TA-3-66/451)	0.0039	2.3×10^{-6}	4.8	0 (0.0029)
Weapons Engineering Tritium Facility (TA-16-205)	0.061	0.000036	110	0 (0.067)
Radiochemistry Facility (TA-48-1)	0.0011	6.4×10^{-7}	0.44	0 (0.00026)
Waste Storage Domes (TA-54)	1,900	2.3 [e]	91,000	55 (54.8)
Device Assembly (TA-16-411)	1.6×10^{-6}	8.9×10^{-10}	0.00017	0 (1×10^{-7})
Decontamination and Volume Reduction System (TA-54-412)	4.9	0.003	1,200	0 (0.7)
Radiography (TA-8-23)	0.00033	2×10^{-7}	0.56	0 (0.00034)
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	27	0.032	6,900	4 (4.2)

MEI = maximally exposed individual, LCF = latent cancer fatality, TA = technical area.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Increased number of LCFs for the offsite population, assuming the accident occurs; value in parentheses is the calculated result.

[d] Offsite population size is approximately 297,030 for TA-03-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-1; 343,069 for Domes and TA-54-412; and 349,780 for TA-8-23.

[e] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means that it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, since the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

Table D–24 Radiological Accident Onsite Worker Consequences for a Wildfire Accident

Accident	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem) [a]	LCF [b]
Sigma Complex (TA-3-66/451)	0.076	0.000046
Weapons Engineering Tritium Facility (TA-16-205)	0.33	0.0002
Radiochemistry Facility (TA-48-1)	0.016	9.3×10^{-6}
Waste Storage Domes (TA-54)	8,700	11 [c]
Device Assembly (TA-16-411)	0.000017	1×10^{-8}
Decontamination and Volume Reduction System (TA-54-412)	16	0.0098
Radiography (TA-8-23)	0.0019	1.2×10^{-6}
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	440	0.53

LCF = latent cancer fatality, TA = technical area.

[a] Individual radiation doses in excess of a few hundred rem would result in acute (near-term) health effects or even death from causes other than cancer. In some cases, medical intervention may be effective in reducing the dose, mitigating health impacts, or both. The listed doses are calculated assuming that the exposed individual takes no protective action during the period of exposure and that no subsequent medical intervention occurs.

[b] Increased risk of an LCF to an individual, assuming the accident occurs.

[c] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.0 as shown. This means it is likely that an individual exposed to the indicated dose would develop a latent fatal cancer. For calculation purposes, the actual value is shown here; however, because the exposed recipient is an individual, the equivalent tables in Chapter 5, Section 5.12 show an LCF of 1.0.

Table D–25 Radiological Accident Offsite Population and Worker Risks for a Wildfire Accident

Accident	Frequency (per year)	Onsite Worker	Offsite Population	
		Noninvolved Worker at 110 Yards (100 meters) [a]	MEI [a]	Population to 50 Miles (80 kilometers) [b, c]
Sigma Complex (TA-3-66/451)	0.05	2.3×10^{-6}	1.2×10^{-7}	0.00014
Weapons Engineering Tritium Facility (TA-16-205)	0.05	1×10^{-5}	1.8×10^{-6}	0.0034
Radiochemistry Facility (TA-48-1)	0.05	4.7×10^{-7}	3.2×10^{-8}	1.3×10^{-5}
Waste Storage Domes (TA-54)	0.05	0.05	0.05	2.7
Device Assembly (TA-16-411)	0.05	5.2×10^{-10}	4.4×10^{-11}	5.2×10^{-9}
Decontamination and Volume Reduction System (TA-54-412)	0.05	0.00049	0.00015	0.035
Radiography (TA-8-23)	0.05	5.7×10^{-8}	1×10^{-8}	1.7×10^{-5}
Waste Characterization, Reduction, and Repackaging Facility (TA-50-69)	0.01 [d]	0.0053	0.00032	0.042

MEI = maximally exposed individual, TA = technical area.
[a] Increased risk of an LCF to an individual per year.
[b] Increased number of LCFs for the offsite population per year; value in parentheses is the calculated result.
[c] Offsite population size is approximately 297,030 for TA-03-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-1; 343,069 for Domes and TA-54-412; and 349,780 for TA-8-23.
[d] Assumes additional failures for source term used in calculation.

Inventories at TA-48-1 (Radiochemistry Laboratory) and TA-8-23 (Radiography Facility) were assumed to be at the building limits. Radiological source material would be at these locations only during material testing. The impacts and risks presented in this section conservatively assume the presence of this material at the allowable limits.

The health risks in Table D–25 (and consequences in D–23 and D–24) are given for individual building releases; it is unlikely that a wildfire would impact all of these facilities. For the case of a wildfire impacting all of these facilities, the overall health risk to the general population, dominated by waste storage domes and DVRS releases, is 2.7 per year, equivalent to a mean of 14 cancer fatalities in the entire general population (out to 50 miles [80 kilometers] from each release) every 5 years of LANL operation. This risk can be contrasted with the more than 2,500 normally occurring cancer fatalities to this same population over 5 years (see Chapter 4, Section 4.6.1). Risks to individuals, on the other hand, cannot be summed, because a single individual would not be exposed to multiple facility releases. Instead, only releases upwind from the individual's location would result in exposure. The maximum health risk to the MEI from any facility's release for exposure at the nearest Pueblo boundary to the waste storage domes is 0.05 probability (5 chances in 100) of an LCF per year of operation. It is highly unlikely that an individual would remain at this location during the entire wildfire event; therefore, this risk is thought to be very conservative.

Each of the building releases (except for the WCRR) was ascribed the same frequency of occurrence, 0.05. Section D.5.2 describes the potential of a wildfire affecting the various onsite technical areas. TA-54 is considered at a low (but not 0) risk of wildfire impacts relative to the other areas.

Tables D–23, D–24 and D–25 are strictly applicable to the No Action Alternative. The Reduced Action Alternative would include a 20 percent reduction in high explosives processing and a likely reduction in risk from the Device Assembly Building. However, the consequences and risk from that facility are insignificant; a decrease in its risk would not affect the overall wildfire risk.

Replacement risks from wildfire accident impacts would result from implementation of the Expanded Operations Alternative. Transuranic waste storage at DVRS and waste storage domes in TA-54 would be moved to a new facility, the TRU Waste Facility, located in TA-50 or TA-63. The impacts of this new facility would be less than those of the existing facilities because of the new location and because less material would be stored and the rest would be moved offsite. The entries in Tables D–23 through D–25 reflect present DVRS and waste storage domes operations because they would be active for part of the time period of interest and because their accident impacts bound the impacts of the new facility. TRU Waste Facility accident impacts are described in Appendix H.

D.5.5.3 Chemical

The chemicals of concern at LANL facilities under the No Action, Reduced Operations, and Expanded Operations Alternatives are shown in **Table D–26**. These have been selected from a complete set of chemicals used onsite based on their quantities, chemical properties, and human health effects. The table shows the ERPG concentration values for which excess concentrations could have harmful health or life-threatening implications, as defined in the table's footnote.

Table D–26 Chemical Accident Impacts under Wildfire Conditions

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]		ERPG-3 [b]		Concentration		
			Value (ppm)	Distance to Value (meters)	Value (ppm)	Distance to Value (meters)	Noninvolved Worker at 100 Meters (ppm)	MEI at 1,000 Meters (ppm)	Nearest Site Boundary (12 m TA-43) (924 m TA-3)
Formaldehyde at TA-43-1	0.05	3.7 gallons (14.1 liters)	10	141	25	89	20	0.23	Exceeds ERPG-3
Hydrogen Cyanide at TA-3-66	0.05	13.5 pounds (6 kilograms)	10	108	25	68	12	0.14	0.16 ppm

ERPG = Emergency Response Planning Guideline, ppm = parts per million, MEI = maximally exposed individual, m = meters, TA = technical area.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their ability to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

Note: To convert meters to yards, multiply by 1.0936.

Table D–26 shows the concentrations of each chemical, if it were released, at specified distances. For a formaldehyde release, the distances to the ERPG-2 and ERPG-3 levels of concern are 154 yards (141 meters) and 97 yards (89 meters), respectively. For a hydrogen cyanide release, the distances to the ERPG-2 and ERPG-3 levels of concern are 118 yards (108 meters) and 74 yards (68 meters), respectively. Depending on the magnitude of the release and plume characteristics, workers and members of the public could be exposed to harmful concentrations of each chemical within these distances from the point of release. Table D–26 also shows the estimated concentration of each chemical at a distance of about 110 yards (100 meters) from the release point where a representative noninvolved worker is assumed to be located. The seriousness of the exposure of a noninvolved worker at this distance is determined by comparing the concentration at that distance to the ERPG-2 and ERPG-3 levels of concern. In addition, Table D–26 also shows the estimated concentration at the nearest site boundary located at a distance from the release point of 13 yards (12 meters) and 1,010 yards (924 meters) for TA-43 and TA-3, respectively. The accident evaluation assumes a hypothetical member of the public is located at this site boundary. As in the case of the noninvolved worker, the seriousness of the exposure of a member of the public located at the nearest site boundary is determined by comparing the concentration at that distance to the ERPG-2 and ERPG-3 levels of concern. If concentration levels exceeding ERPG-2 and ERPG-3 were estimated to occur at distances beyond the site boundary, a segment of the offsite population could be exposed to harmful levels of the released chemical. The direction traveled by the chemical plume would depend upon meteorological conditions at the time of the accident.

D.5.5.4 Additional Environmental Effects

Firewater. Firewater (water used in fighting building fires) at nonnuclear facilities is captured by outdoor containment and temporary dikes erected for firefighting. Firewater at nuclear facilities is captured by the drain system and is sent to TA-50 for processing. Conceivably, some radioactively contaminated water from the nuclear facilities could reach the outdoor environment, but would be of such small volume that it would not leave the building environs. If there were a fire at TA-50, most of the firewater would wash off down the roads. If fire trucks had to spray water, some of that water would go to the adjacent canyon. Resultant contaminated soil would be eroded, pending the return of vegetative cover. As with other contaminated soils, the environmental and human health threat from the new contamination would be assessed and mitigated.

Loss of Protective Cover. The charred plant remains following a severe wildfire are the only immediate visual consequences. The consequences of a wildfire are diverse, continuous through time and space, and frequently include significant changes in geomorphology and biological communities and processes. LANL is perhaps unique in potential consequences because, in addition to a rich presence of biological communities and cultural remains and resources, the site contains soil-bearing legacy contaminants from historical operations.

Trees, grass and herbaceous cover, and forest litter are important features in stabilizing soils by: (1) reducing the velocity and impact of falling raindrops; (2) reducing the velocity of runoff, thereby encouraging infiltration and discouraging its transport by water and wind; and (3) reducing runoff quantities. Loss of vegetative cover will create a setting that can have pronounced effects on flow dynamics, soil erosion, and sediment deposition. These changes also can have significant ramifications for plant and animal communities and cultural resources.

Runoff, Soil Erosion, and Sedimentation. It has been well established through studies around the world that runoff and sediment yields can dramatically increase following wildfires. Accompanying these physical changes are changes in the composition or quality of runoff water. At Los Alamos, these changes may be severe due to the steepness of the burned terrain and the high severity of the burn, creating water-shedding hydrophobic soils. These higher runoff quantities would be discharged into the Rio Grande where they would contribute to the overall floodwater storage of Cochiti Lake. Modified hydrologic conditions likely would cause some watercourses that have only rarely had sufficient flows to reach the Rio Grande to increase their frequency of discharge.

Commensurate with higher runoff quantities and velocities would be an increase in soil erosion. Sheetflow would begin transporting soil suspended by rainfall droplet impact. Both rills and gullies would form on sloping ground surfaces with the first significant rainfall event. Higher channel volumes and velocities would promote both downward and lateral scouring of channels in the steeper portions of the watershed and sediment deposition in the lower portions. (These conditions depend on the quantity of runoff discharges and resulting changes in channel hydraulics.) Headcutting would increase throughout the channel system. Delta formation would increase at the confluence of watercourses and tributaries to the Rio Grande, and added sediment would contribute to the depletion of the sediment reserve of Cochiti Lake.

The gradual establishment of ground cover would correspondingly retard soil erosion and a more stabilized hydrologic regime would return. Extensive rehabilitation after the Cerro Grande Fire minimized runoff, soil erosion, and sedimentation. To understand the possible impact to downstream water bodies, runoff events after the fire were monitored and sampled by LANL staff. An extensive network of automated samplers and stream gages served as the cornerstone of this effort. Due to a general lack of intense “monsoon-like” rainfall during the summer of 2000, severe runoff passing across LANL was limited to a single event on June 28. Record peak discharges were recorded for several drainages leading onto LANL during that event. For example, in Water Canyon above NM 501, the estimated peak of 840 cubic feet (23,800 liters) per second dwarfed the prefire maximum of 0.3 cubic feet (8.5 liters) per second. Concentrations of most metals dissolved in stormwater remain below the Environmental Protection Agency or New Mexico drinking water standards; however, a few (for example, aluminum, barium, manganese) are above the standards in many samples. Dissolved manganese concentrations increased by about 50 times above prefire levels; barium by 20. Concentrations of radionuclides dissolved in stormwater are slightly elevated or comparable to prefire levels.

Effects on Legacy Contaminants. Active erosion processes have moved some contaminants bound to sediment from the watershed into the Rio Grande, mainly as suspended sediment and bedload sediment. Conversely, many of the remaining legacy contaminants at LANL are present in situ, have not been transported far from their origin, or remain onsite. Water transport is a major mechanism for the transport of contaminants in both the dissolved and suspended sediment phases. Because vegetation acts to hold soil and reduce erosion, its loss, however short-term, may significantly increase the potential for erosion and the transportation of contaminants. Some watercourses only rarely have had sufficient flow to reach the Rio Grande; as a result, they have become “discharge sinks” for some contaminants. Increases in runoff amounts and frequency would increase the potential to remove and transport contaminants from LANL’s ground surface, subsurface, and stream channels into the Rio Grande and downstream to Cochiti Lake.

Effects on Biological Systems. Although fire is a natural part of biological systems, anthropogenic influences such as grazing, logging, and fire suppression have produced conditions that have had pronounced adverse effects on forest ecosystems. Natural high-frequency, low-intensity fire regimes have been replaced with low-frequency, high-intensity fires that consume a higher percentage of vegetation. As reflected in other nearby areas that have experienced severe wildfires in the past (for example, the Water Canyon, La Mesa, Dome, and Oso Complex Fires), a wildfire at LANL would result in a period of disequilibrium with a reversion to early seral development and a corresponding change in animal use (Allen 1996). Fire debris, fallen trees, and needle cast would gradually begin to check erosion and develop soil conditions that would promote the establishment of grasses and herbaceous vegetation that would further reduce erosion. This gradual re-establishment of ground cover would begin the dynamic process of seral progression toward a wooded or forested plant community.

A loss of forest or woodland habitat would result in a temporary loss of habitat for a broad spectrum of animals. As vegetation is re-established, an altered community of animal species would follow, its composition changing with the evolution of the plant community. The pattern of burned vegetation would play a significant role in renewed wildlife use. Early plant communities of grasses and herbaceous growth can have a high biomass and species diversity, as exhibited by nearby areas affected by recent wildfires. This expansion of grass and herbaceous growth could provide additional forage for the large elk population in and around LANL and contribute to existing management concerns.

Impacts on threatened and endangered species (such as the Mexican spotted owl, *Strix occidentalis lucida*) would depend on several factors such as the burn pattern, the time of day the burn occurs, the type of fire, topography, and whether nesting is occurring. Threatened and endangered species have remained in or returned to nearby areas that have experienced recent burns. Individual response to fire also would vary. Perhaps the most significant impact to threatened and endangered species precipitated by a wildfire would be the general disturbance caused by the firefighting effort itself (firefighting crews, aircraft, and vehicular traffic).

As discussed previously, increased runoff discharges would result in a commensurate increase in channel scouring, enlargement, and headcutting. This process and any accompanying sedimentation would have the potential to degrade or remove the limited riparian vegetation on LANL. Wetlands associated with watercourses also would be affected, and perhaps several would be removed for a period because of changes in channel morphology. The degradation of riparian vegetation and wetlands would result in a reduction or loss of habitat for a variety of invertebrates, small and large mammals, amphibians, reptiles, and diverse bird species.

Effects on Cultural Resources. LANL is located in a region of abundant and culturally significant prehistoric and historic resources, including traditional cultural properties. As stated, fire is a normal feature of the landscape that has played and continues to play a natural role in the culture of regional communities. Because of anthropogenic influences, the character of recent fires will be different from historic fires and will affect resources differently. The need to protect property and life from wildfire will necessitate measures that can affect cultural resources.

As discussed, high intensity fires can burn an appreciable amount of ground cover and accelerate erosion. Surface erosion can physically disturb surface features and confuse and distort the contextual integrity of the site. More pronounced erosion in the form of gully formation and lateral bank cutting can permanently remove site features. A high-intensity fire also can scorch organic remains located near the ground surface, decreasing their interpretive value. Historical structures can suffer through direct incineration. Damage to these resources also can occur as a consequence of vehicular traffic and mechanical disturbance (from bulldozers and fire trucks for example) and other soil-disturbing activities connected with the firefighting effort.

Traditional cultural properties present on and adjacent to LANL include ceremonial and archaeological sites, natural features, ethnobotanical sites, artisan material sites, and subsistence features. These resources are an integral part of the landscape and almost certainly are and have been affected by natural fires. Because of the altered character of fires, these resources may be affected to a greater extent. Depending on the characteristics of these properties, they could be either permanently or temporarily affected by a wildfire and its subsequent ancillary effects, such as erosion.

D.5.6 Mitigation

After the *1999 SWEIS* was completed, actions were initiated to reduce the wildfire risk to major facilities with significant radiological inventories. Specifically, considerations were given to reducing the risk to low or very low for the following facilities:

- TA-3 Building 66/451, Sigma Complex
- TA-54 (Area G) Pads
- TA-21 Building 209, Tritium Science and Fabrication Facility
- TA-21 Building 155, Tritium Storage and Test Assembly
- TA-16 Building 205/205A, Weapons Engineering Tritium Facility

The planning, evaluation, and beginning of fire mitigation (described in DOE 1999b) that was completed prior to the Cerro Grande Fire undoubtedly contributed to minimizing the impacts to facilities and, possibly, human lives. There is an ongoing, interagency, collaborative program to reduce the threat of catastrophic wildfire occurring at LANL and the townsite by thinning and removing vegetation at the perimeter and in the surrounding Santa Fe National Forest and Bandelier National Monument. This will reduce the frequency and intensity of wildfires that could impact LANL.

D.6 Involved Worker Hazards

Facility workers generally fall into two groups: noninvolved worker and involved worker. Noninvolved workers have assigned duties on the site at a location beyond the general vicinity of an accident. The impacts of postulated accidents to the noninvolved worker are evaluated in this appendix and are presented in Chapter 5. Involved workers actively participate or support operation of the facilities directly involved with the Proposed Action. The analysis to determine involved worker risks are usually presented qualitatively due to the dynamics and potential worker proximity. In general, involved workers are protected by design safety features and operational procedures. Involved workers who are at the greatest risk of serious injury or fatality are those that are located in the immediate vicinity of where an accident takes place. Factors such as the time of the accident, an individual’s distance from the accident, and the effects of shielding mechanisms are highly variable. Given the severity of some accidents, involved worker fatalities could be expected. The number of fatalities could range from zero to the maximum number of workers involved within the facility. For example, an accident involving spills and exposure to contamination could lead to an individual receiving a measurable dose, but not lead to a fatality; however, in a severe earthquake accident, involved workers are likely to be hurt and killed by the collapse of a building before they can be evacuated.

No attempt is made in this SWEIS to evaluate the involved worker effects of such accidents for the following reasons. There is limited information on the circumstances that cause such accidents and the hazardous conditions they involve are difficult to characterize in a manner that would differentiate between alternatives and provide meaningful information for decisionmakers. Modeling methods such as those used for radiological and chemical accidents exposures are not accurate at close distances. Quantitative or qualitative representation of such accidents would introduce data uncertainties that would complicate the decisionmaking process.

The analyses performed by the authors of this SWEIS carefully considered the provisions of NEPA, Council on Environmental Quality Guidelines, and DOE NEPA Guidelines regarding acceptable procedures for estimating the environmental impacts of events where the available data are both uncertain and limited. These provisions and guidelines permit the use of the "sliding scale approach" (DOE 2002b), which allows the analyst to consider specified key factors for determining an appropriate level of technical analysis for estimating impacts.

According to DOE NEPA Guidelines, the key factors to consider in applying a sliding scale approach to accident analyses include:

- Probability that accidents will occur;
- Severity of the potential accident consequences;
- Context of the Proposed Action and alternatives;
- Degree of uncertainty regarding the analyses (for example, whether sufficient engineering design information is available to support detailed analysis); and
- Level of technical controversy regarding the potential impacts.

More recent DOE guidance was also used for the preparation of this SWEIS (DOE 2004e).

D.7 Maximally Exposed Individual-Type Doses versus Distance

Sections D.3, D.4, and D.5 describe various facility and site-wide accident scenarios and the estimated exposures to the accident releases, were such accidents to occur. Exposure to radiological releases is described by dose, measured in rem, to an individual. Exposure to a population is generalized by summing the dose to each individual of that population; the population dose is thus measured in person-rem.

Exposures of the hypothetical noninvolved worker and MEI have been given in the previous sections. These are conservative representations of the exposure to any single individual from the plume that could emanate as a result of an accident. They are mean values, and thus include components of exposure to all of the meteorological conditions that could be experienced throughout the year. A number of assumptions are employed in the calculation of these exposures to individuals (see Table D–2) which result in conservatively large doses.

Foremost, is the assumption that the individual is always downwind of the plume. That is, the direction from the release to the individual is not taken into account (although the distance is); such a dose is sometimes called a sector independent representation of the exposure to the individual. In reality, were there to be an accident resulting in a release, the probability of the plume blowing toward a particular individual would be small. A second conservative assumption is that the individual lies directly in the path of the plume centerline, meaning the portion of the plume in which the release concentration is greatest. Again, even if the wind were blowing from the release in the general direction of the individual, the probability that the individual would be exposed directly to the plume centerline is small. Other conservative assumptions governing the calculation of exposure to the individual include his remaining at the nearest site boundary to the release (MEI) or 100 meters downwind from the release (noninvolved worker) for the duration of the event; no protection (the individual is assumed to remain outside directly in the path of the plume); no deposition (thereby maximizing the inhalable plume concentration), no plume meander (the individual is assumed to be exposed to the plume centerline for the entire event); and use of an annual Meteorology (MET) dataset (2003), which maximizes downwind plume concentrations.

The downwind location of the noninvolved worker, 100 meters from the hypothesized release, does not vary among scenarios. The downwind location at which each MEI exposure is calculated (at the nearest site boundary to a hypothesized release) is specific to each scenario and release location. Although the scenarios and exposure locations correspond to the actions analyzed in this SWEIS, MEI-type doses at other locations could be of present or future interest. An example could be associated with the site-wide wildfire event. In a wildfire event, the locations of the public and onsite personnel such as firefighters may not correspond to those associated with the other accident scenarios. Another example could be interest in the MEI dose at an onsite, publicly accessible location such as a road. These data would also be useful if NNSA were considering changing public accessibility to portions of the site or if the site boundaries were to change.

Table D–27 gives the MEI-type doses at various downwind distances for the accident scenarios considered in this SWEIS. The scenarios are grouped by their section in this and other appendices. Some of the action-specific scenarios (for example, the MDA G explosion scenario) are reported both in this appendix and in the appendix discussing the action.

Table D–27 Maximally Exposed Individual-Type Doses versus Downwind Distance by Accident Scenario

Accident Scenario	*Identifier*	*MEI Location (downwind distance, in meters)*	*MEI Dose (rem)*	*Noninvolved Worker Dose (rem) at 100 Meters Downwind*	*Dose (rem) at Downwind Distance (in meters) of: 250*	*500*	*750*	*1,000*	*1,500*	*2,000*	*3,000*
Facility Accidents (Section D.3)											
RANT Lightning Strike Area Fire (TA-54-38)	RANTLIT	Pueblo Boundary (402)	410	1,900	730	310	180	120	69	45	24
WETF Fire (TA-16-205)	WETFF	W. Jemez Rd (393)	5.9	8.9	7.3	5.1	3.7	2.8	1.7	1.1	0.63
WCRR Lightning Strike Fire (TA-50-69)	WCRLITN	Trailer Park (1161)	46	1,100	360	150	84	56	32	20	11
Waste Storage Dome Fire (TA-54)	DOMEF	Pueblo Boundary (267)	420	2,000	460	160	84	54	29	18	9.3
Onsite Transuranic Waste Accident (TA-54)	DOMET	Pueblo Boundary (267)	190	760	200	87	52	36	21	14	8
Plutonium Facility Materials Staging Area Fire (TA-55-4)	PF4MFIR	Royal Crest Trailer Park (1016)	73	1,600	400	170	110	74	44	28	15
DVRS Operational Spill (TA-54)	DVRS01	Site Boundary (227)	20	51	17	6.8	3.8	2.5	1.4	0.88	0.46
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	DVRS05	Site Boundary (227)	320	890	290	110	64	43	24	16	8.4
SHEBA Hydrogen Detonation	SHEBA	Pueblo Boundary (976)	0.88	15	4.4	1.9	1.2	0.85	0.52	0.36	0.21
CMR HEPA Filter Fire (TA-3-29)	CMR02	Town Site Boundary (924)	0.77	5.4	2.7	1.5	0.97	0.71	0.45	0.3	0.18
Fire Impacting Sealed Sources, CMR, Wing 9 (TA-3-29)	SEAL2CF	Town Site Boundary (924)	0.099	1.2 [a]	0.28	0.13	0.11	0.096	0.08	0.065	0.044
Explosion in a Pit at MDA G	MDAGEXP	Pueblo Boundary (355)	55	410	96	33	17	11	6	3.7	1.9
Site Wide Seismic Event (Section D.4)											
TA-3-29 (CMR) Seismic 1 & 2	CMR08	Town Site Boundary (924)	62	2,000	480	160	86	55	30	18	9.1
TA-16-205 (WETF) Seismic 2	SIT02	W. Jemez Rd (393)	17	150	35	12	6	4	2.2	1.3	0.66
TA-18-168 (SHEBA) Seismic 2	SIT08	Pueblo Boundary (976)	0.03	1.1	0.25	0.085	0.045	0.029	0.016	0.0098	0.005

Accident Scenario	***Identifier***	***MEI Location (downwind distance, in meters)***	***MEI Dose (rem)***	***Noninvolved Worker Dose (rem) at 100 Meters Downwind***	***Dose (rem) at Downwind Distance (in meters) of:***						
					250	***500***	***750***	***1,000***	***1,500***	***2,000***	***3,000***
TA-21-155 (TSTA) Seismic 1 & 2	SIT09	New Mexico 502 (357)	0.0015	0.011	0.0026	0.00088	0.00046	0.0003	0.00016	0.000095	0.000048
TA-21-209 (TSFF) Seismic 1 & 2	SIT10	New Mexico 502 (363)	0.013	0.097	0.023	0.0077	0.0041	0.0026	0.0014	0.00084	0.00042
TA-50-1 (RLWTF) Seismic 1 & 2	SIT11	Royal Crest Trailer Park (1082)	3.02	120	29	9.9	5.3	3.4	1.8	1.1	0.57
TA-50-69 (WCRR) Seismic 2 and Fire	WCRSEIS	Royal Crest Trailer Park (1161)	43	1,100	290	120	75	52	31	20	11
TA-54-38 (RANT) Seismic 1 & 2	SIT14	Pueblo Boundary (402)	64	580	140	46	25	16	8.6	5.3	2.7
TA-55-4 (Plutonium Facility) Seismic 2 and Fire	PF4SEIS	Royal Crest Trailer Park (1016)	150	2,700	760	340	210	150	88	57	31
TA-55-185 (Storage Shed) Seismic 1 & 2	SIT16	Royal Crest Trailer Park (1068)	6	240	57	19	10	6.6	3.6	2.1	1.1
TA-55-355 (SST Facility) Seismic 2	SIT19	Royal Crest Trailer Park (1048)	3.9	130	33	12	6.3	4.1	2.2	1.3	0.67
DVRS (PC-2 Seismic) Seismic 1	DVRS08	Site Boundary NNE (227)	2.8	10	2.4	0.82	0.44	0.28	0.15	0.096	0.05
DVRS (PC-3 Seismic) Seismic 2	DVRS12	Site Boundary NNE (227)	34	120	29	10	5.4	3.5	1.9	1.2	0.61
TA-54 Waste Storage Domes Seismic 2	DOMEM	Pueblo Boundary (267)	460	2,200	510	170	92	59	32	20	10
Site Wide Wildfire Event (Section D.5)											
TA-03-66/451 (Sigma Complex)	WILDF01	Town Site Boundary (924)	0.0039	0.076	0.02	0.0083	0.005	0.0036	0.0025	0.0022	0.002
TA-16-205 (WETF)	WILDF02	W. Jemez Rd (393)	0.061	0.33	0.1	0.05	0.035	0.034	0.04	0.048	0.054
TA-48-1 (Radiochemistry Lab)	WILDF05	Royal Crest Trailer Park (677)	0.0011	0.016	0.0041	0.0016	0.00094	0.00064	0.00038	0.00025	0.00015
TA-54 (Waste Storage Domes)	DOMEM	Pueblo Boundary (267)	1,900	8,700	2,100	760	420	280	160	100	56

Accident Scenario	Identifier	MEI Location (downwind distance, in meters)	MEI Dose (rem)	Noninvolved Worker Dose (rem) at 100 Meters Downwind	Dose (rem) at Downwind Distance (in meters) of:						
					250	500	750	1,000	1,500	2,000	3,000
TA-16-411 (Device Assembly)	WILDF08	Site Boundary South of Facility (576)	1.5×10^{-6}	0.000017	4.5×10^{-6}	1.8×10^{-6}	1.1×10^{-6}	7.1×10^{-7}	4.1×10^{-7}	2.7×10^{-7}	1.6×10^{-7}
TA-54 (DVRS)	WDVRS06	NNE of facility (227)	4.9	16	4.4	1.8	1.1	0.86	0.72	0.75	0.77
TA-8-23 (Radiography)	WILDF10	WSW Boundary (412)	0.00033	0.0019	0.00059	0.00029	0.0002	0.00019	0.00023	0.00028	0.00031
TA-50-69 (WCRR)	WCRWILD	Trailer Park (1161)	27	440	110	51	38	30	21	16	9.6
Radiological Sciences Institute Accidents (Section G.3)											
Hot Cell Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC11	Royal Crest Trailer Park (941)	6.3	33	17	9.4	7.1	6.1	5.1	4.2	3.1
Seismic Induced Building Collapse and Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC16	Royal Crest Trailer Park (941)	30	150	79	44	33	29	24	20	14
Seismic Induced Building Collapse with No Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC15	Royal Crest Trailer Park (941)	19	170	82	41	26	18	11	6.9	3.7
Spill of Plutonium-238 Residue from 2-Liter Bottles Outside of Hot Cell	MRSC13	Royal Crest Trailer Park (941)	0.0066	0.045	0.024	0.013	0.0085	0.0062	0.0039	0.0025	0.0014
Hot Cell Plutonium-238 Spill with No Confinement	MRSC14	Royal Crest Trailer Park (941)	2.1	14	7.6	4.1	2.7	2	1.2	0.81	0.45
Main Vault Fire	MRSC17	Royal Crest Trailer Park (941)	13	66	34	19	14	12	10	8.6	6.2

Accident Scenario	*Identifier*	*MEI Location (downwind distance, in meters)*	*MEI Dose (rem)*	*Noninvolved Worker Dose (rem) at 100 Meters Downwind*	*Dose (rem) at Downwind Distance (in meters) of:*						
					250	*500*	*750*	*1,000*	*1,500*	*2,000*	*3,000*
RH-Transuranic Waste Management Facilities Accidents (Section H.3)											
Explosion at MDA G RH-Transuranic Shaft 205	GS205EX	Pueblo Boundary (355)	0.31	2.3	0.54	0.18	0.097	0.063	0.034	0.021	0.011
Explosion at MDA G RH-Transuranic Shaft 206	GS206EX	Pueblo Boundary (355)	0.74	5.4	1.3	0.44	0.23	0.15	0.081	0.05	0.026
Seismic Event Affecting RH-Transuranic in the TRU Waste Facility	DOMSEIS	Trailer Park (1,437)	0.037	2.3	0.56	0.19	0.1	0.065	0.035	0.021	0.011
Seismic Event Affecting Transuranic Relocated from Area G Waste Domes to the TRU Waste Facility	DOMES	Trailer Park (1,437m)	29	1,800	430	150	78	50	27	16	8.3
Material Disposal Area Remediation Accidents (Section I.5)											
Explosion at MDA G	MDAGEXP	Pueblo Boundary (355)	55	410	96	33	17	11	6	3.7	1.9
Fire at MDA B [b]	MDABFIR	Nearest Boundary (45)	7.1	1.6	0.37	0.13	0.066	0.043	0.023	0.014	0.0068
Sealed Sources Accidents (Section J.3)											
Aircraft Crash at TA-54, Area G	SEAL1CM	Site Boundary NNE (267)	0.084	0.52 [a]	0.091	0.04	0.024	0.017	0.01	0.0066	0.0036
Severe Earthquake and Fire at CMR	SEAL2CF	Town Site Boundary (924)	0.099	1.2 [a]	0.28	0.13	0.11	0.096	0.08	0.065	0.044
Severe Earthquake and Fire at TA-48	SEAL3CF	Royal Crest Trailer Park (941)	0.098	1.2 [a]	0.28	0.13	0.11	0.096	0.08	0.065	0.044

MEI = maximally exposed individual, RANT = Radioassay and Nondestructive Testing, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging, DVRS = Decontamination and Volume Reduction System; SHEBA = Solution High-Energy Burst Assembly, CMR = Chemistry and Metallurgy Research Building, HEPA = high-efficiency particulate air (filter), MDA = material disposal area, TSTA = tritium systems test assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, SST = safe secure trailer, RH = remote-handled, PC = performance category.

[a] Doses include component from external exposure to source.

[b] See Appendix I, Section I.5.12.1 regarding a revision to the material at risk; conclusions of this analysis remain valid.

Note: To convert meters to yards, multiply by 1.0936.

D.8 MACCS2 Code Description

The MACCS2 computer code is used to estimate the radiological doses and health effects that could result from postulated accidental releases of radioactive materials to the atmosphere. The specification of the release characteristics, designated a "source term," can consist of up to four Gaussian plumes that are often referred to simply as "plumes."

The radioactive materials released are modeled as being dispersed in the atmosphere while being transported by the prevailing wind. During transport, particulate material can be modeled as being deposited on the ground. The extent of this deposition can depend on precipitation. If contamination levels exceed a user-specified criterion, mitigating actions can be triggered to limit radiation exposures.

Atmospheric conditions during an accident scenario's release and subsequent plume transport are taken from the annual sequential hourly meteorological data file. Scenario initiation is assumed to be equally likely during any hour contained in the file's dataset, with plume transport governed by the succeeding hours. The model was applied by calculating the exposure to each receptor for accident initiation during each hour of the 8,760 hour-dataset. The mean results of these samples, which include contributions from all meteorological conditions, are presented in this SWEIS.

Two aspects of the code's structure are important to understanding its calculations: (1) the calculations are divided into modules and phases; and (2) the region surrounding the facility is divided into a polar-coordinate grid. These concepts are described in the following sections.

MACCS2 is divided into three primary modules: ATMOS, EARLY, and CHRONC. Three phases are defined as the emergency, intermediate, and long-term phases. The relationship among the code's three modules and the three phases of exposure are summarized below.

The ATMOS module performs all of the calculations pertaining to atmospheric transport, dispersion, and deposition, as well as the radioactive decay that occurs before release and while the material is in the atmosphere. It uses a Gaussian plume model with Pasquill-Gifford dispersion parameters. The phenomena treated include building wake effects, buoyant plume rise, plume dispersion during transport, wet and dry deposition, and radioactive decay and in-growth. The results of the calculations are stored for subsequent use by EARLY and CHRONC. In addition to the air and ground concentrations, ATMOS stores information on wind direction, arrival and departure times, and plume dimensions.

It is noted that dispersion calculations such as used in MACCS2 are generally recognized to be less applicable within 100 meters of a release than they are to further downwind distances (DOE 2004d); such close-in results frequently over-predict the atmospheric concentrations because they do not account for the initial momentum or size of the release, or for the impacts of structures and other obstacles on plume dispersion. Although most of the results presented in this SWEIS are for distances at least 100 meters downwind from a hypothesized release source, two (MEIs from the Chemistry and Metallurgy Research Building and MDA B) are not. The latter results should be interpreted in the above light.

The EARLY module models the period immediately following a radioactive release. This period is commonly referred to as the emergency phase. The emergency phase begins at each successive downwind distance point when the first plume of the release arrives. The duration of the emergency phase is specified by the user, and it can range between 1 and 7 days. The exposure pathways considered during this period are direct external exposure to radioactive material in the plume (cloud shine); exposure from inhalation of radionuclides in the cloud (cloud inhalation); exposure to radioactive material deposited on the ground (ground shine); inhalation of resuspended material (resuspension inhalation); and skin dose from material deposited on the skin. Mitigating actions that can be specified for the emergency phase include evacuation, sheltering, and dose-dependent relocation.

The CHRONC module performs all of the calculations pertaining to the intermediate and long-term phases. CHRONC calculates the individual health effects that result from both direct exposures to contaminated ground and from inhalation of resuspended materials.

The intermediate phase begins at each successive downwind distance point upon conclusion of the emergency phase. The user can configure the calculations with an intermediate phase that has a duration as short as 0 or as long as 1 year. In the zero-duration case, there is essentially no intermediate phase, and a long-term phase begins immediately upon conclusion of the emergency phase.

Intermediate models are implemented on the assumption that the radioactive plume has passed and the only exposure sources (ground shine and resuspension inhalation) are from ground-deposited material.

The mitigating action model for the intermediate phase is very simple. If the intermediate phase dose criterion is satisfied, the resident population is assumed to be present and subject to radiation exposure from ground shine and resuspension for the entire intermediate phase. If the intermediate phase exposure exceeds the dose criterion, then the population is assumed to be relocated to uncontaminated areas for the entire intermediate phase.

The long-term phase begins at each successive downwind distance point upon conclusion of the intermediate phase. The exposure pathways considered during this period are ground shine and resuspension inhalation.

The exposure pathways considered are those resulting from ground-deposited material. A number of protective measures, such as decontamination, temporary interdiction, and condemnation, can be modeled in the long-term phase to reduce doses to user-specified levels. The decisions on mitigating action in the long-term phase are based on two sets of independent actions: (1) decisions related to whether land at a specific location and time is suitable for human habitation (habitability), and (2) decisions related to whether land at a specific location and time is suitable for agricultural production (ability to farm). For the current SWEIS, no mitigation or special protective measures were assumed for the exposure calculations.

All of the calculations of MACCS2 are stored based on a polar-coordinate spatial grid with a treatment that differs somewhat between calculations of the emergency phase and calculations of the intermediate and long-term phases. The region potentially affected by a release is represented with a (r, Θ) grid system centered on the location of the release. Downwind distance is represented by the radius "r". The angle, "Θ", is the angular offset from the north, going clockwise.

The user specifies the number of radial divisions as well as their endpoint distances. The angular divisions used to define the spatial grid are fixed in the code. They correspond to the 16 points of the compass, each being 22.5 degrees wide. The 16 points of the compass are used in the United States to express wind direction. The compass sectors are referred to as the coarse grid.

Since emergency phase calculations use dose-response models for early fatalities and early injuries that can be highly nonlinear, these calculations are performed on a finer grid basis than the calculations of the intermediate and long-term phases. For this reason, the calculations of the emergency phase are performed with the 16 compass sectors divided into 3, 5, or 7 equal, angular subdivisions. The subdivided compass sectors are referred to as the fine grid.

Lifetime doses are the conventional measure of detriment used for radiological protection. These are 50-year dose commitments to a weighted sum of tissue doses defined by the International Commission on Radiological Protection and referred to as "effective dose equivalent." Lifetime doses may be used to calculate the stochastic health effect risk resulting from exposure to radiation. The calculated lifetime dose was used in cancer risk calculations.

D.9 ALOHA Code Description

Consequences of accidental chemical releases were determined using the ALOHA computer code (EPA 2004). ALOHA is an EPA and National Oceanic and Atmospheric Administration-sponsored computer code that has been widely used in support of chemical accident responses and also in support of safety and NEPA documentation for DOE facilities. The ALOHA code is a deterministic representation of atmospheric releases of toxic and hazardous chemicals. The code can predict the rate at which chemical vapors escape (such as from puddles or leaking tanks) into the atmosphere; a specified direct release rate is also an option.

ALOHA performs calculations for chemical source terms and resulting downwind concentrations. Source term calculations determine the rate at which the chemical material is released to the atmosphere, release duration, and the physical form of the chemical upon release. The term "cloud" is used in this document to refer to the volume that encompasses the chemical emission. In general, the released chemical may be a gas, a vapor, or an aerosol. The aerosol release may consist of either solid (fume, dust) or liquid (fog, mist, spray) particles that are suspended in a gas or vapor medium. Liquid particles are also referred to as droplets. The analyst specifies the chemical and then characterizes the initial boundary conditions of the chemical with respect to the environment through the source configuration input. The ALOHA code allows the source to be defined in one of four ways (direct source, puddle source, tank source, or pipe source) to model various accident scenarios. The source configuration input is used either to specify the chemical source term or to provide ALOHA with the necessary information and data to calculate transient chemical release rates and the physical state of the chemical upon release. ALOHA calculates time-dependent release rates for up to 150 time steps (DOE 2004c). ALOHA then averages the release rates from the individual time steps over one to five averaging periods, each lasting at least 1 minute (DOE 2004c). The five averaging periods are selected to most accurately portray the peak emissions. The five average release rates are inputs to the ALOHA algorithms for atmospheric transport and dispersion (DOE 2004c). ALOHA tracks the evolution of the mean concentration field of the five separate chemical clouds and calculates the concentration at a given time and location through superimposition. ALOHA limits releases to 1 hour.

Evolution of the mean concentration field of the chemical cloud is calculated through algorithms that model the turbulent flow phenomena of the atmosphere. The prevailing wind flows and associated atmospheric turbulence serve to transport, disperse, and dilute the chemical cloud that initially forms at the source. For an instantaneous or short-duration release, the chemical cloud will travel downwind as a puff. In contrast, a plume will form for a sustained or continuous release.

The wind velocity is a vector term defined by a direction and magnitude (wind speed). The wind direction and speed determine where the puff or plume will go and how long it will take to reach a given downwind location. For sustained or continuous releases, the wind speed has the additional effect of stretching out the plume and establishing its initial dilution. It also determines the relative proportion of ambient air that initially mixes with the chemical source emission. Atmospheric turbulence causes the puff or plume to mix increasingly with ambient air and grow (disperse) in the lateral and vertical direction as it travels downwind. Longitudinal expansion also occurs for a puff. These dispersion effects further enhance the dilution of the puff or plume. The two sources of atmospheric turbulence are mechanical turbulence and buoyant turbulence. Mechanical turbulence is generated from shear forces that result when adjacent parcels of air move at different velocities (either at different speeds or directions). Fixed objects on the ground, such as trees or buildings, increase the ground roughness and enhance mechanical turbulence in proportion to their size. Buoyant turbulence arises from vertical convection and is greatly enhanced by the formation of thermal updrafts that are generated from solar heating of the ground.

The ALOHA code considers two classes of atmospheric transport and dispersion based upon the assumed interaction of the released cloud with the atmospheric wind flow.

- For airborne releases in which the initial chemical cloud density is less than or equal to that of the ambient air, ALOHA treats the released chemical as neutrally buoyant. A neutrally buoyant chemical cloud that is released to the atmosphere does not alter the atmospheric wind flow; therefore, the term "passive" is used to describe the phenomenological characteristics associated with its atmospheric transport and dispersion. As a passive contaminant, the released chemical follows the bulk movements and behavior of the atmospheric wind flow.

- Conversely, if the density of the initial chemical cloud is greater than that of the ambient air, then the possibility exists for either a neutrally buoyant or a dense-gas type of atmospheric transport and dispersion. In dense-gas atmospheric transport and dispersion, the dense-gas cloud resists the influences of the hydraulic pressure field associated with the atmospheric wind, and the cloud alters the atmospheric wind field in its vicinity. Dense-gas releases can occur with gases that have a density greater than air due either to a high molecular weight or to being sufficiently cooled. A chemical cloud with sufficient aerosol content can also result in a bulk cloud density that is greater than that of the ambient air. Dense-gas releases undergo what has been described in the literature as "gravitational slumping."

Gravitational slumping is characterized by significantly greater lateral (crosswind) spreading and reduced vertical spreading compared to the spreading that occurs with a neutrally buoyant release.

In addition to the source term and downwind concentration calculations, ALOHA allows specification of concentration limits for the purpose of consequence assessment (such as assessment of human health risks from contaminant plume exposure). ALOHA refers to these concentration limits as level-of-concern (LOC) concentrations. Safety analysis work uses the ERPGs and TEELs for assessing human health effects for both facility workers and the public. While ERPGs and TEELs are not explicitly part of the ALOHA chemical database, ALOHA allows the user to input any value, including an ERPG or TEEL value, as the LOC concentration. The LOC value is superimposed on the ALOHA-generated plot of downwind concentration as a function of time to facilitate comparison. In addition, ALOHA will generate a footprint that shows the area (in terms of longitudinal and lateral boundaries) where the ground-level concentration reached or exceeded the LOC during puff or plume passage (the footprint is most useful for emergency response applications).

The ALOHA code uses a constant set of meteorological conditions (such as wind speed and stability class) to determine the downwind atmospheric concentrations. The sequential meteorological datasets used for the radiological accident analyses were reordered from high to low dispersion by applying a Gaussian dispersion model (such as that used by ALOHA) to a representative downwind distance. The median set of hourly conditions for each site (that is, mean wind speed and mean stability) was used for the analysis; this is roughly equivalent to the conditions corresponding to the mean radiological dose estimates of MACCS2.

ALOHA contains physical and toxicological properties for the chemical spills included in the SWEIS and for approximately 1,000 additional chemicals. The physical properties were used to determine which of the dispersion models and accompanying parameters were applied. The toxicological properties were used to determine the levels of concern. Atmospheric concentrations at which health effects are of concern (that is ERPG-2 or ERPG-3 levels) are used to define the footprint of concern. Because the meteorological conditions specified do not account for wind direction (that is, it is not known *a priori* in which direction the wind would be blowing in the event of an accident), the areas of concern can be defined by a circle of radius equivalent to the downwind distance at which the concentration decreases to levels less than the level of concern. In addition, the concentration at 328 feet (100 meters) (potential exposure to a noninvolved worker) and at the nearest public access, typically the site boundary distance, (exposure to the MEI) are calculated and presented.

D.10 References

AIHA (American Industrial Hygiene Association), 2005, Current AIHA ERPGs (2005), Available at http://www.aiha.org/Committees/documents/erpglevels.pdf, January.

Allen, C., 1996, "Elk Response to the La Mesa Fire and Current Status in The Jemez Mountains", *Fire Effects in Southwestern Forests; Proceedings of the Second La Mesa Fire Symposium, Los Alamos, New Mexico, March 29-31, 1994*, USDA Forest Service, General Technical Report RM-GTR-286, September.

Anderson, H., 1982, *Aids to Determining Fuel Models for Estimating Fire Behavior,* General Technical Report INT-122, U.S. Department of Agriculture, Forest Service, April.

Balice, R. G., B. P. Oswald, and C. Martin, 1999, *Fuels Inventories in the Los Alamos National Laboratory Region: 1997*, LA-13572-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, March.

Balice, R. G., J. D. Miller, B. P. Oswald, C. Edminster, and S. R. Yool, 2000, *Forest Surveys and Wildfire Assessment in the Los Alamos Region; 1998-1999*, LA-13714-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, June.

Balice, R. G., K. Bennett and M. A. Wright, 2004, *Burn Severities, Fire Intensities, and Impacts to Major Vegetation Types from the Cerro Grande Fire*, LA-14159, Los Alamos National Laboratory, Los Alamos, New Mexico, December.

Balice, R. G., S. D. Johnson, K. D. Bennett, T. L. Graves, S. Donald, P. D. Braxton, and W. F. Chiu, 2005, *A Preliminary Probabilistic Wildfire Risk Model for Los Alamos National Laboratory*, LA-UR-05-3321, Los Alamos National Laboratory, Los Alamos, New Mexico, June.

Breshears, D. D., N. S. Cobb, P. M. Rich, K. P. Price, C. D. Allen, R. G. Balice, W. H. Romme, J. H. Kastens, M. L. Floyd, J. Belnap, J. J. Anderson, O. B. Myers, and C. W. Meyer, 2005, "Regional vegetation die-off in response to global-change-type drought," LA-UR-05-4982, *Proceedings of the National Academy of Sciences* (102:15144-15148), October 18.

Chanin, D. and M. L. Young, 1997, *Code Manual for MACCS2: Volume 1, User's Guide*, NUREG/CR-6613, SAND97-0594, Vol. 1, Washington, DC, March.

Cuesta, I., 2004, *Design-Load Basis for LANL Structures, Systems, and Components*, LA-14165, Los Alamos National Laboratory, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 1992, *DOE Standard, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, Washington, DC, December.

DOE (U.S. Department of Energy), 1997, *Emergency Management Guide Volume II*, *Hazards Surveys and Hazards Assessments*, DOE G 151.1-1, Office of Emergency Management, Washington, DC, August 21.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Mitigation Action Plan for the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, DOE/EIS-0238, Albuquerque Operations Offices, Albuquerque, New Mexico, October.

DOE (U.S. Department of Energy), 2000, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2002a, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, Washington, DC, August.

DOE (U.S. Department of Energy), 2002b, *Recommendations for Analyzing Accidents under the National Environmental Policy Act*, Office of NEPA Policy and Compliance, Available at http://www.eh.doe.gov/nepa/tools/guidance/analyzingaccidentsjuly2002.pdf, July.

DOE (U.S. Department of Energy), 2003a, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350, Los Alamos Site Office, Los Alamos, New Mexico, November.

DOE (U.S. Department of Energy), 2003b, *Safety Evaluation Report for TA-54 Area G Documented Safety Analysis*, National Nuclear Security Administration, Los Alamos Site Operations, Los Alamos, New Mexico, November 25.

DOE (U.S. Department of Energy), 2003c, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE), ISCORS Technical Report No. 1*, DOE/EH-412/0015/0802 Rev. 1, Office of Environmental Policy and Guidance, Washington, DC, January.

DOE (U.S. Department of Energy), 2004a, *ERPGs and TEELs for Chemicals of Concern*: Rev. 20, DKC-04-0003, Available at http://www.eh.doe.gov/chem_safety/teel/TEELs_Rev20_ Introduction.pdf and http://www.eh.doe.gov/chem_safety/teel/TEELs_Rev20_Table2.pdf, April.

DOE (U.S. Department of Energy), 2004b, *Safety Evaluation Report (SER), Basis for Interim Operation (BIO) and Technical Safety Requirements (TSRs) for the Decontamination and Volume Reduction (DVRS) Glovebox in Support of the Quick-to-WIPP Project*, Technical Area 54-412, ABD-WFM-009, Rev. 0, National Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, June 8.

DOE (U.S. Department of Energy), 2004c, *ALOHA Computer Code Application Guidance for Documented Safety Analysis*, DOE-EH-4.2.1.3-ALOHA Code Guidance, Office of Environment, Safety, and Health, Washington, DC, June.

DOE (U.S. Department of Energy), 2004d, *MACCS2 Computer Code Application Guidance for Documented Safety Analysis*, DOE-EH-4.2.1.4-MACCS2-Code Guidance, Office of Environment, Safety and Health, Washington, DC, June.

DOE (U.S. Department of Energy), 2004e, *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements,* Second Edition, Office of NEPA Policy and Compliance, December.

DOE (U.S. Department of Energy), 2005a, *Comprehensive Emergency Management System*, DOE Order 151.1C, Office of Emergency Operations, Available at http://www.directives.doe.gov/pdfs/doe/doetext/neword/ 151/01511c.pdf, November 2.

DOE (U.S. Department of Energy), 2005b, Revision 21 of AEGLs, ERPGs and TEELs for Chemicals of Concern, DKC-05-0002, Available at: http://www.eh.doe.gov/chem_safety// teel.html, November.

EPA, (U.S. Environmental Protection Agency), 1988, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, Federal Guidance Report No. 11, EPA-520/1-88-020, Washington, DC, September.

EPA, (U.S. Environmental Protection Agency), 1993, *External Exposure to Radionuclides in Air, Water, and Soil, Exposure-to-Dose Coefficients for General Application, Based on the 1987 Federal Radiation Protection Guidance*, Federal Guidance Report No. 12, EPA-402-R-93-081, Washington, DC, September.

EPA (U.S. Environmental Protection Agency), 2004, *ALOHA – Areal Locations of Hazardous Atmospheres – User's Manual*, Chemical Emergency Preparedness and Prevention Office, Washington, DC, Available at http://www.epa.gov/ceppo/cameo/pubs/aloha.pdf, March.

EPA (U.S. Environmental Protection Agency), 2005, Radiation Risk Assessment Software: CAP88 PC, Version 3.0 User Guide, Radiation Protection Division, Available at http://www.epa.gov/radiation/assessment/CAP88/index.html.

Fresquez, P. R., and J. K. Ferenbaugh, 1999, *Moisture Conversion Ratios for the Foodstuffs and Biota Environmental Surveillance Programs at Los Alamos National Laboratory (Revision 1)*, LA-UR-99-253, Los Alamos National Laboratory, Los Alamos, New Mexico, January.

Gonzales, G. J., A. F. Ladino, and P. J. Valerio, 2004, *Qualitative Assessment of Wildfire-Induced Radiological Risk at the Los Alamos National Laboratory*, LA-UR-03-7237, Los Alamos National Laboratory, Los Alamos, New Mexico, January.

Gonzales, G. J., C. M. Bare, P. J. Valerio, and S. F. Mee, 2004, *Radionuclide Activity Concentrations in Conifer Trees at the Los Alamos National Laboratory*, LA-UR-03-7237, Los Alamos National Laboratory, Los Alamos, New Mexico, April 16.

Holzworth, G. C., 1972, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States,* PB-207 103, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, January.

LANL (Los Alamos National Laboratory), 2001, *Updated Calculation of the Inhalation Dose from the Cerro Grande Fire Based on Final Air Data*, LA-UR-01-1132, Los Alamos National Laboratory, Los Alamos, New Mexico, February.

LANL (Los Alamos National Laboratory), 2002, *Radiological and Nonradiological Effects after the Cerro Grande Fire*, LA-13914, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2004, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Risk Reduction and Environmental Stewardship, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2005, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Environmental Stewardship Division, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document,* Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2007a, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Design Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2007b, Letter to J. Vozella, National Nuclear Security Administration, from R. McQuinn, Nuclear High Hazards Operations, Justification for Continued Operation, LANL Site-Wide Nuclear and High Hazard Operations, Reference No. AD-NHHO:07-145, Los Alamos, New Mexico, June 22.

McHugh, C. W., T. E. Kolb and J. L. Wilson, 2003, "Bark Beetle Attacks on Ponderosa Pine Following Fire in Northern Arizona," *Environmental Entomology*, 32(3): 510-522, June.

NNSA (National Nuclear Security Administration), 2007, Memorandum to R. McQuinn, Nuclear and High Hazards Operations, from D. Winchell, Los Alamos Site Office, Response to Justification for Continued Operations Related to Seismic Hazards Assessment, Los Alamos, New Mexico, July 31.

NRC (U.S. Nuclear Regulatory Commission), 2003, *SECPOP2000: Sector Population, Land Fraction, and Economic Estimation Program*, NUREG/CR-6525, Rev. 1, Washington, DC, August.

USDA (United States Department of Agriculture), 1998, Forest Service, *Farsite: Fire Area Simulator—Model Development and Evaluation*, Missoula, Montana, March.

USDA (United States Department of Agriculture) 2002, "Changes in Fire Hazard as a Result of the Cerro Grande Fire," *Fire Management Today,* Volume 62, No. 1, Winter 2002, Forest Service, Washington, DC.

APPENDIX E
CURRENT UNDERSTANDING OF THE GROUNDWATER REGIME AT LOS ALAMOS NATIONAL LABORATORY

APPENDIX E
CURRENT UNDERSTANDING OF THE GROUNDWATER REGIME AT LOS ALAMOS NATIONAL LABORATORY

This appendix summarizes the current understanding of groundwater flow at Los Alamos National Laboratory (LANL) and the conceptual models that have been developed for the purpose of numerical modeling of groundwater flow and contaminant transport. This appendix presents the components by which researchers develop their concepts of the geohydrologic system at LANL.

E.1 Introduction

A comprehensive study of the geology, hydrologic processes, and site characteristics of an area must be understood to formulate a conceptual model of a groundwater flow system. Geologic information must be used in conjunction with the hydrologic data to define hydrostratigraphic units. A geologic unit can be used as a model layer or several units can be combined into model layers if their hydrologic characteristics are similar. Knowledge of the geology is required to define the areal extent of the units. Inferences about the flow system's hydraulic behavior and transport characteristics are drawn from information about geologic structures, lithologic properties, and groundwater geochemistry.

The setting occupied by LANL is geologically and hydrologically complex. Before recent drilling activities were implemented, conceptual models and numerical simulations of regional groundwater flow that had been developed were based on sparse data (Keating, Robinson, and Vesselinov 2005). The knowledge base regarding recharge, discharge, and how waterborne contaminants interact with and move through rock fractures and rock matrix in the vadose zone into perched water zones and the regional aquifer below LANL is growing. In 2005, the LANL contractor was regularly sampling 74 surface monitoring stations and 137 groundwater-monitoring locations based on agreements with the New Mexico Environment Department and the U.S. Environmental Protection Agency. These activities have resulted in modification of the conceptual models (Newman and Robinson 2005). As a result of further agreements, the LANL contractor will be expanding its data collection activities while conducting further analysis of existing data. This understanding of the hydrologic and chemical components at the site will aid in the development of sound conceptual models of flow and transport through the fractures and the matrix of the vadose zone into the saturated zone. It is anticipated that the new data, coupled with improvement in numerical flow and transport models and improved calculational techniques, will enable better prediction of flow and transport of groundwater in the LANL region and more accurately define the ultimate impacts on the regional groundwater resources below LANL.

This appendix provides a framework for understanding the geohydrology and the development of numerical models. In 2005, a series of reports of investigations in the *Vadose Zone Journal* developed conceptual models and discussed flow and transport through the vadose zone to perched groundwater bodies and the regional aquifer below LANL. Some of the reports from this series are discussed. The descriptions are brief and references are provided.

E.2 Regional Setting

LANL and the adjacent communities of Los Alamos and White Rock are located on the Pajarito Plateau (**Figure E–1** and Chapter 4, Figure 4–9). The plateau is an accumulation of east-sloping volcanic material that lies over the western part of the Española Basin and extends from the Sierra de los Valles on the eastern rim of the Jemez Mountains to White Rock Canyon and the Española Valley west of the Rio Grande. The plateau covers an area of about 240 square miles (620 square kilometers), of which about 90 square miles (230 square kilometers) is in the central part of the plateau and includes the area covered by LANL (Broxton and Vaniman 2005) (Figure E–1). The plateau is drained by easterly flowing ephemeral and intermittent streams that have formed deeply incised canyons separated by elongated mesas. The mesas range in elevation from west to east from 7,700 feet (2,350 meters) on the slopes of the Sierra de los Valles to 6,200 feet (1,900 meters) at their ends overlooking the Española Valley (Broxton and Vaniman 2005).

The drainage of the high slopes of the Jemez region (Sierra de los Valles) extends across the tuff outcrops of LANL. Precipitation potential in the north-central part of New Mexico is strongly altitude-dependent. Precipitation in the form of rainfall and snowfall at the higher elevations is about 18 inches (46 centimeters) and about 14 inches (36 centimeters) on the semiarid lower slopes of the area (Broxton and Vaniman 2005). Flow across the Pajarito Plateau from the higher elevations to the Rio Grande has resulted in the mesa and canyon landscape of the area. The steeply cut canyons slope eastward from the Jemez Mountains toward the Rio Grande and are the cumulative result of the alternating humid and arid climatic cycles of the past 2.8 million years (Pleistocene glacial and interglacial). The canyon bottoms are covered with a relatively thin layer of alluvium. The mesa tops display little soil formation and are sparsely vegetated with water-efficient plants. Devitrification of the tuffs on the surface of the plateau has generated a nutrient-poor soil with smectitic clays as its principal argillaceous component. The mesa surfaces are generally quite flat and receive no runoff from the higher elevations. Soil moisture infiltration and runoff is controlled by plant growth and downward transport of precipitation that falls on the mesa surfaces.

E.3 Structural Setting

The tectonic episodes that occurred in southern Colorado and north-central New Mexico from the late Campanian stage of the Cretaceous Period (approximately 75 million years ago) through the Eocene Epoch (about 35 million years ago) formed the Rocky Mountains (Cather 2004). The mountain building (termed the Laramide orogeny) was caused by compression of the Earth's crust and formed two large basins that are separated by an uplifted area in north and central New Mexico and extend into southern Colorado. The structures formed were the San Juan Basin to the west and the Raton Basin to the east, which are separated by the San Luis Uplift. The southern part of the San Luis Uplift in the LANL vicinity has been called the Pajarito Uplift (Cather 2004). The Pajarito Uplift is bounded by the Picuris-Pecos fault zone in the Sangre de Cristo Mountains to the east and the Pajarito fault zone to the west (Broxton and Vaniman 2005).

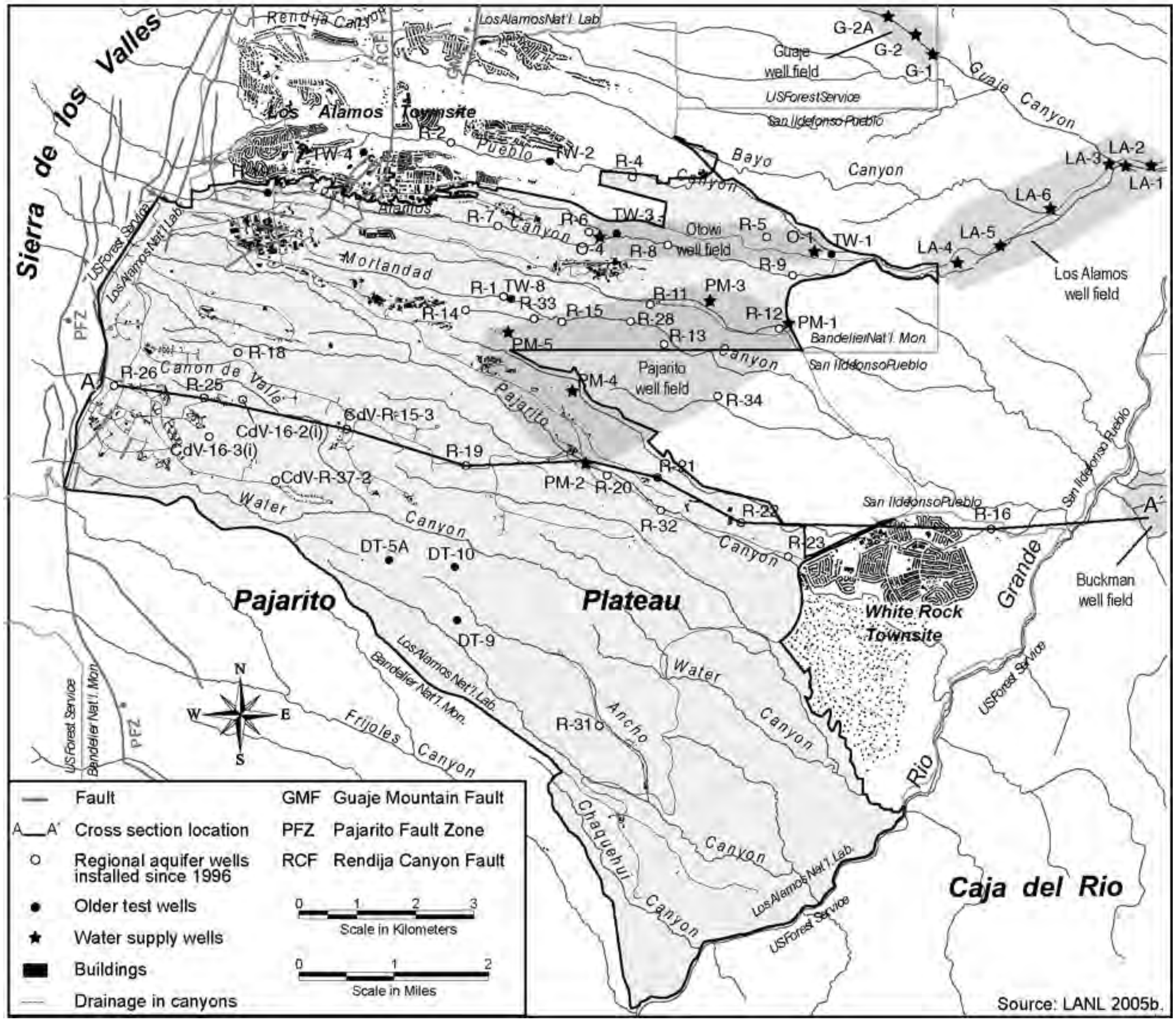


Figure E–1 Location Map of the Central Pajarito Plateau

At the end of the Eocene Epoch, three large-scale processes began and continued until the late Pleistocene Epoch: (1) widespread volcanism, (2) extension of the crust (rifting) from Colorado through New Mexico to west Texas, and (3) extensive erosion of the High Plains east of a rift zone that is delineated by the Rio Grande (from which the zone's name is derived) and the Colorado Plateau west of the Rio Grande rift (Smith 2004). The Pajarito Uplift and other uplifts began to undergo extensional inversion (lowering) along the rift zone. In northern New Mexico, the Rio Grande Rift formed a series of semi-coaxial, elongated, oppositely tilted grabens that became narrow, sediment-filled basins (Smith 2004, Broxton and Vaniman 2005, LANL 2005a) (**Figure E–2**). The basins along the axis of the rift are flanked by a series of discontinuous mountains (Smith 2004). The Española Basin is flanked by the Nacimiento Mountains and the Jemez Mountains to the west and the Sangre de Cristo Mountains to the east. The western margin of the basin is obscured by Jemez volcanics and the margin may be further west at the Laramide Nacimiento Uplift (Smith 2004).

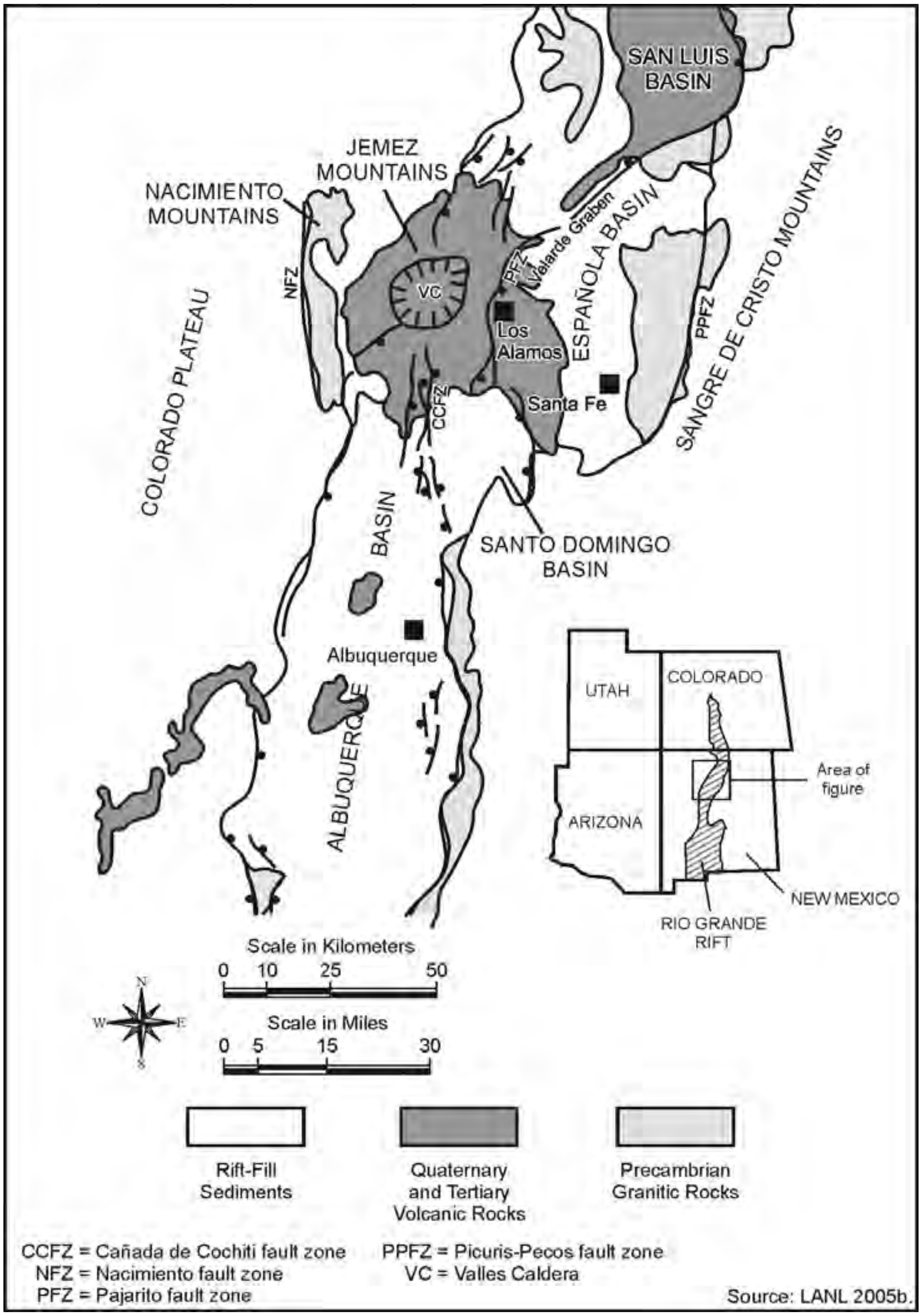


Figure E–2 Locations of Major Structural and Geologic Elements in the Vicinity of Los Alamos National Laboratory

Basins along the Rio Grande Rift are bounded by normal faulting that occurs along the margins and within the basins. The Española Basin is a west-tilting half graben bounded on the west edge by north-trending faults called the Pajarito fault zone (Figure E–2); on the north by northeast-trending transverse faults of the Embudo fault zone; and on the south by northwest-trending transverse faults called the Bajada fault zone (LANL 2005a). Gravity evidence indicates that deep within the Española Basin are three buried grabens associated with the Pajarito and Embudo fault zones (Smith 2004, Broxton and Vanimin 2005). One graben forms the north-trending Los Alamos sub-basin and is near Los Alamos. It is bounded by the Pajarito fault zone on the west and by the buried faults that lie east of the southern projections of Rendija Canyon and Guaje Mountain (Smith 2004, Broxton and Vaniman 2005).

The Pajarito fault zone forms a 400-foot (120-meter)-high escarpment on the western margin of the plateau that looks like a monocline, but examination along the strike reveals a simple normal fault, several small normal faults, and faulted and unfaulted monoclines (Broxton and Vaniman 2005).

Other major fault zones in the LANL area include the north-trending Rendija Canyon fault that is down-to-the-west, and the north-trending Guaje Mountain fault that is also down-to-the-west (Broxton and Vaniman 2005). The faults are parallel in the northern part of the plateau. Additional faults are buried beneath or within the Bandelier Tuffs under the Pajarito Plateau. Faulting also occurs in the older Santa Fe Group rocks on the eastern side of the Española Basin.

E.4 Volcanic Setting

Jemez Volcanic Field

The Jemez Mountains were formed by rift-related volcanism along the Jemez lineament (**Figure E–3**) where the Colorado Plateau abuts the Española Basin. The lineament is a feature that may be a reactivated zone of ancient crustal weakness that trends northeast from eastern Arizona through the Jemez Mountains into southeastern Colorado (Goff and Gardner 2004, Broxton and Vaniman 2005). The volcanic zone that forms the Jemez Mountains overlaps the Colorado Plateau and western Española Basin (Broxton and Vaniman 2005). The region around the Valles Caldera in the Jemez Mountains west of the Pajarito Plateau is the source of most of the volcano-derived material that forms the Pajarito Plateau (Broxton and Vaniman 2005).

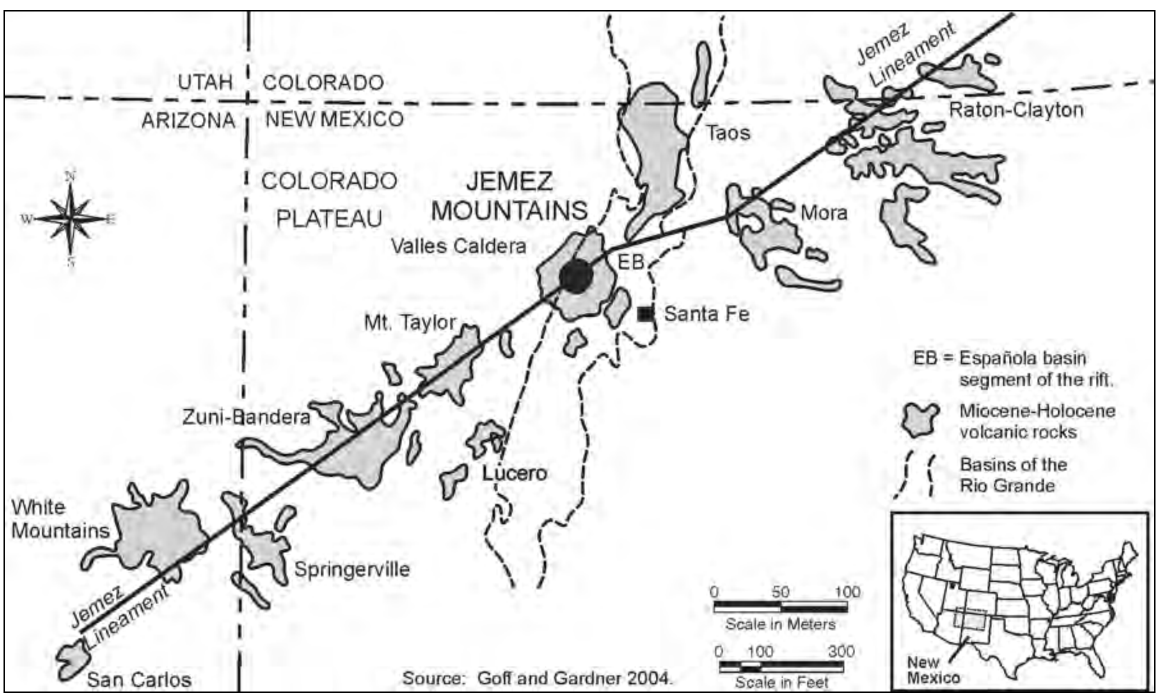


Figure E–3 Location Map of the Jemez Mountains and Valles Caldera with Respect to the Jemez Volcanic Lineament, the Colorado Plateau, and the Rio Grande Rift

For the past 14 million years, the structural province of this region has been extensively affected by tectonic forces. Volcanic activity and subsidence due to rifting were contemporaneous. The early Española Basin was the depositional site of alluvium derived from the Colorado Plateau and later from the Jemez Mountain volcanic field (to the west) and the Sangre de Cristo Mountains (to the east). The volcaniclastics from the Jemez Mountain volcanic field and the Precambrian basement rocks to the east and north formed large alluvial fans that intertongued, forming a vertical intergradation of wedge-shaped layers (Goff and Gardner 2004; Smith 2004; and Broxton and Vanimin 2005).

The Jemez Mountain volcanic field is divided into three groups. The oldest groups are the Keres Group in the south and the Polvadera Group in the north. These are succeeded by the Tewa Group in the central part and on the flanks of the Jemez Mountain volcanic field (Goff and Gardner 2004). This is not to imply that some of the volcanic eruptions that formed these three groups did not occur at the same time. Eruptions in different areas can overlap in time. The Lobato Basalt of the Polvadera Group was somewhat synchronous with the Keres Group basalts (Broxton and Vaniman 2005). LANL staff is conducting detailed examination of basalt and rhyolite outcrops and drill-hole data from beneath the Pajarito Plateau. The new data provide insight into the ages of the rocks and are being used to determine whether the rocks can be correlated throughout the volcanic field.

Knowledge gained from the study of the rock materials present in the LANL area is important to understanding hydrologic and chemical properties when developing conceptual models of groundwater flow and transport. A summary of the units present in the region, including their approximate ages and short descriptions, is given in **Table E–1**. Further descriptions and the relationships of these units with the alluvial units under the Pajarito Plateau are provided in Section E.5, Stratigraphic Framework of the Pajarito Plateau.

In the LANL area, on the east side of the Rio Grande, is the Caja del Rio Basalt Plateau (Figure E–1). It is an exposed part of the Cerros del Rio volcanic field that extends westward 7 miles (11 kilometers) underneath the Pajarito Plateau where it is covered by Bandelier Tuff (Goff and Gardner 2004; Broxton and Vaniman 2005). These volcanics are dissected by the Rio Grande, forming the steep-sided White Rock Canyon.

Caldera formation and subsequent collapse during the Late Pliocene to Late Pleistocene Epochs formed the Jemez Mountains and resulted in significant chemical evolution of the magma-, ash-, and tuff-forming phases. The Bandelier Tuff Formation consists of ashfalls, pumiceous beds, and flow tuffs and ranges up to tens of feet thick in the plateau area and is spread widely east and south of the main caldera. These tuffaceous deposits of the Bandelier Tuff, the Otowi, Cerro Toledo interval, and Tshirege define the geomorphology of the plateau and control the development of the terrain of canyons and mesas at LANL.

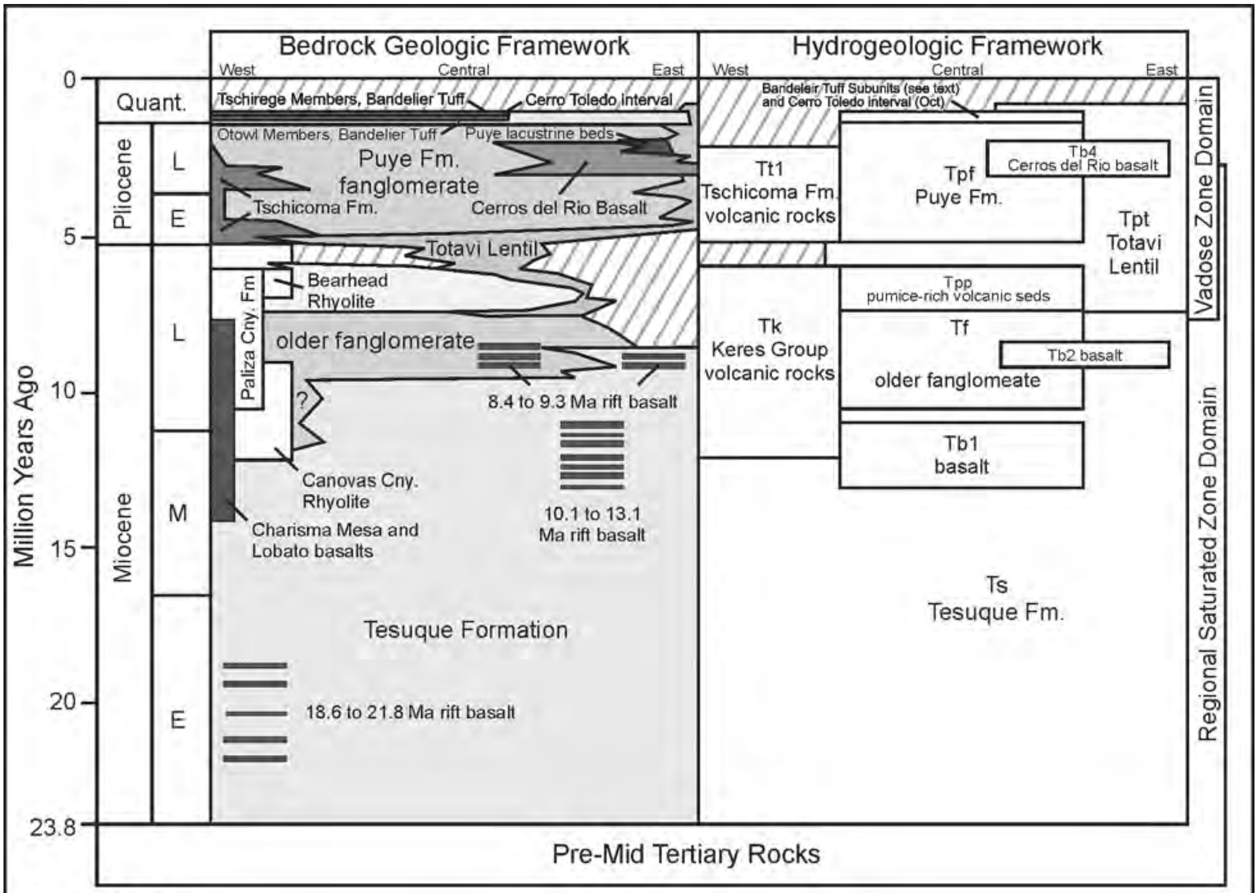
Table E–1 Summary of Jemez Mountain Volcanic Field Names, Rock Types, and Rock Ages

Group Name	*Unit Name*	*Description*
Middle Miocene Units		
Polvadera Group (Oldest unit in north part of LANL. Contemporaneous with parts of the Keres Group.)	Lobato Basalt (14 to 7.6 million years ago)	Multiple flows and cinder deposits coeval with Chamisa Mesa Basalt. Primarily olivine; dikes intruded Santa Fe Formation; interbedded with Santa Fe Formation.
Keres Group (Oldest unit in south part of LANL. Contemporaneous with parts of the Polvadera Group.)	Chamisa Mesa Basalt (13 to 9 million years ago)	Thin flows of basaltic lavas and cinder deposits that overlie rhyolitic tuff; forms mesa tops to the south and northeast of LANL. May be oldest unit in the Jemez Mountain volcanic field.
	Canovas Canyon Rhyolite (12.4 to 8.8 million years ago)	Domes, plugs, and pyroclasts (tuff, ash); weathered; intrudes Paliza Canyon Formation; rhyolite and basalt.
	Paliza Canyon Formation (10.6 to 7.1 million years ago)	Thick flows, domes, and pyroclasts; basalt, andesite and dacite composition.
	Peralta Member (6 to 7.1 million years ago)	Thick, tuffaceous deposits.
	Bearhead Rhyolite (6 to 7.1 million years ago)	Domes, intrusions, and pyroclasts; high silica rhyolites, plugs, domes, and tuffs.
	Cochiti Formation. (< 13 to < 6 million years ago)	Volcaniclastic rocks derived from Keres group rocks and interfingers with Santa Fe Group, Canovas Canyon Rhyolite, and Paliza Canyon Formation.
Late Miocene to Late Pliocene Units		
Polvadera Group	Tschicoma Formation (5 to 3 million years ago)	Large, overlapping domes and flows of dacite, rhyodacite, and andesite.
Late Pliocene to Late Pleistocene Units		
Tewa Group	Bandelier Tuff Pumice fall covered by ash-flow – High silica Rhyolite tuff; exposures at Pajarito Plateau in canyons; forms Pajarito Plateau east of and Jemez Plateau west of the Jemez Mountain Volcanic Zone.	
	Otowi Member (1.61 million years ago)	Guaje Pumice – Eruption formed the Toledo caldera, which was destroyed; less welded than Tshirege Member; basal pumice fall overlain by ash-flow tuffs.
	Cerro Toledo Interval	Cerro Toledo Rhyolite, Rhyolite domes.
	Tshirege Member (1.22 million years ago)	Tsankawi Pumice – Eruption formed the Valles Caldera that subsequently collapsed; basal pumice fall overlain by ash-flow tuffs.
Peripheral Lavas	Basalts of the Cerros del Rio (2.8 to < 1 million years ago)	Basalt lavas and dikes; relationship to Otowi unclear (Goff and Gardner 2004).

Source: Summarized from Broxton and Vaniman 2005 and Goff and Gardner 2004.

E.5 Stratigraphic Framework of the Pajarito Plateau

This section describes the stratigraphy of the Pajarito Plateau and shows how the volcanics described above fit in the sequence of deposition (**Figure E–4**). As mentioned above, volcaniclastics and sediments derived from the volcaniclastics from the Jemez Mountain volcanic field to the west of the Pajarito Plateau and sediment from the Precambrian basement rocks to the east and north formed alluvial fans that intertongued, forming a vertical intergradation of wedge-shaped layers.



Source: LANL 2005b.

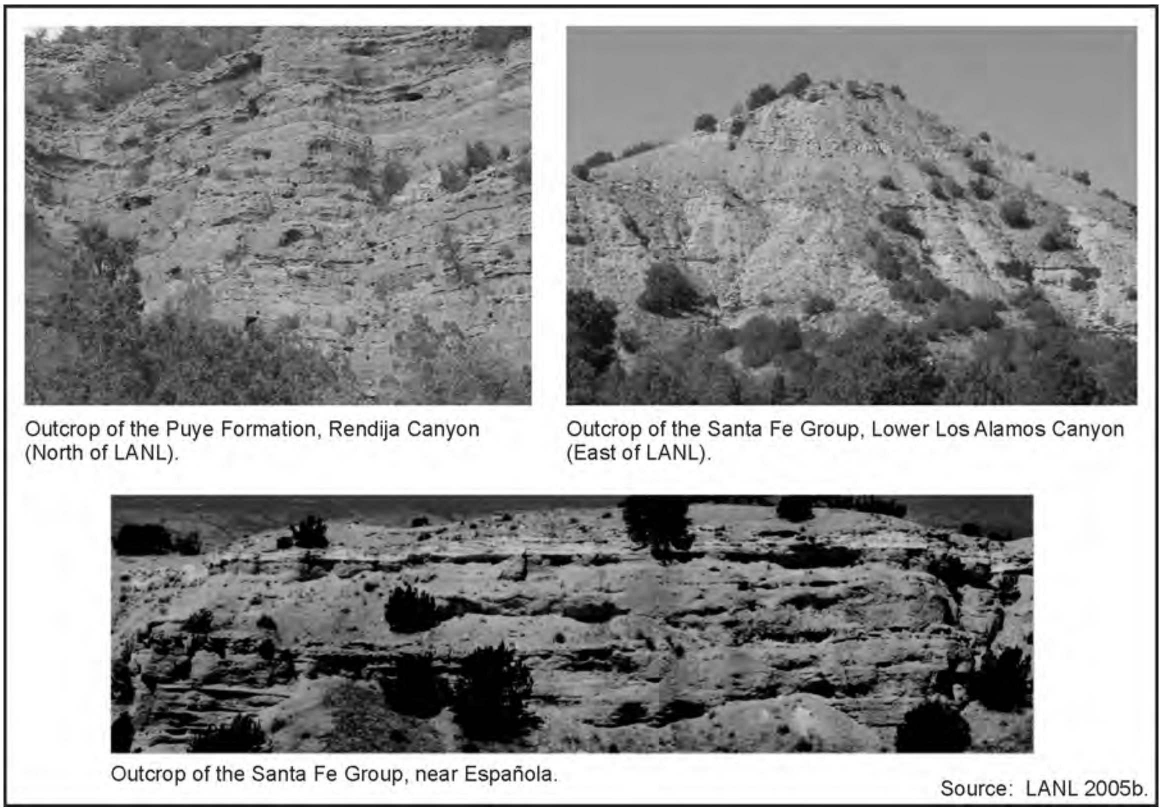
Figure E–4 Pajarito Plateau Stratigraphy and Hydrogeologic Units

E.5.1 Santa Fe Group

The basins along the Rio Grande Rift average several tens of miles long and are filled with sediments that reach depths of a few tens of thousands of feet. This thick accumulation of sediments in the Española Basin was derived from Precambrian rocks exposed in the highlands north and east of the basin. The basin sediments in north-central New Mexico were first collectively termed the Santa Fe Formation, but the formation was later elevated to a group name and subdivided into several formations. The Tesuque Formation is subdivided into, in ascending order, the Bishop's Lodge, Nambe, Skull Ridge, Pojoaque, Chama-El Rito, and Ojo Caliente Members and the Chamita Formation. The Puye Formation was added and the Ojo Caliente was elevated to a formation (Broxton and Vaniman 2005). The age of the Tesuque ranges from about 30.45 to 8.48 million years ago. The name Tesuque Formation was used for the youngest formation of the Santa Fe Group in the Española Basin because it was felt that some of the members and formation designations could not be mapped properly because they were not defined over a large enough area (Smith 2004). Interfingered into these sediments are volcaniclastic sediments from the Jemez volcanic field (Broxton and Vaniman 2005).

Most of the rocks that were pre-Española Basin were stripped away in the Pajarito Plateau vicinity. Denudation of Paleozoic and Mesozoic rocks may have been due to erosion of the Pajarito Uplift (Cather 2004, Smith 2004), resulting in the absence of pre-Eocene rocks.

Mesozoic units may be present under the Pajarito Plateau, but at this time there is no supporting evidence (Broxton and Vaniman 2005). There are no exposures of the Santa Fe Group within the LANL boundaries; but on the eastern margins of the Pajarito Plateau and north of LANL, there are exposures in deep canyons such as Rendija Canyon and lower Los Alamos Canyon (**Figure E–5**). East of the Pajarito fault, the Santa Fe Group may be 6,650 feet (2,000 meters) thick, but much thinner (less than 1,640 feet [500 meters]) west of the fault, as indicated by examination of outcrops and drill-hole data (Goff and Gardner 2004, Broxton and Vaniman 2005). Because of the thickness of the Santa Fe Group, not much is known about units that are of hydrologic significance and are older than the Tesuque in the LANL region. Most of what is known about the Tesuque Formation's lithologic and hydrologic properties comes from drill holes.



Outcrop of the Puye Formation, Rendija Canyon (North of LANL).

Outcrop of the Santa Fe Group, Lower Los Alamos Canyon (East of LANL).

Outcrop of the Santa Fe Group, near Española.

Source: LANL 2005b.

Figure E–5 Deep Canyon Exposures

New drill hole data and exposures of rocks near the Rio Grande provide much of what is known about the stratigraphy, lithology, and ages of the Santa Fe Group in the LANL area. A recent attempt to address controversies dealing with stratigraphy and mechanisms that formed the Española Basin is reported in a synthesis of work performed up to the present (Smith 2004). Units believed to be of significance in the Pajarito Plateau area, in ascending order, are the Tesuque Formation, older fanglomerate deposits of the Jemez Mountain volcanic field, the Totavi Lentil and older river deposits, pumice-rich volcaniclastic rocks, and the Puye Formation (Broxton and Vaniman 2005).

Tesuque Formation

The Miocene Tesuque Formation has been characterized from data taken from partially penetrating water production wells for local communities west of the Rio Grande on the eastern edge of the Pajarito Plateau and from exposures east of the Rio Grande. The Tesuque Formation below the plateau is derived from arkosic sediments from the Precambrian Eon and sedimentary rocks of the Sangre de Christo Range to the east, and from Tertiary volcanic material to the north. The partly lithified fluvial sediments are thin-bedded (less than 10 feet, [3 meters]), massive to planar, cross-bedded, light pink to buff sandstones (Smith 2004; Broxton and Vaniman 2005). West of Española, the Tesuque Formation is interbedded with Lobato Basalt (Smith 2004). The Tesuque Formation dips to the west-northwest at about 11 degrees on the east side of the plateau (Broxton and Vaniman 2005).

Miocene Basalts

There are two groups of Miocene basalts underneath the east edge of the Pajarito Plateau. One group is 10.9 to 13.1 million years old near Guaje Canyon north of LANL, and the other is 8.4 to 9.3 million years old and extends from Bayo Canyon on the north end of the eastern part of the plateau to almost the southern end of LANL.

Older Fanglomerate

This unit of the Santa Fe Group is important because high-yield municipal water supply wells with low drawdown have been developed in these rocks. Recent data indicate that the older fanglomerates are widespread below the Pajarito Plateau (Broxton and Vaniman 2005). The unit is made up of volcanic detritus from the Keres Group and possibly from the Tschicoma Formation of the Polvadera Group. Data for the Otowi-4 well show that the older fanglomerate is a thick (1,650 feet [500 meters]) unit made up of dark, lithic sandstone with gravel and cobbles (Broxton and Vaniman 2005). An interpretive cross-section was developed using well data that indicate the older fanglomerate interfingers with the upper Tesuque Formation (Broxton and Vaniman 2005). This is consistent with data from Guaje Canyon wells that suggest that the fanglomerate may have accumulated as the Los Alamos sub-basin subsided (Broxton and Vaniman 2005).

Totavi Lentil and Older River Deposits

The Totavi Lentil (**Figure E–6**) is made up of poorly consolidated and well-rounded sands, gravels, and cobbles formed by the ancestral Rio Grande (Broxton and Vaniman 2005; Goff and Gardner 2004) and is used as a marker bed for supply wells beneath the Pajarito Plateau. The deposits at some locations are conformable with the Puye Formation and are used by some workers to delineate the base of the Puye Formation (Broxton and Vaniman 2005). The Totavi Lentil is highly variable in thickness and ranges from 50 feet (15 meters) to more than 323 feet (98 meters). New well data show a range in thickness of 30 to 100 feet (10 to 30 meters), but data from Well H-19 at the western limit of the Totavi Lentil indicate that the unit is only 10 feet (3 meters) thick.

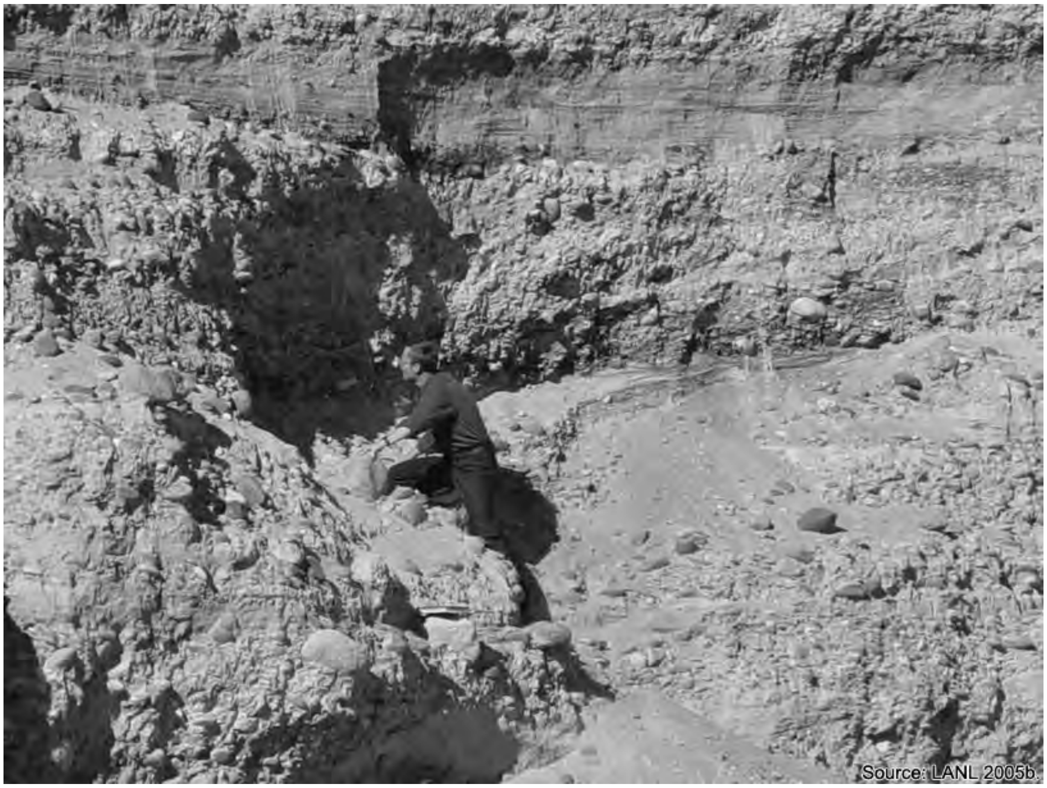


Figure E–6 Outcrop of Totavi Lentil Along SR 304

New well data show that the unit is coeval with several stratigraphic units and late Miocene river gravels and put the age of through-going rivers (rivers that are regional in nature with origins outside of the study area) at about 6.96 million years (Broxton and Vaniman 2005).

Pumice-Rich Volcaniclastic Rocks

The pumice-rich volcaniclastic rocks have well-bedded horizons of light-colored, reworked tephra-rich sedimentary deposits and subordinate primary ash- and pumice-fall deposits. The rocks consist mainly of tuffaceous sandstones with a few beds of gravels made of reworked lava (Broxton and Vaniman 2005). The deposits of pumice-rich volcaniclastic rocks become thinner eastward over the Pajarito Plateau and are made up of subangular to rounded lapilli (30 percent) and ash and lithic sands (70 to 90 percent). Samples of material from the saturated zone taken from wells in and near the Otowi Well Field (R-5, R-8, R-9, R-12) at the northeastern edge of LANL contained diagenetically altered volcanic glass replaced by smectite, but in other areas the lapilli are still vitric with only some surface oxidation and minor clay development (Broxton and Vaniman 2005). The source rocks may be from the Keres Group volcanism.

Tschicoma Formation

The Tschicoma Formation consists of thick dacite and low-silica rhyolite lava flows erupted from major peaks of the Sierra de los Valles highlands north and east of Valles Caldera and west of Los Alamos (Broxton and Vaniman 2005). The formation interfingers with the deposits of the Puye Formation, becomes thinner eastward across the Pajarito Plateau, and is absent at the eastern end of the plateau (Goff and Gardner 2004, Broxton and Vaniman 2005). The Tschicoma

Formation is lenticular, resulting in variable thicknesses (up to 2,500 feet [762 meters] in the Sierra de los Valles) (Broxton and Vaniman 2005).

Puye Formation

The Puye Formation is a large complex of alluvial fans made up of volcanic material and alluvium. It is well exposed north of the Pajarito Plateau; unconformably overlies the Santa Fe Group; and is intersected by most deep wells on the Pajarito Plateau (Goff and Gardner 2004, Broxton and Vaniman 2005). The formation's source rocks are the domes and flows of the Sierra de los Valles; consequently, the formation overlaps and postdates the Tschicoma Formation (Broxton and Vaniman 2005). The unit has two facies, fanglomerate and lacustrine. The fanglomerate is a widespread intertonguing mixture of stream flow, sheet flow, debris flow, block and ash fall, pumice fall, and ignimbrite deposits and may be up to 1,100 feet (330 meters) thick (Goff and Gardner 2004). The lacustrine facies include lake and riverine deposits in the upper part of the Puye; consist of fine sand, silt, and clay; and may be up to 30 feet (9 meters) thick. The lacustrine deposits are discontinuously exposed along Los Alamos Canyon (Broxton and Vaniman 2005).

Basaltic Rocks of the Cerros Del Rio Volcanic Field

These thick sequences of stacked lava unconformably overlie the Tesuque Formation and intertongue with the upper Puye under the Pajarito Plateau. Basalt outcrops occur east of the river and in Frijole Canyon and White Rock Canyon (Broxton and Vaniman 2005). The features are typical of basalt flows; that is, there is a flow base of vesicular basalt with scoria and clinkers, a collonade structure, a complex overlapping fractured zone, and a flow top with clinkers and scoria. The cooling rates of the basalts influenced the different zones of materials. The lower part of the interior units cooled more slowly than the upper part and formed columnar structures separated by vertical fractures. As cooling rates increased upward, the upper part developed into an array of web-like random fractures. The interflows consist of clastics, ash, and sedimentary deposits. The flows are generally 200 to 300 feet (61 to 183 meters) thick and reach a maximum of 983 feet (300 meters). There are some maar deposits formed when molten basalt encountered water (Broxton and Vaniman 2005).

E.5.2 Upper Pliocene and Quaternary Units

Bandelier Tuff

The Bandelier Tuff comprises the surface and near surface materials in the LANL area. It is an extensive, wedge-shaped pyroclastic unit that gets thinner as it extends eastward from Sierra de los Valles toward the eastern edge of the Pajarito Plateau and was deposited during a recent eruptive phase of the Jemez volcanic complex (1.6 to 1.2 million years ago) (Goff and Gardner 2004; Broxton and Vaniman 2005). The Bandelier Tuff is made up of two similar units, the Otowi Member (the oldest) and the Tschirege Member. The two members are divided into subunits, a basal pumice layer overlain by multiple tuff layers, and their characteristics are based mostly on thermal and depositional features. The two members are separated by a layer of tephras and volcaniclastics and make up the Cerro Toledo interval (Birdsell et al. 2005, Goff and Gardner 2004, Broxton and Vaniman 2005).

Otowi Member of the Bandelier Tuff

The Otowi Member (equivalent to the Qbo hydrologic unit discussed in Section E.6.3) is exposed in Los Alamos Canyon, the deeper canyons to the north at the edge of the Pajarito Plateau, and in the deeper canyons at the edge of the Jemez Plateau west of the Jemez Mountains (Goff and Gardner 2004; Birdsell et al. 2005; Broxton and Vaniman 2005). The basal layer of the Otowi Member, the Guaje Pumice (equivalent to the Qbog hydrologic unit discussed in Section E.6.3), is a pumice layer, ranges in thickness from about 7 to 50 feet (2 to 15 meters) (Birdsell et al. 2005), and averages about 30 feet (9 meters) (Broxton and Vaniman 2005). The pumice, a distinctive marker bed, is overlain by a series of poorly welded rhyolitic ash-flow units that collectively form an extensive, homogeneous rock unit. The Otowi Member is wedge-shaped and thins eastward away from its source, the caldera, over the central part of the plateau. The Otowi Member on the western part of the Pajarito Plateau has two thick zones ranging from 350 to 400 feet (100 to 125 meters) separated by an elongated zone ranging from less than 100 to 300 feet (30 to 90 meters). The thin zone is overlain with a thick deposit of Cerro Toledo sediments (equivalent to the Qct hydrologic unit discussed in Section E.6.3). Erosion removed a large amount of the Otowi Member in some parts of the plateau, leading to a suggestion that the thin zone is indicative of an east-trending drainage incised into the surface of the member (Broxton and Vaniman 2005).

Cerro Toledo Interval

The Otowi and Tshirege Members of the Bandelier Tuff are separated by a stratified sequence of volcaniclastics informally named the Cerro Toledo interval (Goff and Gardner 2004, Broxton and Vaniman 2005). The unit is exposed in Los Alamos Canyon and the deeper canyons to the north at the edge of the Pajarito Plateau. The Cerro Toledo is variable in thickness, ranging from 3 to 390 feet (1 to 120 meters) (Broxton and Vaniman 2005), and is composed of rhyolites that are representative of the Toledo caldera before it collapsed (Goff and Gardner 2004). Dacite and andesite detritus from the Tschicoma Formation are intertongued with reworked Otowi deposits and Cerro Toledo interval rhyolites (Goff and Gardner 2004, Broxton and Vaniman 2005).

Tschirege Member of the Bandelier Tuff

The Tschirege Member is the most distinctive and widely exposed unit on the Pajarito Plateau. It is somewhat more resistant to weathering and erosion in the western part of the plateau because the tuffs are strongly welded and form steep, narrow canyons that become wider downgradient where the tuff is not as strongly welded (Goff and Gardner 2004, Broxton and Vaniman 2005, Birdsell et al. 2005). Like the Otowi, the Tschirege Member has a basal pumice layer, the Tsankawi Pumice, that unconformably overlies the Cerro Toledo sediments (Goff and Gardner 2004; Broxton and Vaniman 2005). The pumice layer is much thinner than the Guaje Pumice and ranges in thickness from 20 to 30 inches (50 to 75 centimeters). The Tsankawi Pumice is overlain by a compound cooling sequence of four welded ash-flows (Goff and Gardner 2004). The thickness of the four units ranges from 200 feet (61 meters) in the north-central part of LANL to 600 feet (183 meters) at the southern edge of LANL (Broxton and Vaniman 2005). The degree of welding in the Tschirege increases westward on the plateau as one approaches the caldera that is the source of the tuff (Broxton and Vaniman 2005). The high temperatures were maintained longer due to the thicker deposits, which increases welding.

Cooling joints in the Otowi tuffs and poorly welded portions of the Tschirege are mostly lacking (Birdsell et al. 2005).

The four mappable cooling units of the Tschirege tuffs have been subdivided into subunits based on distinctive lithologic characteristics because the units occupy a "significant portion of the vadose zone" (Broxton and Vaniman 2005). The unit names are also used for the hydrologic units discussed in Section E.6.3. Briefly, from the oldest to the youngest, the designations for the units are:

> **Qbt 1g**. This unit is a porous, nonwelded tuff with no devitrification or vapor phase alteration of the glass (g). The unit has a resistant caprock that protects the soft tuffs underneath, forming steep cliffs.
>
> **Qbt 1v**. This unit is nonwelded, porous, crystalline tuff that has undergone vapor-phase (v) crystallization of pumice and glass shards. The lower part (Qbt 1vc) is a collonade tuff with columnar cooling joints. The tuff alternates between cliff-forming and slope-forming units.
>
> **Qbt 2**. This unit is a series of surge beds, forming brownish vertical cliffs. The unit conformably overlies Qbt 1v in some parts of LANL. The unit is dense and porosity is lower than the other units. Welding increases upward.
>
> **Qbt 3**. This unit is a nonwelded to partly welded, vapor-phase tuff that forms the cap rock of mesas. It grades upward from a soft basal unit that is a purple-gray, porous, unconsolidated, crystal-rich, nonwelded tuff to a partly welded, white cliff-forming tuff that becomes moderately to densely welded in the western part of LANL. Qb 3t, a subunit of Qbt 3, is moderately to densely welded ash-flow tuff in the far-western part of LANL and is transitional to Qbt 4.
>
> **Qbt 4**. This unit is a complex unit in the western part of LANL made up of nonwelded to partly welded ash-flow tuffs with pumice and surge deposits in the lower part of the unit and densely welded ash-flow tuffs that form caprocks. The unit has mostly undergone devitrification and vapor phase alteration, but locally there are thin rhyolitic, vitric ash-flow tuff deposits.

Alluvium

Alluvium of the Holocene and Pleistocene occurs on the canyon floors at LANL. Continuous alluvial deposits from the Pleistocene occur at the foot of the eastern slopes of Sierra de los Valles and on the Pajarito Plateau on top of the Bandelier Tuff (Broxton and Vaniman 2005). The alluvium on the floors of small canyons that head (begin) on the Bandelier Tuff consists of Bandelier Tuff detritus. Canyons that have headwaters farther west in the Sierra de los Valles have detritus from the Bandelier and the Tschicoma Formations. The alluvium consists of unconsolidated fluvial sands and gravels and forms stratified lenticular-shaped deposits along the canyon floors and at the mouths of canyons. The alluvium deposits intertongue with the colluvium, which may have blocks of material up to 10 feet (3 meters) in cross-section at the bases of the walls of the canyons. The deposits are cross-cut by the ephemeral or intermittent streams, forming complex deposits on the canyon floors and at the mouths of the canyons. The alluvial deposits vary in thickness within the canyons and from canyon to canyon. Alluvium thickness in Pueblo Canyon ranges from 11 feet (3.4 meters) on the west side of the plateau to about 18 feet (5.5 meters) at the confluence with Los Alamos Canyon (Broxton and Vaniman 2005; Robinson et al. 2005); at Mortandad Canyon, the range is from 1 to 2 feet (0.3 to 0.6 meters) at its headwaters to 100 feet (30 meters) at the eastern margin of LANL.

E.6 Hydrogeology

E.6.1 Comparison of the Bedrock Geologic Framework with the Hydrologic Framework

Cross-sections that represent subsurface geology result from the integration of:

- Structural geologic observations consisting mostly of the elevations of contacts between rock bodies of different character measured in wells,
- Stratigraphic descriptions of the character and thickness of individual rock bodies from wells and the study of outcrops, and
- Down-hole geophysical studies.

The observations from wells define the fundamental data necessary to accurately construct cross-sections. The cross-sections, structural contour maps, and interpreted character of the rocks around LANL serve as the framework for flow and transport models (Figure E–4). Cross-sections drawn from west to east across the Pajarito Plateau are presented in **Figures E–7** (along Los Alamos Canyon) and **E–8** (along Pajarito Canyon).

The comparison shows how the geologic units differ from the hydrologic units. The geologic units are combined because they possess similar hydrologic properties, which allows for modeling efficiency. This does not imply that the hydrologic units are homogeneous regions of unvarying properties. Large local internal variations in hydrologic properties have been noted and are due to rock texture, composition, and structure. The basis for defining the hydrologic units is that the gross character of a unit can be modeled relatively consistently. The following discussion compares the geologic and hydrologic frameworks (Broxton and Vaniman 2005).

E.6.2 Groundwater Occurrence

There are three modes of groundwater occurrence in the Pajarito Plateau: (1) perched alluvial groundwater in canyon bottoms; (2) zones of intermediate-depth perched groundwater whose location is controlled by availability of recharge and by subsurface changes in permeability; and (3) the regional aquifer beneath the Pajarito Plateau (Broxton and Vaniman 2005). In wet canyons, stream runoff percolates through the alluvium until downward flow is impeded by less permeable layers, maintaining shallow bodies of perched groundwater within the alluvium. Contaminant distributions in the groundwater under the Pajarito Plateau suggest that the three systems may be in communication under certain conditions (Robinson, McLin, and Viswanathan 2005). The hydrogeology of the Pajarito Plateau is typical of the semi-arid, sediment-filled basins along the Rio Grande Rift in that the basins receive recharge from mountain ranges along the margins (Broxton and Vaniman 2005). This section discusses alluvial, perched, and regional groundwater.

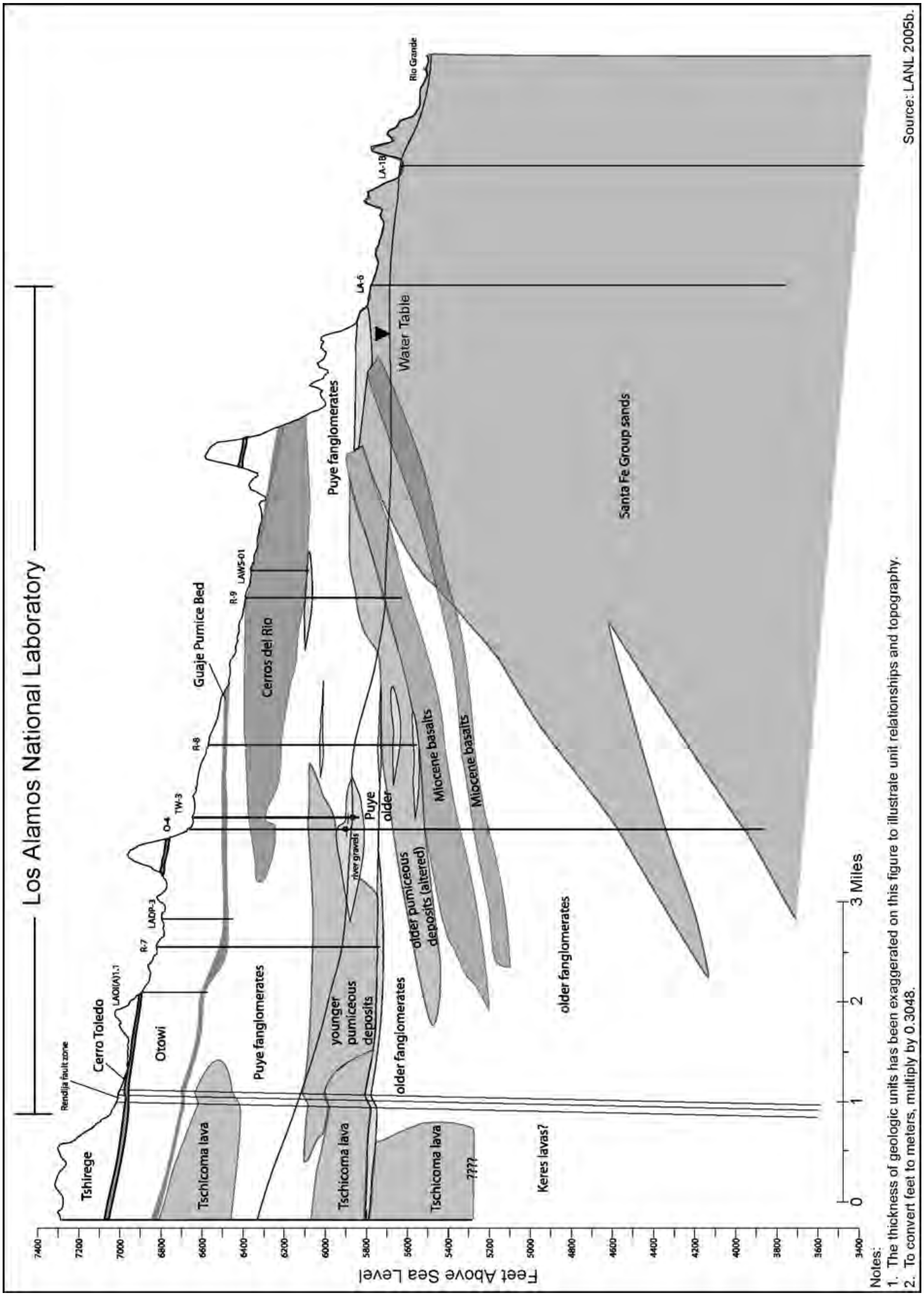
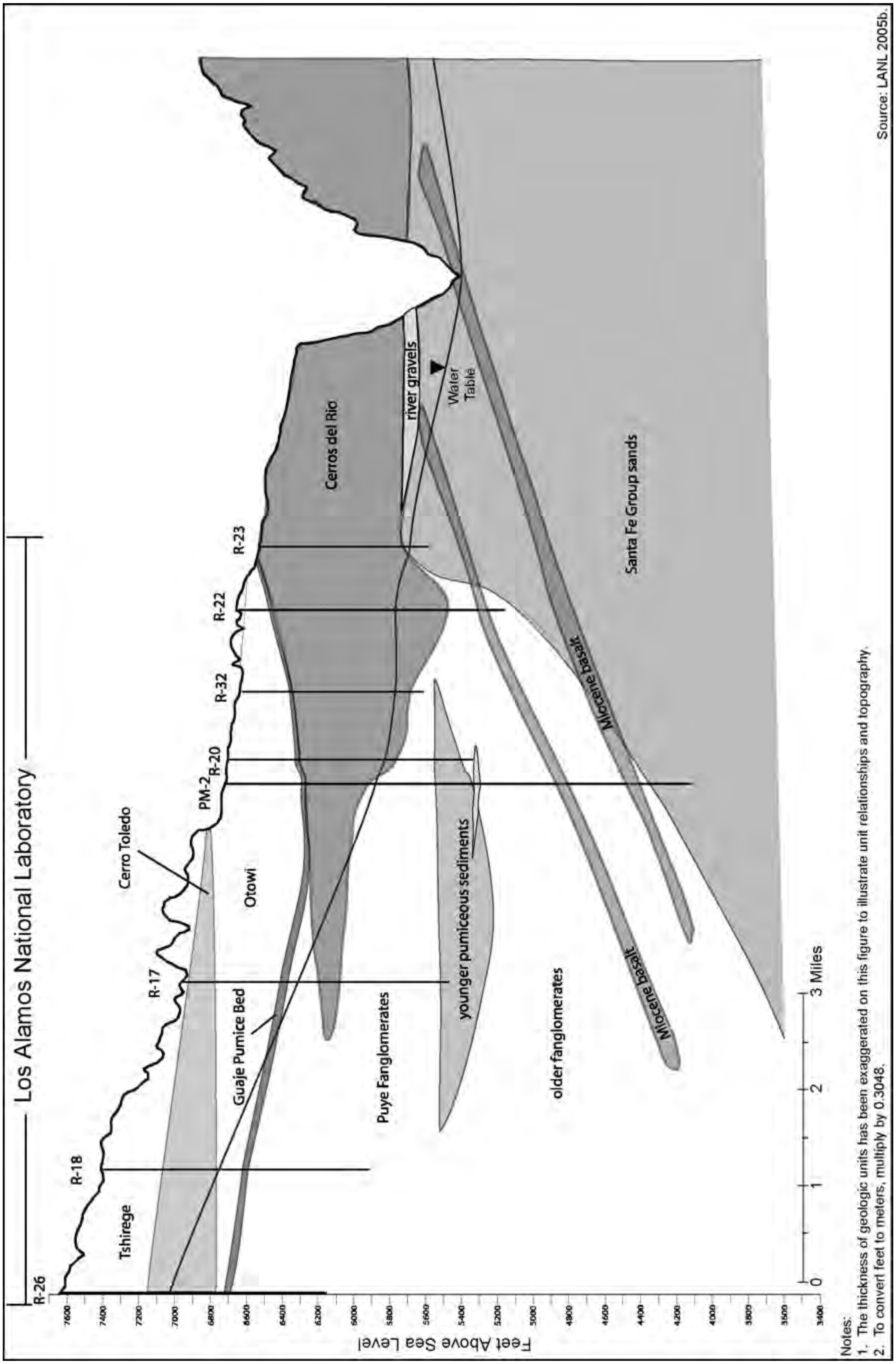


Figure E–7 Conceptual Cross-Section Across the Pajarito Plateau Along Los Alamos Canyon



Notes:
1. The thickness of geologic units has been exaggerated on this figure to illustrate unit relationships and topography.
2. To convert feet to meters, multiply by 0.3048.

Source: LANL 2005b.

Figure E–8 Conceptual Cross-Section Across the Pajarito Plateau Along Pajarito Canyon

The geology of the regional aquifer was discussed above. Knowledge of the origin and depositional history of the rocks at LANL, coupled with groundwater sampling and aquifer testing, helps to determine the hydraulic properties of the regional aquifer. Single well tests of small volumes of rock have been conducted by withdrawing water from or injecting water into a well and measuring the rate of recovery of the original water surface. Multiple-well tests of large volumes of rock involve pumping a well and then making observations of the effects on nearby wells completed in the same interval. Extensive downhole geophysical studies are also a part of the deep-well program. Studies of rock properties and geochemical information with hydrologic testing results provide a basis for evaluating travel times and transport in the vadose zone (Keating, Robinson, and Vesselinov 2005). Summaries of these properties obtained from well tests, sampling programs, and analyses have been reported previously (Keating, Robinson, and Vesselinov 2005; Robinson, McLin, and Viswanathan 2005; Birdsell et al. 2005). Potentiometric maps, hydraulic gradients, and permeability data for the regional aquifer have also been discussed (Keating, Robinson, and Vesselinov 2005).

E.6.2.1 Alluvial Groundwater

Alluvial groundwater in the LANL area primarily occurs in canyons that originate in the Sierra de los Valles or in the Pajarito Plateau watersheds. Groundwater in the canyons is supported by seasonal runoff from the mountains, by episodic precipitation events on the plateau, perennial springs, and by discharge from LANL outfalls. Liquid wastewater from LANL released to the outfalls above the canyons was responsible for contamination of alluvial groundwater in the past. The wastewater also plays a part in the hydrogeology of the canyons.

As mentioned above in the stratigraphy section, the canyon floors are covered with alluvium of variable thickness and consist of fluvial sands, gravels, and cobbles. The alluvium is derived from the mountains to the west and from rocks that have been incised by the ephemeral and intermittent streams that formed the canyons (parts of some canyon streams have perennial flow). The alluvium is intermingled laterally with colluvium from the canyon walls. Groundwater in the canyons occurs above permeability barriers at the base of the alluvium above the Bandelier Tuff or above well-sorted tight sequences of canyon floor alluvium. Seasonal variation in the amount of snowmelt or storm runoff affects the saturated thickness and lateral extent of alluvial groundwater.

E.6.2.2 Deep Perched Groundwater

The extent and nature of deep perched water beneath Pajarito Plateau has been investigated to determine whether the alluvial systems on the plateau are in communication with the deep perched water or the regional aquifer and whether there is a potential for contaminants to travel to the regional groundwater (Robinson, Broxton, and Vaniman 2005). At the time of the investigation, 33 perched water zones had been identified in 29 wells. The study defined perched water "as a hydrologic condition in the rock or sediment above the regional aquifer in which the rock pores are completely saturated with water." Perched water may occur because of capillary barriers or because of low permeability barriers coupled with structures in the stratigraphic section. For example, faults may intersect hydraulically conductive zones with low permeability materials and block flow paths. Another cause may be that, when a saturated zone becomes unsaturated due to a decline in water level, water may become trapped in a zone of high permeability where it is unable to move to the new level.

The perched zones at LANL do not have enough water to warrant putting in municipal water supply wells, but the perched groundwater zones are important for four reasons: (1) the water is protected under state law; (2) transport rates through the unsaturated rocks are affected by the chemistry of the perched zones; (3) the zones restrict vertical movement of groundwater or may indicate the presence of fast-paths; and (4) the zones can be used for monitoring movement of groundwater toward the regional aquifer (Robinson, Broxton, and Vaniman 2005). The deep, perched zones get water from surface and alluvial groundwater associated with the large canyons that head in the Sierra de los Valles; deep, perched water below the smaller canyons on the plateau can also be recharged by liquid effluent from LANL. The deep, perched water zones have a saturated thickness ranging from 100 to 400 feet (30 to 120 meters) (Robinson, Broxton, and Vaniman 2005).

Perched water bodies are important elements of the hydrogeology of the site for several reasons. There is a probability that the zones can intercept contaminants being transported downward through the vadose zone. The perched water can be a permanent or long-term residence for contaminants because the chemical makeup of the rocks may result in adsorption. Perched water can also serve as a place where dilution occurs, lowering the concentration of contaminants. There is a possibility that perched zones may be intersected by streams in the lower parts of the canyons, resulting in lateral flow under the influence of gravity out of the canyon walls into the alluvial aquifer and subsequently to the Rio Grande.

E.6.2.3 Regional Groundwater

The regional aquifer below LANL is very deep (up to 1,200 feet [360 meters]) and is separated from the surface by a thick vadose zone with some perched water zones (Keating, Robinson, and Vesselinov 2005). The depth to the water of the regional aquifer on the eastern part of the plateau near the rim of White Rock Canyon is about 614 feet (200 meters), about 210 feet (65 meters) above the level of the Rio Grande (Broxton and Vaniman 2005). It has been reported that a well drilled in the lower Los Alamos Canyon near the Rio Grande flowed to the surface when installed in the regional aquifer, indicating confined or semi-confined conditions, and that there are seeps and springs in White Rock Canyon (Broxton and Vaniman 2005).

Sedimentary bedrock units at the top of regional saturation zones below the Pajarito Plateau at LANL include the Puye Formation (Tpf), pumiceous deposits (Tpp), older fanglomerate (Tf), and Tesuque Formation (Ts). The volcanic rocks in which groundwater occurs are the Cerros del Rio basalts (Tb4), the Tschicoma Formation (Tt), and Miocene basalt (Tb2) (Broxton and Vaniman 2005). Groundwater recharge to the regional aquifer under the Pajarito Plateau comes from underflow from the Sierra de los Valles and from drainages across the plateau (Kwicklis et al. 2005). The stratigraphy of the rocks is discussed in Section E.5. The most productive wells on the plateau occur in the central part of the plateau within the basin fill deposits consisting of the Puye Formation, the pumiceous deposits, the Totavi Lentil, the older fanglomerates, and the Tesuque Formation. The wells have screens up to 1,600 feet (500 meters) long spanning these units (Broxton and Vaniman 2005). The Tesuque is the primary productive unit in the eastern part of the plateau, in Guaje Canyon, and in the lower Los Alamos Canyon.

E.6.3 Hydrogeologic Units

Basal Confining Units

The rock units that occur below the regional aquifer are considered to be all of the units below the Tesuque Formation, including Precambrian igneous and metamorphic rocks, Paleozoic and Mesozoic sedimentary rocks, and mid-to-upper Tertiary terrestrial sediments.

Santa Fe Group Rocks

Hydrologic unit Ts is generally considered to be equivalent to the Tesuque Formation. The lithology of the unit is silty to sandy with some basalt and flow breccias (Tb1). The basalts are about 11 to 13 million years old and have intercalated sedimentary units. Water supply wells in the lower Los Alamos Canyon completed in this unit yield about 600 gallons per minute (2,200 liters per minute), and in the western part of LANL where the Ts is coarser, supply wells yield about 1,000 gallons per minute (3,800 liters per minute). Flow in the volcaniclastics and altered basalts is associated with fractures; the interflow breccias are plugged with secondary minerals (Broxton and Vaniman 2005).

Older Fanglomerate

This hydrogeologic unit (Tf) is a thick sequence of gravel and cobble beds and interbedded sandstones. It has been identified as the most productive zone (1,000 gallons per minute [3,800 liters per minute]) in the LANL area. The Tf is vertically heterogeneous and anisotropic because of the bedding, but may be strongly isotropic in the lateral direction. Reinterpretation of earlier well logs puts the contact with the Ts at the transition zone where coarse grain gravels and cobbles overlay sands and silts (Broxton and Vaniman 2005). Basalts (8.4 to 9.3 million years old) and intercalated sedimentary rocks in the Tf are designated as Tb2. Hydrologic unit Tk is intertongued with the Tf and is made up of Keres Group volcanic rocks.

Hydrologic unit Tpt represents the Totavi Lentil and older river deposits that make up a poorly consolidated conglomerate. Data from one water production well completed in this interval show that 18 percent of the water produced comes from only 2.5 percent of the screened interval (Broxton and Vaniman 2005). The hydrologic unit Tpp below the Tpt is a well-stratified, heterogeneous, pumice-rich, volcaniclastic rock. It is fine grained and more porous than the more coarsely grained overlying and underlying hydrologic units. The unit is anisotropic because, vertically, the alternating fine grained bedding is less hydraulically conductive than in the lateral direction. These pumice rich rocks also have a lower bulk density than Tpt and Tf (Broxton and Vaniman 2005; Birdsell et al. 2005).

Beneath the pumice deposits is the hydrologic unit Tpf that is similar to, but predates, the lacustrine deposits of the Puye Formation (Birdsell et al. 2005). The lacustrine deposits are equivalent, which may indicate that the rocks are contemporaneous (Broxton and Vaniman 2005). The Tpf is a deposit of coalesced alluvial fans and consists of much coarser material than the Tpp; like the Tpp, however, it is heterogeneous and anisotropic. Vertically, heterogeneity is due to layering; laterally, it is due to cross-cutting and variable grain size characteristic of fluvial deposits in an alluvial fan environment. It has been hypothesized that the hydraulic conductivity in the vertical direction is less than the hydraulic conductivity in the horizontal direction parallel to the bedding planes (Broxton and Vaniman 2005).

Basaltic Rocks of the Cerros del Rio Volcanic Field

The heterogeneous hydrologic unit Tb4 basalts are intercalated with subordinate amounts of upper Puye Formation and constitute the top of the regional aquifer at the southeast corner of LANL (Birdsell et al. 2005; Broxton and Vaniman 2005). As noted above, these basalts are exposed on the east side of the Rio Grande. In the LANL region, the basalts are located under the central and eastern part of the Pajarito Plateau. The connected porosity of the highly brecciated clinker and scoria zones and sediments at the tops and bottoms of the stacked lavas may extend for hundreds of yards or may be limited in some areas where the voids are filled with clay minerals (Birdsell et al. 2005; Broxton and Vaniman 2005). The dense lava flow interiors are impermeable, with flow of gases and liquid water restricted to fractures. Flow in the scoriated breccia zones is lateral along the beds and mostly vertical in the interflow zones.

Bandelier Tuff

The stratigraphic divisions presented in Table E–1 were retained for the hydrologic units because the rock properties for the stratigraphic subunits are laterally ubiquitous and traceable throughout the plateau (Broxton and Vaniman 2005). This section presents the hydrologic units of the Bandelier Tuff with descriptions from oldest to youngest (Broxton and Vaniman 2005, Birdsell et al. 2005, Springer 2005).

Ash-flow tuffs and fall deposits (the Guaje Pumice Bed) of the Otowi Member are hydrologic units Qbog and Qbo, respectively. Qbo is uniform with respect to vertical density and density-porosity profiles in the central and eastern parts of the plateau, but is more variable in the west where changes are more abrupt (Broxton and Vaniman 2005). The ash-flow tuffs of the Otowi do not have pervasive cooling joints found in the welded tuffs in the upper Bandelier (Birdsell et al. 2005). The Guaje Pumice Bed (fall deposits) at the base of the Otowi Member is designated hydrologic unit Qbog. It is well sorted and stratified; has less matrix ash than the other Bandelier units; and is an excellent marker bed between the Bandelier Tuff and the units below it.

The stratified volcaniclastic deposits of the Cerro Toledo Interval are designated as hydrologic unit Qct. Because the unit consists of rocks that are variable in grain size, sorting, and bedding thickness, a strong vertical anisotropy exists above Qct within the Bandelier (Broxton and Vaniman 2005). These characteristics provide a favorable setting for perched groundwater.

The upper Tshirege Member is a complex hydrologic unit of welded ash-flow tuffs separated by poorly welded tuffs and a basal unit of pumice fall deposits. The welded tuffs have joints and fractures caused by cooling and tectonic processes that die out in the nonwelded layers (Birdsell et al. 2005). The basal hydrologic unit Qbt t is equivalent to the Tsankawi Pumice Bed (Broxton and Vaniman 2005). Unit Qbt t is overlain by hydrologic subunits Qbt 1g and Qbt 1v. Qbt t and Qbt 1g are the only ash and pumice falls in the Tshirege that are made up of similar, unaltered volcanic glass.

Volcanic glass above Qbt 1g in hydrologic unit Qbt 1v has undergone post-depositional devitrification and vapor-phase crystallization. These processes may affect grain size and decrease effective porosity by creating poorly connected pore spaces (Broxton and Vaniman 2005). Unit Qbt 1vc is indurated and poorly welded with a system of well-developed columnar joints. Unit Qbt 1vu is generally nonwelded to partly welded, but lacks extensive jointing (Broxton and Vaniman 2005, Birdsell et al. 2005).

Hydrologic unit Qbt 2 is separated from the altered beds of unit Qbt v by a thin pyroclastic surge bed in the eastern part of the Pajarito Plateau; but in other parts of the plateau, Qbt 1v grades into Qbt 2. In the western part of the plateau, density and density-porosity profiles indicate that Qbt 2 has a cooling break present at its center. The break is not present in the eastern part of the plateau. Upper Qbt 2 is strongly welded, becomes less welded down-section, and has higher bulk densities than other Tshirege units.

Hydrologic unit Qbt 3 is strongly welded in the western part of the plateau and becomes less welded eastward. The strongly welded interior of Qbt 3 has a high bulk density and low density porosity. Hydrologic unit Qbt 4 is a nonwelded to strongly welded unit and is present only in the western Pajarito Plateau.

E.7 Conceptual Models

Potential contamination of the regional aquifer below LANL is of major concern. It is the responsibility of LANL to determine whether past contaminant releases pose a threat to human health. Flow and transport mechanisms through the vadose zone are being examined. This section discusses recent papers in the *Vadose Zone Journal* published on August 16, 2005. The papers collectively describe the work that has been completed or contemplated for the purpose of developing conceptual models of the hydrogeology and numerical models of groundwater flow and transport under the Pajarito Plateau in general and under LANL in particular. The journal articles summarize extensive observational data regarding deep perched water on the plateau and discuss the controls on the distribution of deep perched water and the ways perched zones may develop (Robinson et al. 2005). There is a description and a numerical model of the regional aquifer below the Pajarito Plateau that is used for determining fluxes and transport (Keating, Robinson, and Vesselinov 2005). There is a report on net infiltration on the plateau, which is a major concern when modeling groundwater flow under LANL and streamflow on the plateau (Kwicklis et al. 2005). A comprehensive discussion of a statistical analysis of hydrologic properties also is presented (Springer 2005). Several articles discuss the roles of matrix and fracture flow within the Bandelier Tuffs and basalts (Robinson, Broxton, and Vaniman 2005, Levitt et al. 2005, Stauffer and Stone 2005). There is also a summary paper that describes the hydrogeologic setting and site history of LANL (Newman and Robinson 2005).

Conceptual models constantly change as knowledge about hydrologic processes and events that control groundwater movement increases for a particular site. The following section includes a discussion of the conceptual models, numerical model development, modeling results, and conclusions. The papers are presented in the order of the hydrostratigraphy of the region: the vadose zone; the deep perched zones; and the regional aquifer.

E.7.1 Geochemical Conceptual Model

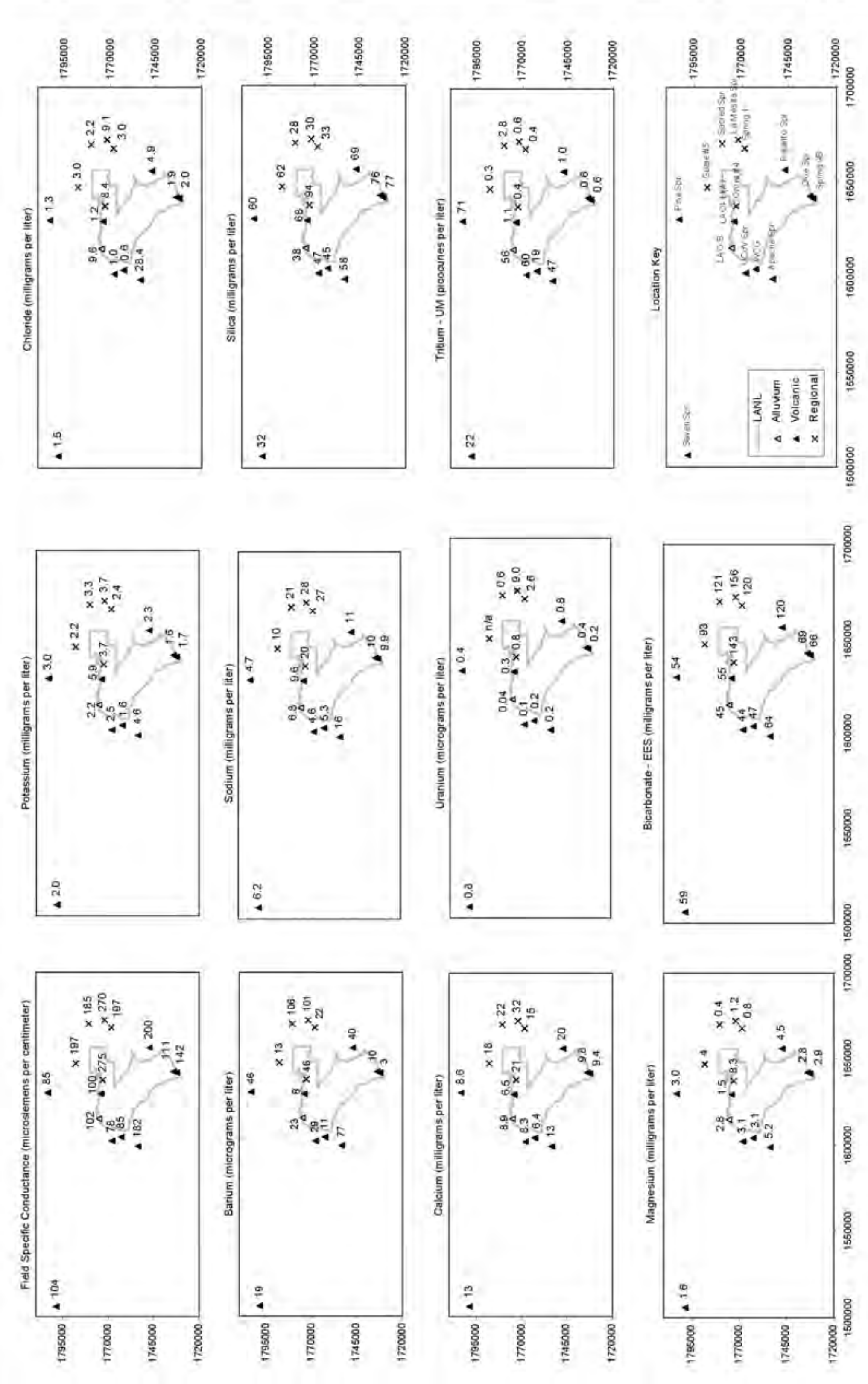
This section is a discussion of the geochemistry of the groundwater in the LANL region as presented in *Los Alamos National Laboratory's Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998-2004) (Hydrogeologic Synthesis Report)* (LANL 2005b). First, the *Hydrogeologic Synthesis Report* discusses a geostatistical methodology of reducing the data from many sources outside the area that might have been contaminated and develops a groundwater chemistry baseline. Second, it presents conceptual models of each reach of canyon drainage that is thought to be unique in its natural and artificial flow and its contaminant transport history. Third, alternative models of contaminant transport to the perched water bodies and the regional groundwater are presented to relate the contaminant concentrations, recharge, and transport processes to probable sources, predominantly the canyon bottom alluvial aquifers. Last, it presents a discussion of conceptual models of the hydrogeology and geochemistry of the canyon springs.

The discussion of the components of geochemical conceptual models was broken into seven parts in the *Hydrogeologic Synthesis Report*. The components are:

- Natural geochemical composition of groundwater,
- Residence time of contaminant ions in the perched alluvial aquifer and the rocks of the vadose zone,
- Reactive minerals controlling groundwater composition and solute mobility,
- Adsorption and precipitation reactions,
- Redox conditions,
- Chemical speciation, and
- Colloids.

Natural Composition of Groundwater

Groundwater sampling to establish a baseline (background) of the chemistry of groundwater in the LANL area was conducted from 1997 to 2000. The composition of natural groundwater in the LANL area ranges from calcium-sodium bicarbonate water at the Sierra de los Valles to sodium-calcium bicarbonate water east and northeast of LANL. Sodium bicarbonate groundwater occurs in deep wells in the lower Los Alamos Canyon and along the Rio Grande and in springs in White Rock Canyon (LANL 2005b). This characterization of the natural groundwater permits the discrimination of natural components in the groundwater from manmade contaminants. **Figure E–9** shows the average concentrations of solutes, including specific conductance, major cations and anions, silica, tritium, and several trace elements such as uranium and barium from six sampling rounds.



Source: LANL 2005b.

Figure E–9 Average Spatial Distribution (n=6) for Key Analytes in Los Alamos National Laboratory Background Wells and Springs

Residence time

Residence time refers to the distribution of the ages of groundwater in the various groundwater environments under the Pajarito Plateau. Determining the residence time helps determine transport rates through the rocks. The residence time of natural major ions and trace elements in natural groundwater under the Pajarito Plateau increases from west to east and with depth in all modes of groundwater occurrence. Measurements of tritium in groundwater from within the Sierra de los Valles fractured volcanic rocks indicate that the groundwater is less than 60 years old; however, groundwater in the discharge area at White Rock Canyon ranges from 3,000 to 10,000 years old (LANL 2005b). Carbon-14 dating of regional groundwater in the LANL area indicates that a component of the groundwater is several tens of thousands of years old, becoming older from west to east. The presence of tritium indicates that younger water is mixing with the older water. Future studies are planned to determine the fractions of young and old water (LANL 2005b).

Reactive minerals

Groundwater reacts with the minerals in rocks through which it passes or in which it is stored. These reactions control basic chemical conditions such as pH and influence mineral precipitation and dissolution, as well as sorption of ions from groundwater by minerals. These are important controls on the evolution of groundwater as it migrates and on the mobility of contaminant ions.

In the natural groundwater, sodium, calcium, and bicarbonate are the most abundant major ion solutes. Silica is the second most abundant due to the interaction of volcanic glass with the groundwater. Average concentrations of natural arsenic and fluoride were highest in the Cerros del Rio basalts. Average concentrations of dissolved natural barium, boron, bromide, strontium, and uranium in the regional aquifer were highest at La Mesita Spring. Silica-rich rocks such as the Bandelier Tuffs contain more natural uranium than the basalts, which are silica-poor. Uranium in trace minerals such as zircon may exceed 1,000 parts per million, but zircon is highly refractory and has a low aqueous solubility ($10^{-15.4}$ molar at pH 7); consequently, it does not dissolve readily in the natural groundwaters at LANL. Some uranium is associated with volcanic glass in the Bandelier Tuff. In comparison with zircon, volcanic glass has a higher aqueous solubility ($10^{-27.1}$ molar at pH 7), but a low concentration of uranium. Therefore, even though the leachability is higher for volcanic glass, the concentration of uranium in perched water in the Bandelier Tuff is low (LANL 2005b).

Dissolved organic carbon is a component of groundwater derived from leaching solid organic matter from forests and grasslands. At LANL, organic matter is found in the perched water in the intermediate zones and in the regional aquifer and is typically less than 2 milligrams of carbon per liter. Higher concentrations are found in alluvial groundwater, soil, and surface water (20 milligrams of carbon per liter) (LANL 2005b). Ash from the Cerro Grande Fire in May 2000 increased the amount of leachable carbon in the LANL area. The increased concentration of total organic carbon can be used as a tracer for tracking recharge. Perched zones in the Cellos del Rio basalt in Los Alamos Canyon have exceeded 300 milligrams of carbon per liter.

Calcite, smectite, hydrous ferric oxide, manganese hydroxide, and zeolites are highly adsorptive for trace elements including chromium, lead, strontium, and thorium. As groundwater flows through the intermediate perched zones, the soluble silica glass that is present reacts with the groundwater and forms clay minerals, including kaolinite and smectite. Smectite increases the adsorption capacity of aquifer material under circumneutral (6.5 to 7.5) pH conditions. These interactions are only partially known in the specific groundwater environments beneath the Pajarito Plateau, but knowledge is expanding as new programs are being incorporated.

Adsorption and Precipitation

Adsorption and precipitation are the principal mechanisms that retard the transport of contaminants and keep them in residence in the vadose zone. These reactions are well documented for most of the contaminant ions present under the Pajarito Plateau. The specific groundwater environment in terms of pH and parallel mineral reactions are important controls on sorption and precipitation reactions. Definition of those relationships is an interactive process that is underway in the areas of specific concern at LANL (LANL 2005b). Geochemical processes increase concentrations (measured as total dissolve solids) of trace elements downward from the alluvial aquifer to perched water and on to the regional aquifer from west to east due to residence time and rock and water interactions such as adsorption-desorption (LANL 2005b). Relatively fresh water in the form of precipitation recharges the groundwater at the Sierra de los Valles and reacts with the rocks as it moves along flow paths, becoming more mineralized toward its discharge points. Notice in Figure E-9 that tritium decays along the flow path from west to east and that the concentration decreases within the noncontaminated intermediate perched water and the regional aquifer.

Redox Conditions

Redox condition refers to whether the local groundwater conditions are oxidizing or reducing. This influences mineral stability and sorption reactions and is another aspect of groundwater chemistry that controls contaminant mobility. As mentioned above, uranium is a naturally occurring trace element found in groundwater below the Pajarito Plateau. It is processed at LANL and is discussed at length in the *Hydrogeologic Synthesis Report* (LANL 2005b). As stated above, some other natural components of groundwater are calcium, bicarbonate, and silica compounds. The *Hydrogeologic Synthesis Report* (LANL 2005b) concludes that the temperature, pH, redox potential, and dissolved activities of the ions mentioned influence precipitation and dissolution of uranium compounds. These conclusions were based on geochemical calculations and the oxidizing conditions of natural groundwater beneath the Pajarito Plateau. The *Hydrogeologic Synthesis Report* (LANL 2005b) also concluded that, although it is useful to perform saturation index calculations to evaluate mineral equilibrium, most of the deep groundwaters are not in equilibrium with respect to the uranium compounds. Based on the results of the calculations they presented, adsorption processes appear to control dissolved concentrations of uranium in groundwater.

Chemical Speciation

Ions can exist as various stable isotopes and as parts of stable compounds (some organic) in groundwater. The form in which each contaminant ion exists influences its entry into precipitating minerals or sorption, and thus influences its mobility (LANL 2005b).

Colloids

The role of colloids in transport of contaminants at LANL is largely unknown and uninvestigated.

E.7.1.1 Contaminant Distributions

Anthropogenic contaminants in the groundwater at LANL generally derive from liquid effluent disposal into canyons or from surface impoundments on the mesa tops rather than from solid waste disposal. (Most solid waste disposal sites are located on mesa tops where there is little natural or artificial percolation to carry anthropogenic constituents to groundwater.) These effluents have degraded shallow perched water in some canyons (LANL 2005b). Canyons that have received radioactive effluent include Mortandad Canyon, Pueblo Canyon from its tributary Acid Canyon, and Los Alamos Canyon from its tributary DP Canyon. Effluents from high explosive processing and experiments contributed effluent to Water Canyon, its tributary Cañon de Valle, and Pajarito Canyon. Los Alamos County and the LANL contractor have operated sanitary treatment plants over the years (**Figure E–10**).

Effluent releases have impacted alluvial groundwater and in a few cases perched groundwater at depths of a few hundred feet. Little contamination from the perched groundwater zones under the mesas reaches the deep regional groundwater because the perched water is separated from the deep aquifer by hundreds of feet of unsaturated rock. LANL contaminants are found in groundwater below the alluvial aquifers in some canyons or below mesa tops where large retention ponds were located or where there were large-quantity discharges to the surface (LANL 2005b). The *Hydrogeologic Synthesis Report* (LANL 2005b) contains a summary of monitoring data by watershed and groundwater zone.

Observation of contaminant data and knowledge of geochemistry and the history of releases of contaminants provides a method of determining the rates and modes of groundwater flow through the subsurface to the regional aquifer. Nonreactive chemicals and compounds like tritium, perchlorate, and nitrate are used to determine how groundwater moves through the rocks. Some compounds or constituents (uranium, strontium-90, barium, some high explosive compounds, and solvents) are slowed by adsorption, precipitation-dissolution, oxidation-reduction, or radioactive decay, and some constituents (americium-241, plutonium) are strongly absorbed onto sediment and are nearly immobile (LANL 2005b).

Alluvial groundwater does not extend beyond LANL boundaries and has a short residence time. Tritium studies have shown that there is a rapid turnover of alluvial groundwater volume in the alluvial aquifers in the canyons and that contaminants do not accumulate. Since effluent limits were adopted in 2001, LANL has improved effluent quality and the once high values of tritium contamination are not present today. Since that time, tritium activity is barely detectable in Pueblo Canyon, DP Canyon, and Los Alamos Canyon and is below the maximum contaminant level in Mortandad Canyon.

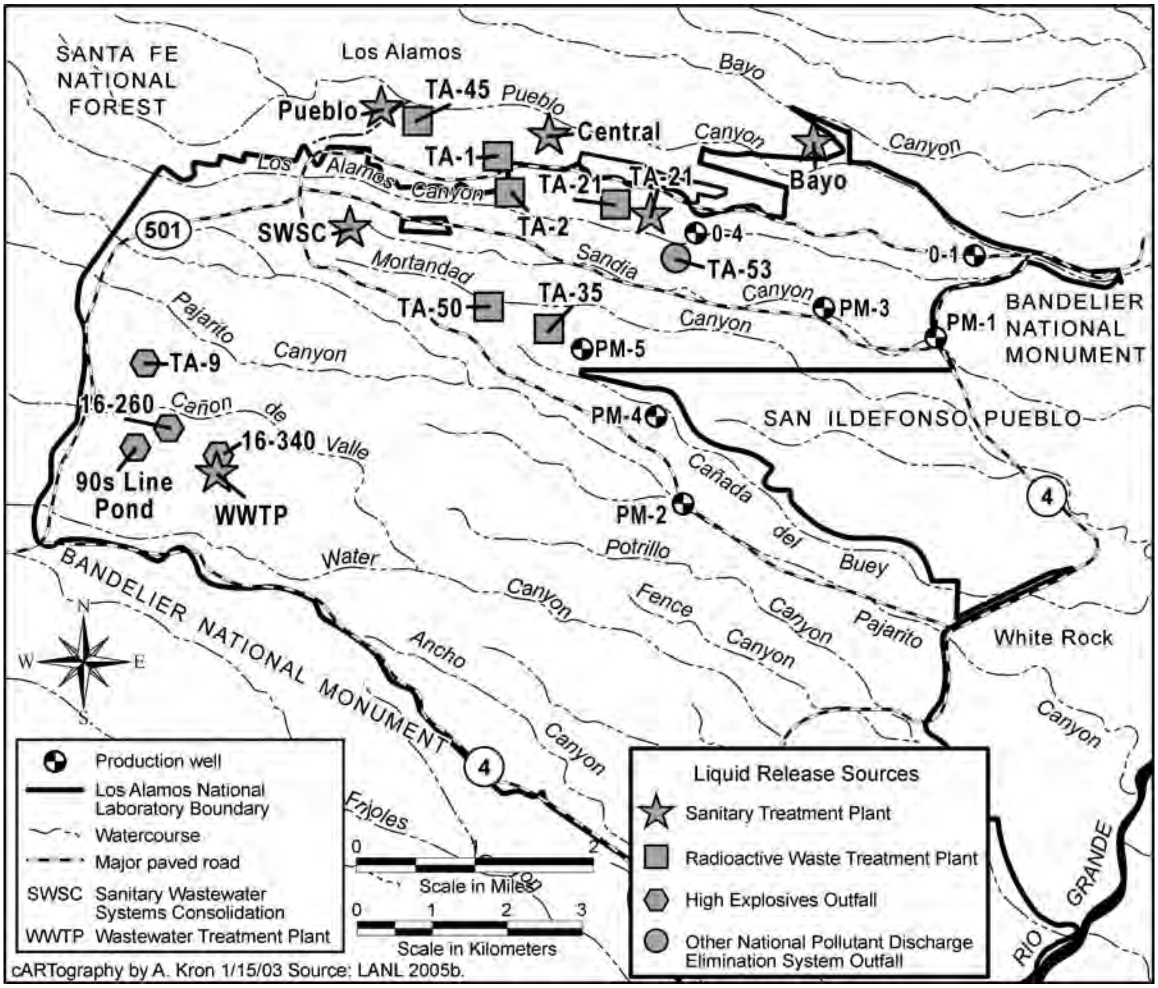


Figure E–10 Major Liquid Release Sources that have Potentially Affected Groundwater at Los Alamos National Laboratory (most of these are now inactive)

As mentioned above, perched groundwater is separated from alluvial groundwater by several hundred feet of unsaturated rock; even though recharge occurs slowly, contaminants in alluvial groundwater may reach the intermediate perched groundwater. Contaminant concentration data from the perched water zones below Mortandad Canyon indicate alluvial groundwater is the source of recharge to the intermediate groundwater by a process of infiltration (LANL 2005b).

The regional aquifer is separated from the intermediate perched groundwater by hundreds of feet of unsaturated rock. Recharge through these rocks to the regional aquifer occurs over a longer time than under the alluvial aquifers. Contaminants are found below alluvial groundwater in canyon bottoms or in perched water below mesa-tops where large amounts of effluents had been discharged to the surface. Tritium concentrations are much lower than values found in alluvial or intermediate groundwater due to dilution or to radioactive decay (LANL 2005b). Some high values are found in conjunction with effluent discharges near the liquid radioactive waste treatment plants shown in Figure E–10, at a past tritium disposal site (R-22 near Material Disposal Area G), and at a spring that had a value of 45 picocuries per liter, which may be due to a component of surface water because it is similar to rainfall and Rio Grande data (LANL 2005b).

Four alternative models are presented in the *Hydrogeologic Synthesis Report* (LANL 2005b). The models are described and examined to identify the strengths and weaknesses of the possible interpretations of available data. There is also a discussion of how the alternative models would change the current conceptual model and how the alternatives could be tested.

E.7.2 Geohydrologic Conceptual Model

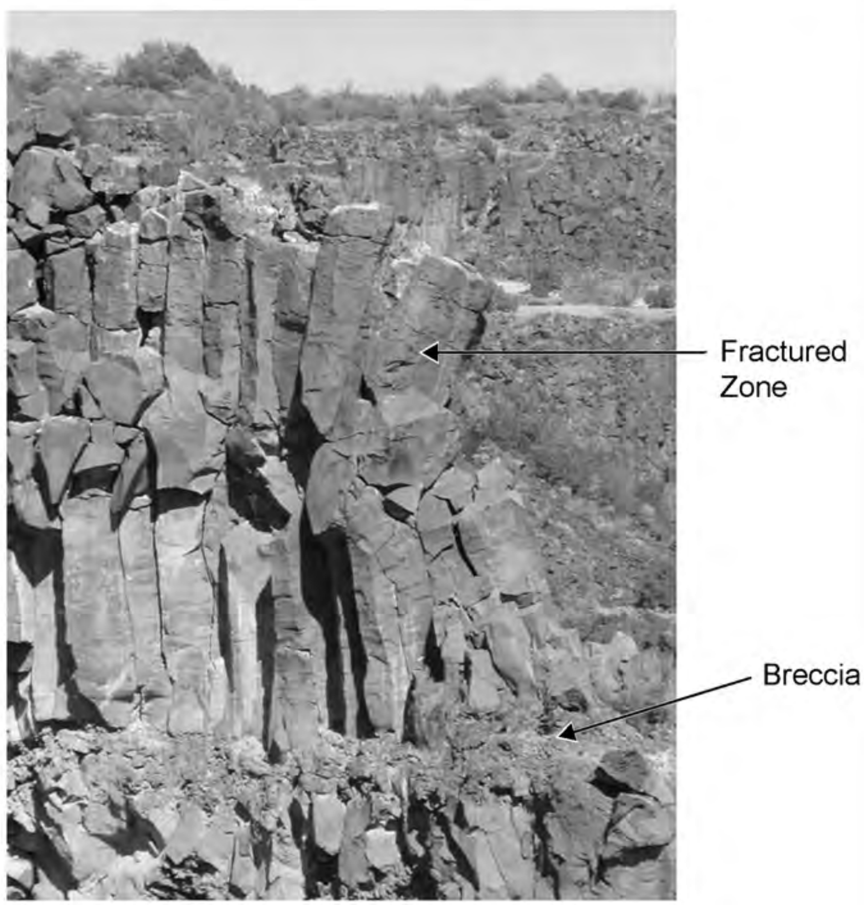
A conceptual model of the geohydrologic system at LANL is used for most numerical simulations by LANL workers and others (Robinson et al. 2005; Robinson, McLin, and Viswanathan 2005; Robinson, Broxton, and Vaniman 2005; Birdsell et al. 2005; Stauffer and Stone 2005; LANL 1995). The conceptual model was developed and supported based on field data. This section describes the components of the conceptual model and how they fit into the conceptual model.

Topography and Surface Water Setting. Deep canyons that begin in the Sierra de los Valles have large catchment areas, frequent surface flow, and perched alluvial groundwater (Birdsell et al. 2005). The wet canyons receive discharge from outfalls and wastewater treatment (anthropogenic water), as well as from infiltration of water from precipitation and shallow groundwater flow in the alluvium. Dry canyons originate on the plateau and have small catchment areas, infrequent flows, and no saturated alluvium in their floors. The dry canyons may display characteristics of the wet canyons if they receive anthropogenic water. In contrast to the wet canyons, there is little infiltration from these canyons. Mountain fronts receive more infiltration and this gives rise to localized perched water. Mountain front groundwater also flows laterally through fractures to nearby canyon walls, forming springs. As evidence for this conceptual model component, there are water budget studies (Kwicklis et al. 2005); moisture profile measurements and model simulations; major ion, stable-isotope, and contaminant concentration studies; and tracer tests in perched water for the mountain front case.

Anthropogenic Impacts. A second conceptual model component examines how anthropogenic activities significantly modified canyons and the intervening mesas of the Pajarito Plateau (Birdsell et al. 2005). Asphalt pavements have reduced evapotranspiration and built up subsurface moisture underneath. In addition, asphalt may focus runoff or may crack and cause infiltration where it may not have normally occurred. Effluent discharges to canyons from LANL or Los Alamos County sources have increased surface and groundwater flows, which have increased the infiltration rate to the vadose zone. In support of this component, water content measurements, contaminant transport measurements, and numerical simulations of paved areas and canyons influenced by LANL facilities are cited.

Flow and Transport Mechanisms. A third conceptual model component examines matrix and fracture flow transport mechanisms through the vadose zone to the regional aquifer (Robinson, McLin, and Viswanathan 2005; Birdsell et al. 2005; Springer 2005). Two principal hydrostratigraphic units with respect to vadose zone flow are the Bandelier Tuff and the Cerros del Rio basalts. Water movement in tuffs and basalts was examined. In poorly welded and fractured areas of the Bandelier Tuff, water moves into the fractures and is quickly absorbed into the high-permeability matrix; as a result, fractures play only a minor role in groundwater movement (Robinson, McLin, and Viswanathan 2005).

It was stated above that, at the Sierra de los Valles mountain front above the Pajarito fault zone west of LANL, the Bandelier tuffs are more densely welded than they are eastward under LANL toward the Rio Grande. Wellbore injection testing shows that water moves primarily in fractures of densely welded tuffs and basalts and is not absorbed as readily into the low-permeability rocks as it is into the fractures of poorly welded tuff (Robinson, McLin, and Viswanathan 2005; Birdsell et al. 2005). Typically, groundwater flow through basalts is controlled by cooling structures. Groundwater flow is vertical through the interior basalts where slow cooling occurred and columnar structures were formed with pronounced vertical fractures. **Figure E–11** is a photograph of the Cerros del Rio basalts below the Bandelier Tuff Otowi Member. Note the vertically fractured, dense interior columnar section and the more porous horizontal breccia zone. Groundwater flow is horizontal through these rapidly cooled breccias that make up the tops and bottoms of the basalt-flows. Groundwater flow is also horizontal in the interflow sediments. Perched water occurs in these porous brecciated zones underlying highly fractured basalt that overlies a massive unfractured flow interior (Birdsell et al. 2005). This conceptual model is supported by cited reports of water content measurements, major ion measurements, contaminant transport measurements, numerical simulations, field measurements at instrumented sites, and fluid injection tests (Birdsell et al. 2005).



Source: LANL 2005b.

Figure E–11 Outcrop of Cerros del Rio Basalt at White Rock Overlook (East of Los Alamos National Laboratory)

Vadose Zone Travel Times. Travel times in the vadose zone at LANL vary from several years to several decades. Travel time is shortest in fractured basalts, decades long where there are significant thicknesses of Bandelier Tuff, and in excess of thousands of years in dry canyons (Birdsell et al. 2005). The conceptual model was supported by numerical modeling of wet canyons (Robinson et al. 2005, as discussed in Section E.8.1), contaminant profiles in vadose zone boreholes, chloride and isotope profiles, and groundwater surveillance reports.

These conceptual model components provide a basis for numerical simulations of groundwater flow and transport through the vadose zone at LANL. Summaries of numerical modeling research at LANL are provided below.

E.8 Numerical Modeling Studies

This section describes numerical modeling activities by LANL workers. The numerical simulations mainly incorporate the conceptual model developed by Birdsell et al. (2005), as presented in the previous section.

E.8.1 A Vadose Zone Flow and Transport Model for Los Alamos Canyon, Los Alamos, New Mexico (Robinson et al. 2005)

Purpose: The purpose of this effort was to develop a large-scale numerical model to advance understanding of vadose zone flow and the transport of contaminants to the regional aquifer. This required applying a conceptual model to knowledge of the hydrostratigraphy, hydrologic conditions, and field measurements. Primarily, the purpose was to develop a numerical simulation of flow; but the transport of tritium in the form of tritiated water beneath Los Alamos Canyon was also modeled. Tritiated water is a good tracer and acted as a constraint on the numerical model (Robinson et al. 2005).

Conceptual Flow Model: The hydrologic system was characterized as an equivalent continuum model; that is, the model captured the characteristics of both the fractures and the matrix. The fractures are predicted to be dry until the capillary pressure of the matrix is a low value (saturated), fracture flow begins, and liquid permeability rises. The equivalent continuum model then behaves like a single continuum model (Robinson et al. 2005).

The infiltration rates used for the canyons and mesa tops were based on the Birdsell et al. (2005) conceptual model outlined above for wet canyons. Infiltration rates used in the simulation were calculated from previous studies using the rates from direct drainage from the alluvium to the vadose zone along the floor of Los Alamos Canyon (Birdsell et al. 2005). The highest rate (42.4 inches [1,076 millimeters] per year) occurs in the upper reaches of the canyon near the Guaje Fault zone where it is probably highly fractured due to faulting.

The source of contaminants used for this model was the Omega West reactor site that was used from 1943 to 1994 to house various reactors. Tritium was one of various radionuclides released into the canyon from a cooling water system leak discovered in 1993 that may have started in late 1969 or early 1970 (Robinson et al. 2005). It is used as a tracer because of its chemical state as a water molecule; it is not readily sorbed; and it does not precipitate out of solution or have complicated speciation processes.

Model Development: Information from 20 geological units was integrated into computational grids using a three-dimensional framework. Site-specific data from LANL's program of site characterization and their comprehensive drilling program, coupled with previous numerical modeling activities, were used for the framework. The accepted stratigraphic designation described previously was used (Broxton and Vaniman 2005). Los Alamos Canyon cuts deep into the Bandelier Tuff with the result that the Tshirege Member is not very thick at the canyon head and absent at the lower reach of the canyon. The Otowi Member is the first unit encountered below the canyon alluvium in much of the model domain. In the lower reach of the canyon, the Cerros del Rio basalts (Tb4) are below the alluvium.

Numerical Grids: The numerical model incorporated both two- and three-dimensional finite element grids. The model used was the Finite Element Heat and Mass code. This code was used because it was used in previous numerical modeling efforts at LANL for saturated and unsaturated flow and the code solved the equations needed for two-phase flow of air and water (Robinson et al. 2005; Birdsell et al. 2005). A two-dimensional grid was used for scoping and sensitivity analysis because it has a smaller number of nodes and elements and is computationally efficient.

Results: Model results suggest that the nonwelded and partially welded Bandelier Tuffs dampen episodic infiltration events; that is, the steady-state model shows that, if infiltration occurs all at once or is averaged over a year, the result yields a similar water content profile. Transients caused by anthropogenic activities over a decade or longer significantly affect predicted water content. Tritium transport modeling indicates that tritium has decayed and that most other contaminants released reside in the vadose zone. The model also suggests that, where the tuffs are absent, such as the lower Los Alamos Canyon near the confluence with Pueblo Canyon, there is a risk of contaminants getting to the regional groundwater.

E.8.2 Hydrologic Behavior of Unsaturated, Fractured Tuff: Interpretation and Modeling of a Wellbore Injection Test (Robinson, McLin, and Viswanathan 2005)

Purpose: This study interprets and models a reported injection test in the Tshirege Member of the Bandelier Tuff and examines different conceptual models. Four conceptual models were developed for flow and transport in fractured tuffs utilizing data from an early injection test in the Tshirege Member of the Bandelier Tuff.

Model Development: The first conceptual model tested was a single continuum model where fractures play no role in flow and transport. A second conceptual model was an equivalent continuum model that captures characteristics of both fractures and matrix. The third conceptual model was a dual-permeability model where it is assumed that the fractures and matrix represent two separate, but coupled, continua. The fourth conceptual model was a discrete fracture model that represents the fractures with distinct hydrologic properties within a model domain that includes the rock matrix. A numerical simulation was then run for each conceptual model. For kilometer-scale simulations, basalts are considered by some workers as a homogeneous continuum with a high permeability and low porosity (Stauffer and Stone 2005).

The same numerical grid, boundary conditions, and hydrologic properties were used for all of the numerical simulations of the conceptual models except for the discrete fracture model. For the discrete fracture model, idealized calculations were performed to develop a mechanistic explanation of how the hydrologic behavior of the tuffs changes when water is injected into a dry fracture.

Results: The study results suggest that flow and transport in the tuffs is through the matrix rather than fractures. This is the result of the high matrix permeability of the tuff. The matrix-dominated flow decreases travel velocities and increases retardation by sorption. Sorption is increased because more water comes in contact with the rock by absorbtion into the rock rather than by contact with the walls of a fracture. Rocks with rather high capillary suction properties would be expected to result in more lateral movement and spreading of a plume.

E.8.3 Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau (Keating, Robinson, and Vesselinov 2005)

Purpose: This study integrates new site-wide data into a model of the regional aquifer beneath the plateau and provides new insight into large-scale aquifer properties. This aquifer is the primary source of water for Santa Fe, Española, Los Alamos, various Pueblos, and LANL. There is a concern about dropping water levels because in 2002 there was a decrease in baseflow to the Rio Grande. There is also a concern that water quality is decreasing because of contamination from LANL sources. This study provides a comprehensive literature review for the aquifer and supplements it with interpretations of new data. This appendix synopsis of the study includes other supporting citations.

Recharge and Discharge: This study (Keating, Robinson, and Vesselinov 2005) discusses and cites various concepts of recharge to the regional aquifer. Early workers thought recharge occurred at various places: Sierra de los Valles, along stream channels on the western edge of the Pajarito Plateau, and in Valles Caldera. Water chemistry did not support these concepts. It was then proposed by various workers that recharge areas were either from the Sangre de Cristo Mountains to the east or from the north and east, but not from the west. Water balance and chloride mass-balance analyses indicate that basin recharge does occur in the mountains at the margins of the basins. Findings based on stable isotope ratios suggest that recharge to groundwater under Pajarito Plateau is from Sierra de los Valles and very little is from Valles Caldera (LANL 2005a). Some recharge is also from streamflow infiltration along arroyos and canyons on the plateau and some recharge, although volumetrically small compared to mountain recharge, is from the surface of the mesas. This study (Keating, Robinson, and Vesselinov 2005) reports that tritium data indicate that water below LANL is relatively young and derives from fast-path flow through the vadose zone. Tritium studies in groundwater discharging from springs within the Sierra de los Valles indicate that the water is about 60 years old. However, groundwater from springs in White Rock Canyon has no tritium and probably ranges in age somewhere between 3,000 to 10,000 years (LANL 2005a).

Discharge of groundwater from under the plateau is assumed by many workers to be to the Rio Grande at White Rock Canyon and may occur as lateral flow, upward flow, or flow from springs. One hypothesis being explored is that the springs come from draining perched aquifers. A second hypothesis is that discharge of groundwater from the regional aquifer may also be southeasterly to the lower Albuquerque Basin, but a structural high at the boundary of the

Española Basin and the Albuquerque Basin may be impeding flow. This would cause interflow upward to the surface. This hypothesis has not been resolved because no studies have been conducted in the lower part of the Española Basin (Keating, Robinson, and Vesselinov 2005).

Aquifer Properties: The hydrostratigraphic units were described above. It is apparent that the units are complex because of the tectonic, volcanic, and sedimentary processes that occurred in the LANL region. Santa Fe Group and Puye Formation rocks are made up of intertonguing alluvial fans separated by layers of volcaniclastics, lava deposits, breccia zones, and other materials, resulting in vertically anisotropic conditions. This is supported by short-term well tests where permeability data are derived from production wells with large screened intervals. The well test results show permeability perpendicular to bedding planes is less than permeability parallel to bedding planes (Keating, Robinson, and Vesselinov 2005). Anisotropy may also be the result of the numerous north-south faults in the basin interfering with spatial continuity of low- or high-permeability rocks. For instance, a layer may look as if it has good permeability, but when tested on a large scale, it may appear to have a poor hydraulic connection to other parts of the same unit because it is interrupted by a low-permeability fault zone.

Several conceptual models regarding the regional aquifer have been developed. The complex geologic structures and data from well tests have several interpretations. Earlier workers postulated the Santa Fe Group is under water table conditions near the Sierra de los Valles and becomes confined eastward. Specific storage data indicate that parts of the aquifer exhibit "leaky-confined" conditions because of semi-confining layers of rocks. Another conceptual model proposes that the anisotropic condition of the aquifer interferes with vertical movement of groundwater, making it appear to be confined during short-term pumping tests. A third conceptual model is that a laterally extensive low-permeability layer confines the lower part of the aquifer and is overlain by groundwater under water table conditions.

Model Development: Three numerical models were integrated: a three-dimensional hydrostratigraphic framework model, a three-dimensional numerical flow and transport model (based on the Finite Element Heat and Mass Transfer Model discussed above), and a model of recharge based on precipitation data. The model incorporates no-flow boundaries at the Santa Clara River to the north, the Valles Caldera to the west, the Rio Frijoles to the south, and the Rio Grande to the east. The upper boundary represents the top of the saturated zone, which has a constant thickness throughout the simulation. The eastern edge of the upper boundary of the model is the Rio Grande and has a specified head. The Buckman well field is a transient flux (sink) to simulate production.

Results: Groundwater flow in the numerical model was to the south-southeast and generally fits the conceptual models of flow. Calculated heads near wells R-9, R-12, R-22, and R-16 were not matched well with actual heads. The model showed that transport calculations would benefit from a refinement of the hydrostratigraphic framework. It was felt that a low-permeability layer separating the upper aquifer from the lower aquifer would allow a closer match of the calculated heads and fluxes with actual data. Calculated total recharge to the aquifer was within the range of early estimates and does occur to the west. The simple recharge model demonstrated that production water is coming from storage from the deeper zones in the aquifer rather than from the shallow zones that receive water from local recharge. Parameter uncertainty impacts the ability to make predictions of fluxes and velocities through individual units downgradient from

LANL. Estimated pore-water velocities varied from 3.3 feet per year (1 meter per year) to 415 feet per year (125 meters per year) in the deep Miocene basalt unit Tb2. This makes predictions of lateral contaminant movement difficult where the basalts are present and brings up the possibility that contaminants may have traveled a significant distance laterally (Keating, Robinson, and Vesselinov 2005). Uncertainties about porosity and permeability also lead to model uncertainty.

E.8.4 Observations and Modeling of Deep Perched Water beneath the Pajarito Plateau (Robinson, Broxton, and Vaniman 2005)

Purpose: The purpose of this study was to perform numerical simulations using vadose zone flow models of two deep perched water zones. One zone is relatively stagnant and the other more dynamic.

Conceptual Model: The conceptual model is also presented in Section E.7.2. Much has been learned about perched water in spite of some difficulties encountered. Small perched bodies are not easily identified because of the drilling techniques required. The lateral extent of deep perched water bodies is also difficult to determine because of the cost of drilling wells. Identification of perched water systems is mostly from observation of saturation in open boreholes using video logs, water measurements, electric logs, neutron logs, wells, and piezometers. Thirty-three occurrences of deep perched water across the Pajarito Plateau are reported (Robinson, Broxton, and Vaniman 2005). The depth to perched water ranges from 118 to 894 feet (36 to 272 meters). The principle occurrence of perched groundwater is in the large wet canyons (Los Alamos and Pueblo Canyons), the smaller watersheds (Sandia and Mortandad Canyons), and Cañon de Valle. Perched water is found in the Puye Fanglomerates, Cerros del Rio basalts, and Bandelier Tuffs (Robinson, Broxton, and Vaniman 2005). Perched water is less common under the dry mesas.

Some deep perched water contains mobile (nonsorbing) anthropogenic chemicals, but no direct measurements have been made to determine how the chemicals reached the perched water. Two conceptual models that are at present untestable are presented to explain the process: a low-velocity, stagnant water resting in a depression above the perching horizon and a high-velocity, laterally migrating fluid that travels on top of the perching horizon (Robinson, Broxton, and Vaniman 2005). Perching horizons in the low-velocity model slow the downward percolation of water, but seem to become dry when penetrated by a borehole and not recharged. In the high-velocity model, water percolates into a deep perched zone; then moves laterally to where the zone pinches out or reaches another vertical, permeable pathway; and then moves downward. This is repeated until it can no longer move downward or it reaches the regional aquifer. These two scenarios can occur together. Deep perched water does not appear to extend far below the dry mesas (Robinson, Broxton, and Vaniman 2005).

Model Development: A model that considers perching horizons as interfaces between hydrostratigraphic units was developed. It uses an interface reduction factor method to account for perched water. When mean values for hydraulic conductivity are used in a model, the water will move through the unsaturated zone and will not perch or move laterally. The derivation of an equation called the permeability reduction factor was added to the Finite Element Heat and Mass Transfer code. The reduction factor allows the user to enter a multiplier that will reduce the permeability at the interface of two hydrostratigraphic units and allow increased saturation. A two-dimensional model was then run using permeability reduction factors for simulating the perched zone. Models without the low-permeability barrier were run for comparison.

Results: The results were compared to information from wells LADP-3 and LAOI(A)-1.1, which penetrate the Guaje Pumice Bed-Puye Formation interface. The Guaje Mountain fault zone was used as the high-infiltration zone. The base case had no permeability reduction factor, but showed a slight increase in saturation at the Guaje Pumice Bed; however, no perching occurred. When the reduction factor was used, perching occurred and increased as the factor was lowered. Particle tracking showed that, as the reduction factor was decreased, migration of contaminants moved laterally. Some contaminants moved through the interface.

Perched water zones in the Pajarito Plateau and Yucca Mountain, Nevada, are being extensively studied and have some similarities. Both places have the low-permeability zones required for perching to occur. The low-permeability zone at Yucca Mountain is an extensive low-permeability zone of zeolites. At Pajarito Plateau, the low-permeability zones are limited in area and are associated with stratified sedimentary units and dense basalts.

Fluid velocity in the perched zones is unknown and hydrologic testing, tracer tests, or groundwater dating methods are required to determine the age of the groundwater. Anthropogenic chemicals found in perched zones in some wet canyons allow for some estimates of travel times that may be only on the order of decades.

E.9 References

Birdsell, K. H., B. D. Newman, D. E. Broxton, and B. A. Robinson, 2005, “Conceptual Models of Vadose Zone Flow and Transport beneath the Pajarito Plateau, Los Alamos, New Mexico,” *Vadose Zone Journal*, 4:620-636, August 16.

Broxton, D. E., and D. T. Vaniman, 2005, “Geologic Framework of a Groundwater System on the Margin of a Rift Basin, Pajarito Plateau, North-Central New Mexico,” *Vadose Zone Journal*, 4:522-550, July 18.

Cather, S. M., 2004, “Laramide Orogeny in Central and Northern New Mexico and Southern Colorado,” *The Geology of New Mexico, A Geologic History*, p. 203-248, Special Publication 11, The New Mexico Geological Society, Socorro, New Mexico.

Goff, F., and J. N. Gardner, 2004, “Late Cenozoic Geochronology of Volcanism and Mineralization in the Jemez Mountains and Valles Caldera, North Central New Mexico,” *The Geology of New Mexico, A Geologic History*, p. 295-312, Special Publication 11, The New Mexico Geological Society, Socorro, New Mexico.

Keating, E. H., B. A. Robinson, and V. V. Vesselinov, 2005, “Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau,” *Vadose Zone Journal*, 4:653-671, August 16.

Kwicklis, E., M. Witkowski, K. Birdsell, B. Newman, and D. Walther, 2005, “Development of an Infiltration Map for the Los Alamos Area, New Mexico,” *Vadose Zone Journal*, 4:672-693, August 16.

LANL (Los Alamos National Laboratory), 1995, *The Unsaturated Hydraulic Characteristics of the Bandelier Tuff*, LA-12968-MS, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *Groundwater Background Investigation Report*, LA-UR-05-2295, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *Los Alamos National Laboratory’s Hydrogeologic Studies of the Pajarito Plateau: A Synthesis of Hydrogeologic Workplan Activities (1998-2004)*, LA-14263-MS, Los Alamos, New Mexico, December.

Levitt, D. G., D. L. Newell, W. J. Stone, and D. S. Wykoff, 2005, “Surface Water–Groundwater Connection at the Los Alamos Canyon Weir Site: Part 1. Monitoring Site Installation and Tracer Tests,” *Vadose Zone Journal*, 4:708-717, August 16.

Newman, B. D., and B. A. Robinson, 2005, “The Hydrogeology of Los Alamos National Laboratory: Site History and Overview of Vadose Zone and Groundwater Issues,” *Vadose Zone Journal*, 4:614-619, August 16.

Robinson, B. A., D. E. Broxton, and D. T. Vaniman, 2005, “Observations and Modeling of Deep Perched Water Beneath the Pajarito Plateau,” *Vadose Zone Journal*, 4:637-652, August 16.

Robinson, B. A., G. Cole, J. W. Carey, M. Witkowski, C. W. Gable, Z. Lu, and R. Gray, 2005, "A Vadose Zone Flow and Transport Model for Los Alamos Canyon, Los Alamos, New Mexico," *Vadose Zone Journal*, 4:729-743, August 16.

Robinson, B. A., S. G. McLin, and H. S. Viswanathan, 2005, "Hydrologic Behavior of Unsaturated, Fractured Tuff: Interpretation and Modeling of a Wellbore Injection Test," *Vadose Zone Journal*, 4:694-707, August 16.

Smith, G. A., 2004, "Middle to Late Cenozoic Development of the Rio Grande Rift and Adjacent Regions in Northern New Mexico," *The Geology of New Mexico, A Geologic History*, p. 331-358, Special Publication 11, The New Mexico Geological Society, Socorro, New Mexico.

Springer, E. P., 2005, "Statistical Exploration of Matrix Hydrologic Properties for the Bandelier Tuff, Los Alamos, New Mexico," *Vadose Zone Journal*, 4:505-521, July 18.

Stauffer, P. H., and W. J. Stone, 2005, "Surface Water–Groundwater Connection at the Los Alamos Canyon Weir Site: Part 2. Modeling of Tracer Test Results," *Vadose Zone Journal*, 4:718-728, August 16.

APPENDIX F
ENVIRONMENTAL SAMPLE DATA

APPENDIX F
ENVIRONMENTAL SAMPLE DATA

Appendix F presents an analysis of 2001 through 2005 environmental monitoring analytical results for use in this *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (LANL SWEIS). In Appendix F these results are evaluated for the following three purposes:

- To summarize and present the 2001 through 2005 environmental sample data in a manner[1] analogous to that used in the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999);
- To evaluate the effects of the Cerro Grande Fire of May 2000, at an aggregate level, on the concentration of radioisotope analytical results in groundwater, sediment, stormwater runoff, and soil samples in and around LANL (in Section F.2); and
- To provide conservative assessments of environmental concentrations of radioisotopes and chemicals (in Section F.3) for use in calculating the Offsite Resident (Los Alamos County resident), Recreational User, and Special Pathways receptor impacts presented in Appendix C, Section C.1.4.

Appendix F is not intended to replace or supplement the LANL annual Environmental Surveillance Reports (LANL 2002, 2004a, 2004b, 2005, 2006b). Those reports provide analyses of environmental measurement results along with statistical interpretation of the data and assessments of data importance. The statistical analysis in the LANL Environmental Surveillance Reports results in a determination as to whether each specific chemical or radioisotope (denoted an analyte) is conclusively present, that is, has actually been detected, in a sample. The data analysis in Appendix F is for the purposes described above and is not intended to indicate the presence of known contamination in the environment.

F.1 Environmental Monitoring Selection

Los Alamos National Laboratory (LANL) staff conducts an ongoing environmental monitoring program that encompasses locations within LANL, along the perimeter of LANL, and throughout the region of non-LANL land in the adjoining counties. This program provides an extensive set of measurements of radiological and hazardous chemical substances in the air, surface water or stormwater runoff, groundwater, sediment, and soil.

For radiological monitoring, periodic samples are obtained and measured for a wide range of radioisotopes, as well as gross alpha, beta, and gamma radiation. Monitored radioisotopes

---

[1] A similar approach is used in Section F.2 as was used to average the environmental data presented in the 1999 SWEIS. This allows the 2001 through 2005 environmental data in Section F.2 to be compared with the data from 1991 through 1996 presented in the 1999 SWEIS. The statistical treatment of data and the comparison between the two time frames does not account for differences in measurement techniques or instrument accuracy.

include americium-241, cesium-137, cobalt-60, iodine-129, neptunium-237, plutonium-238, plutonium-239, plutonium-240, potassium-40, radium-226, radium-228, sodium-22, strontium-90, technetium-99, tritium, uranium-234, uranium-235, uranium-236, and uranium-238. Radioisotope concentrations in the soil collected within and around LANL has been very low and, for the most part, has not increased over time. Soils are now sampled every 3 years. Tritium is measured in both solid and liquid samples because of its high affinity for the liquid state as tritiated water. Most of these radioisotopes have relatively long half-lives (greater than 10 years, except for cobalt-60, radium-228, and sodium-22), can have significant health impacts in sufficient quantities, and represent many of the radioisotopes that are handled, managed, and stored at LANL. They also constitute the entire range of high-energy emitters of alpha, beta, gamma, and neutron radiation.

During 2001 through 2005, radiological samples were obtained from 15 onsite canyons, as well as sites along LANL's borders. Further measurements were made of samples from the surrounding counties. These samples were used to measure radioactivity levels, and the data were subjected to statistical analysis. The data were subdivided into three principal regions of interest: Regional, Perimeter, and Onsite.

F.2 Evaluation of Los Alamos National Laboratory Environmental Sampling Data

Numerous studies and analyses have been performed on the effects of the Cerro Grande Fire at LANL. One area of major interest is the redistribution of radioisotopes in the environment in and around LANL due to this wildfire. The current measured[2] distribution of radioisotopes in the environment was used to calculate doses to special receptors as reported in Appendix C of this SWEIS. The current measured radioisotope distribution in soil, surface water or stormwater runoff, sediment, and groundwater was also used to calculate worker and public doses from a postulated wildfire accident in Appendix D.

As environmental measurements of radioisotopes in and around LANL now exist for 2001 through 2005 and the same data were developed for the *1999 SWEIS* for the years 1991 through 1996, a graphical presentation was prepared to compare the distribution for selected radioisotopes in each of the four environmental media (groundwater, sediment, soil, and surface water or stormwater runoff). Only those radioisotopes that were measured in both sets of data were presented graphically. **Figures F–1** through **F–23** present the mean measured concentration of a specific radioisotope at a specific location in or near LANL. One symbol represents the 2001 through 2005 data, while a different symbol represents the 1991 through 1996 data, resulting in a "scatter plot" for each radioisotope and medium. The use of this type of plot allows the observer to make general observations regarding any trend.

The data in these figures were based on measurements at Regional, Perimeter, and Onsite locations. Each mean measured concentration data point was calculated from annual measurements at one of the various locations. The radioisotopes of interest that were plotted are americium-241, cesium-137, plutonium-238, plutonium-239 and plutonium-240, strontium-90, and tritium. These isotopes represent relatively long half-life nuclides with potentially

[2] *In this appendix, the use of the terms measured or measurements refers to values derived from the sample analytical data in accordance with the statistical evaluation described in Section F.3.*

significant health hazards that may have been released by LANL facilities. For soil environmental data, only the mean for the composite Regional, Perimeter, and Onsite stations is presented because those are the only data available for both periods. In addition, strontium-90 data are not available for soil data from both time periods. Each sediment and soil graph also presents the LANL human health risk-based Screening Action Level (SAL) (LANL 2001) that LANL uses as a criterion for acceptable sediment and soil radioisotope mass concentration level except for tritium, which is defined as a volumetric concentration value. The SAL indicates whether further study or environmental remediation is required. These LANL SALs for sediments and soil were first developed in 2001 and are based on the U.S. Environmental Protection Agency (EPA) guidance limit of 15 millirem per year for residential, commercial, recreational, and industrial use of the land. The SAL calculation includes inhalation, ingestion, and external exposure pathways. The radionuclide SALs were calculated for a 1,000-year timeframe with no loss by erosion or leaching (LANL 2001).

The grouping of the data has changed over the years. To allow visual comparison in graphs, the data for 1991 through 1996 are related to 2001 through 2005 data as shown in **Table F–1**. **Figures F–1** through **F–6** are graphs for groundwater data for measured isotopes for the groundwater data sets as shown in Table F–1. Table F–1 also indicates the Section F.3 data tables that correspond to the 2001 through 2005 data sets.

Table F–1 Groundwater Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Alluvial Groundwater	Canyon Alluvial Groundwater Systems [a]	F–15, F–16
2	Spring from Basalt	Basalt Springs [b]	F–18
3	Main Aquifer	Regional Aquifer Wells [c]	F–10
4	Test Wells	Test Wells	F–12
5	Springs	Regional Aquifer Springs	F–14
6	Springs from Volcanics [d]	Water Gallery (2001-2003) [d]	F–18
7	San Ildefonso	San Ildefonso Pueblo	F–19
8	Intermediate Perched	Intermediate Perched Groundwater Systems [e]	F–17, F–18
9	Not Measured	Hydrogeologic Characterization Wells	F–11
10	Not Measured	Water Supply Wells	F–13
11	Not Measured	Santa Fe Water Supply Wells	F–20

[a] Canyon Alluvial Groundwater Systems encompasses Canyon Alluvial Wells and Canyon Alluvial Springs, which are separated into Table F–15 and Table F–16.
[b] Basalt springs is a subset of the Los Alamos Canyon data in Table F–18, Intermediate Perched Springs.
[c] Regional Aquifer Wells is a summation of Hydrogeologic Characterization Wells, Test Wells, and Water Supply Wells.
[d] Data from the location identified as Springs from Volcanics in 1991 through 1996 most closely correlates with data from Water Gallery (2001-2003). Water Gallery data are a subset of the Water Canyon data in Table F–18, Intermediate Perched Springs.
[e] Intermediate Perched Groundwater Systems encompasses Intermediate Perched Wells and Intermediate Perched Springs, which are separated into Table F–17 and Table F–18.

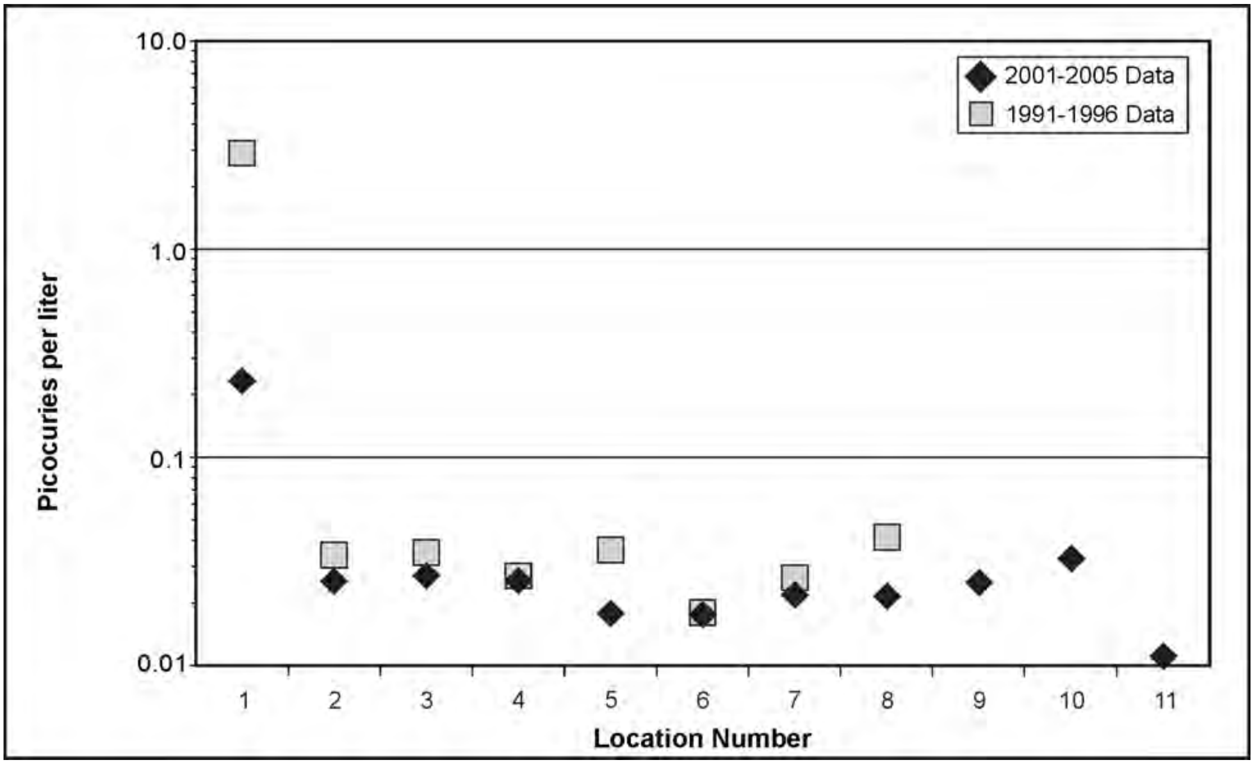


Figure F–1 Americium-241 Measured Mean Concentration Value for Groundwater

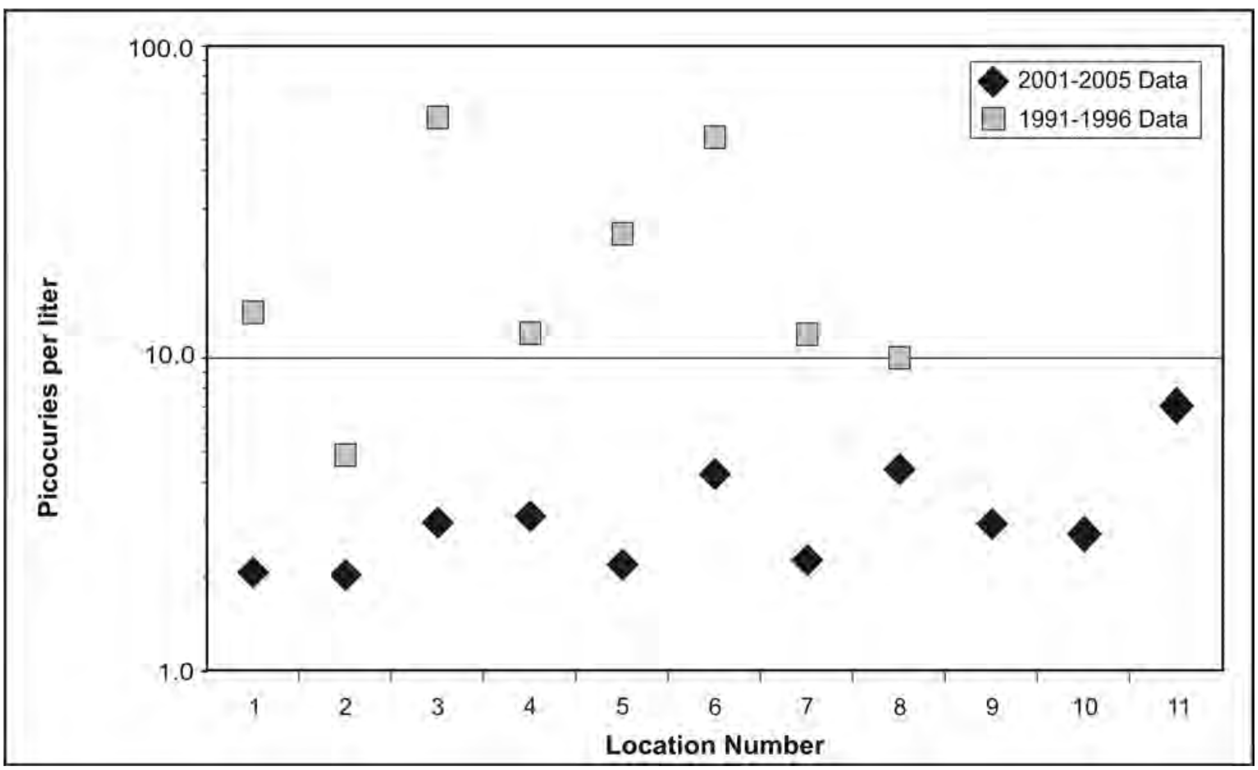


Figure F–2 Cesium-137 Measured Mean Concentration Value for Groundwater

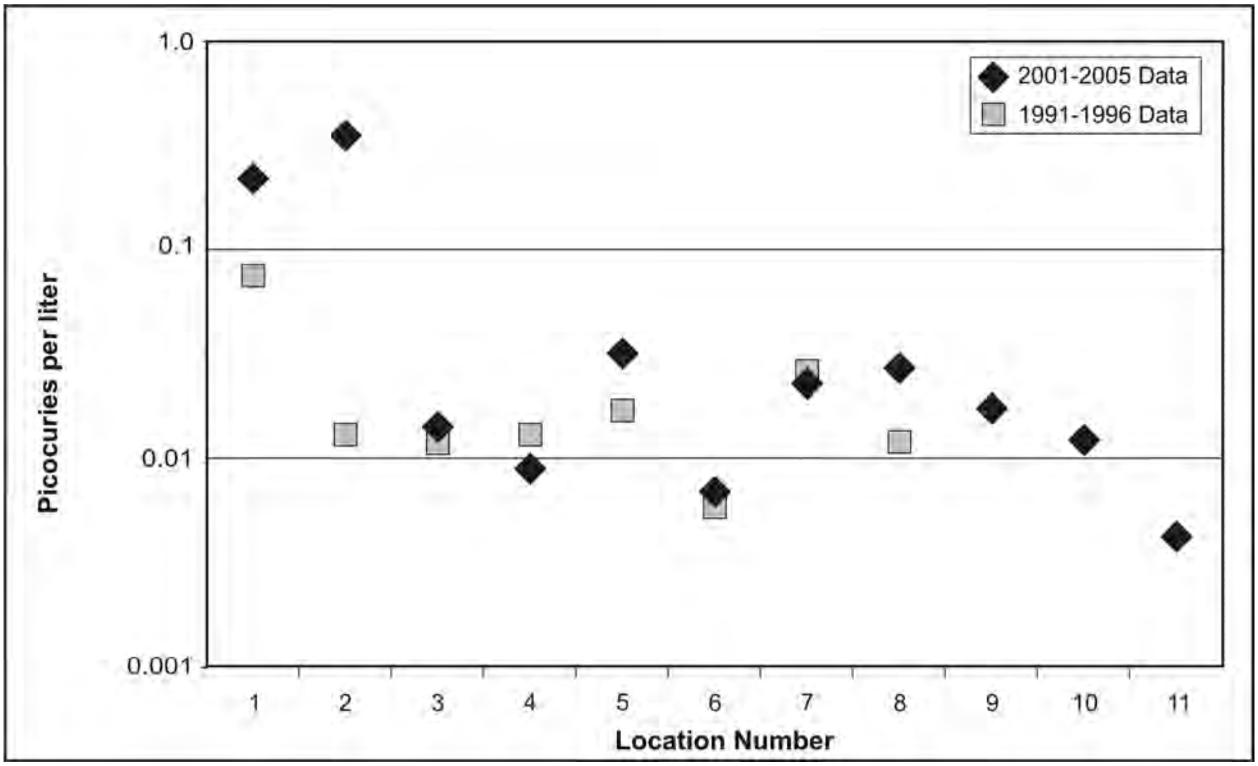


Figure F–3 Plutonium-238 Measured Mean Concentration Value for Groundwater

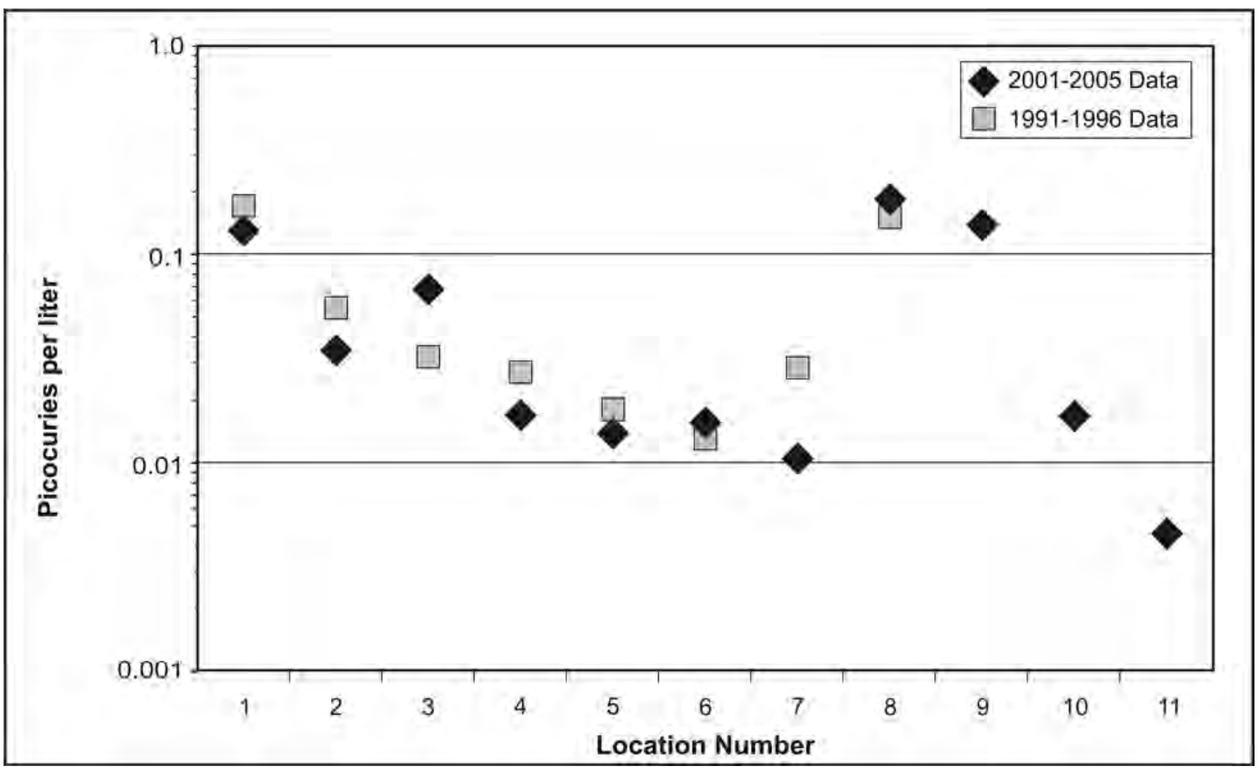


Figure F–4 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Groundwater

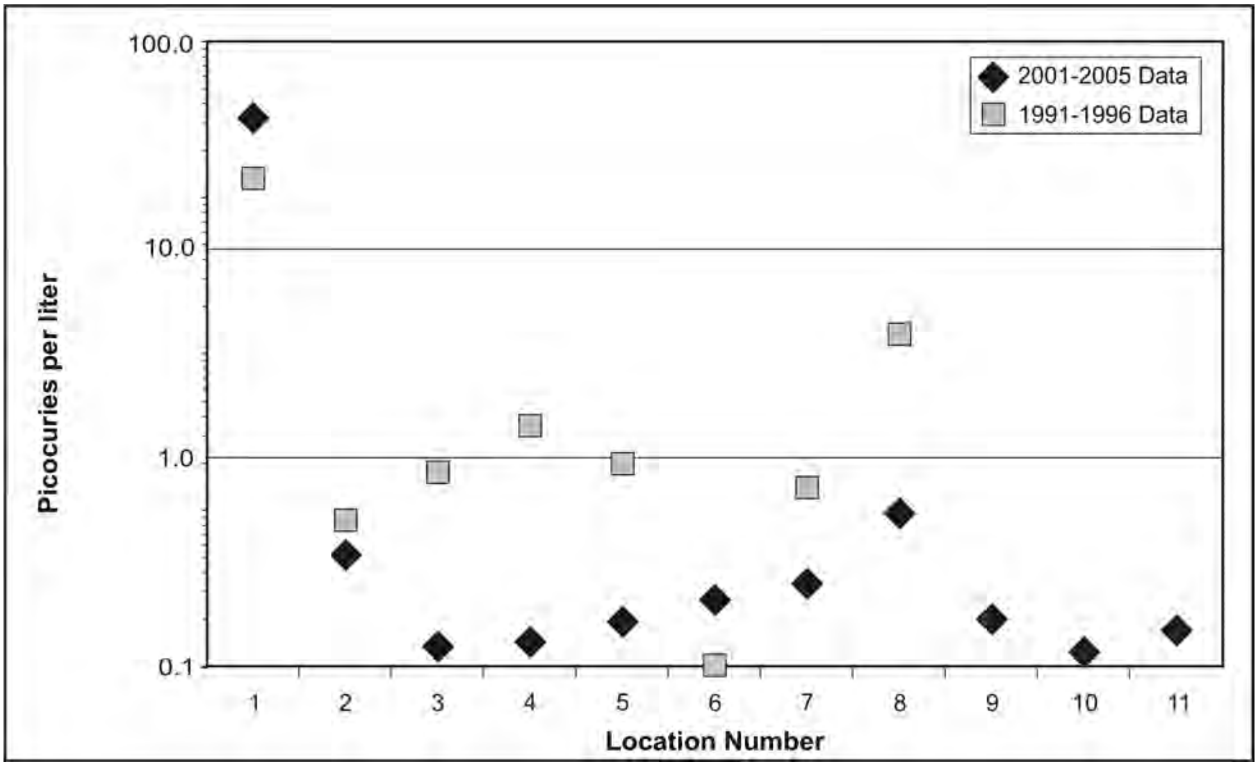


Figure F–5 Strontium-90 Measured Mean Concentration Value for Groundwater

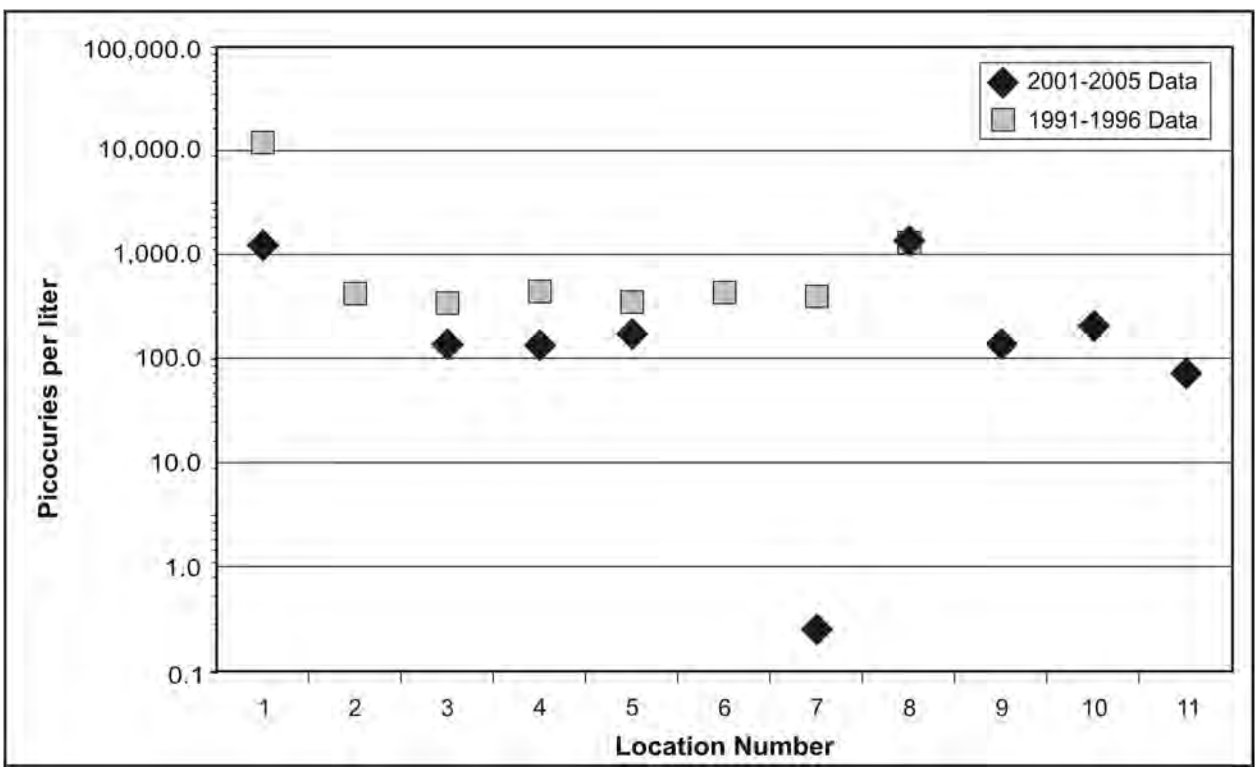


Figure F–6 Tritium Measured Mean Concentration Value for Groundwater

Figures F–7 through **F–12** are graphs for isotopes measured in sediments. The data points are in the order shown in **Table F–2**. Table F–2 also indicates the Section F.3 data table that corresponds to the 2001 through 2005 data sets. In 2001 through 2005 data, measurements in sediments were provided for Fence and Indio Canyons for some isotopes that were not considered in the 1991 through 1996 data. Plutonium-238 and tritium do not have measured values for Indio Canyon in the 2001 through 2005 data. For Bayo Canyon, strontium-90 and plutonium-239 and plutonium-240 do not have measured values in the 2001 through 2005 data.

Table F–2 Sediment Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Regional Stations	Regional Stations	F–21
2	Perimeter Stations	Perimeter Stations	F–21
3	Onsite Stations	Onsite Stations	F–21
4	Ancho Canyon	Ancho Canyon	F–21
5	Bayo Canyon	Bayo Canyon	F–21
6	Cañada del Buey Canyon	Cañada del Buey Canyon	F–21
7	Chaquehui Canyon	Chaquehui Canyon	F–21
8	Not Measured	Fence Canyon	F–21
9	Frijoles Canyon	Frijoles Canyon	F–21
10	Gauje Canyon	Gauje Canyon	F–21
11	Not Measured	Indio Canyon	F–21
12	Los Alamos Canyon	Los Alamos Canyon	F–21
13	Mortandad Canyon	Mortandad Canyon	F–21
14	Pajarito Canyon	Pajarito Canyon	F–21
15	Potrillo Canyon	Potrillo Canyon	F–21
16	Pueblo Canyon	Pueblo Canyon	F–21
17	Sandia Canyon	Sandia Canyon	F–21
18	Water Canyon	Water Canyon	F–21

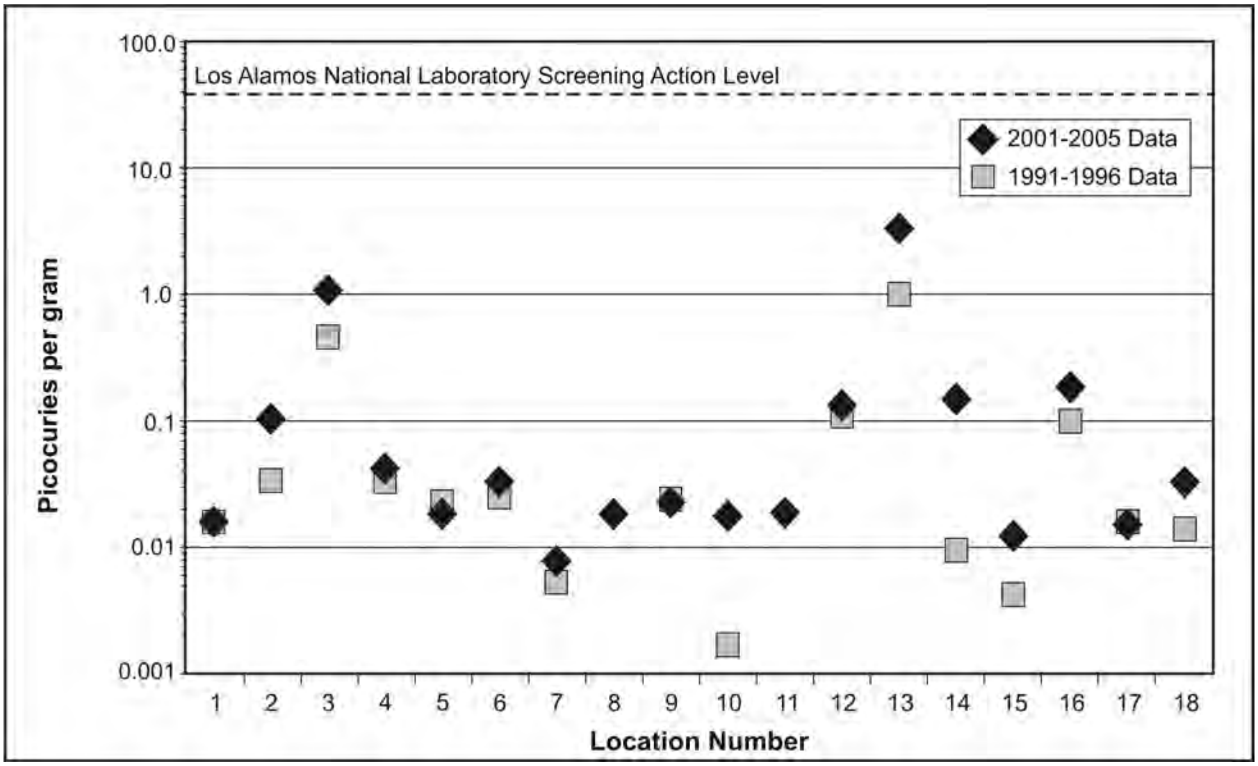


Figure F–7 Americium-241 Measured Mean Concentration Value for Sediment

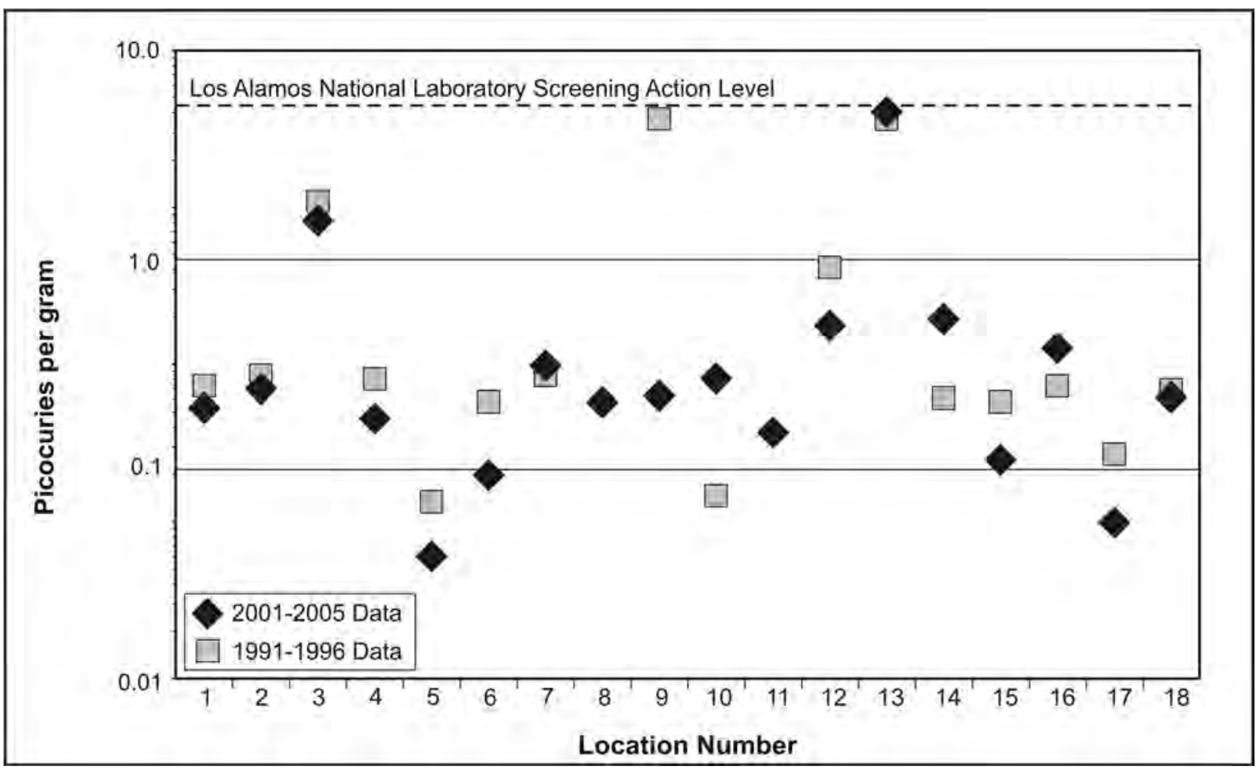


Figure F–8 Cesium-137 Measured Mean Concentration Value for Sediment

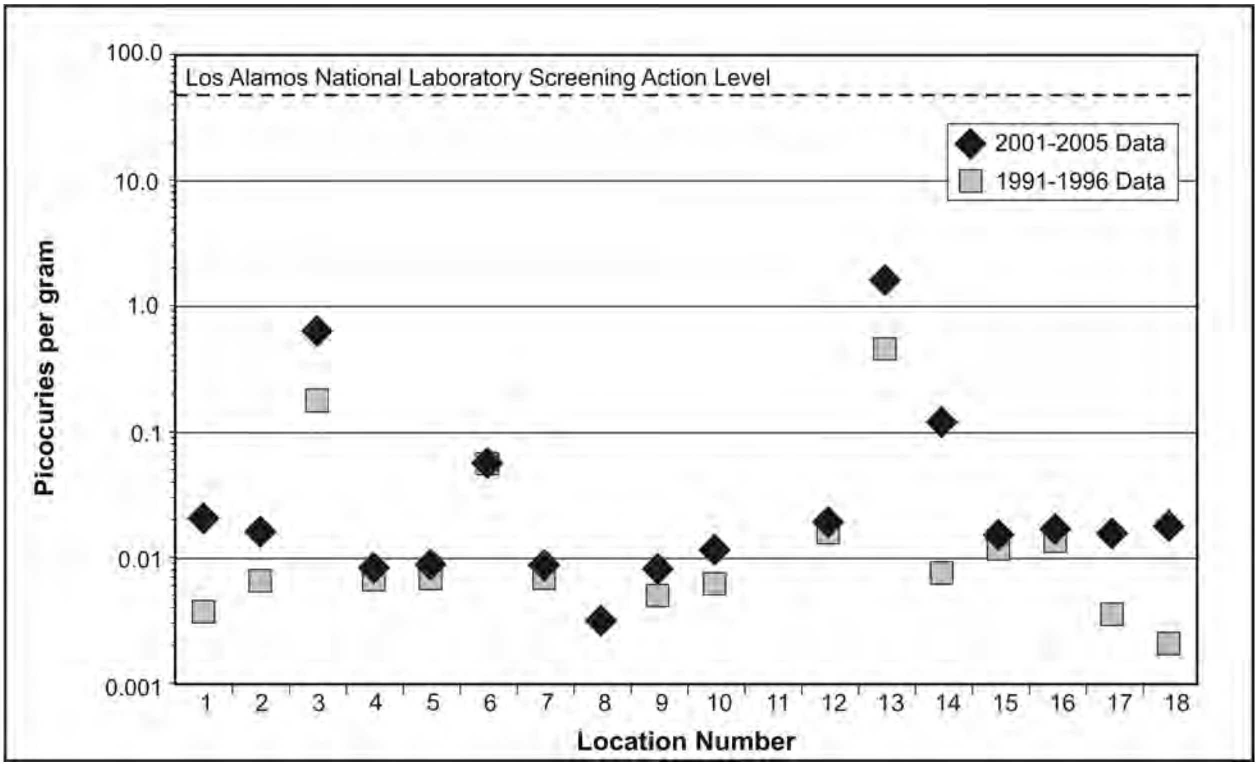


Figure F–9 Plutonium-238 Measured Mean Concentration Value for Sediment

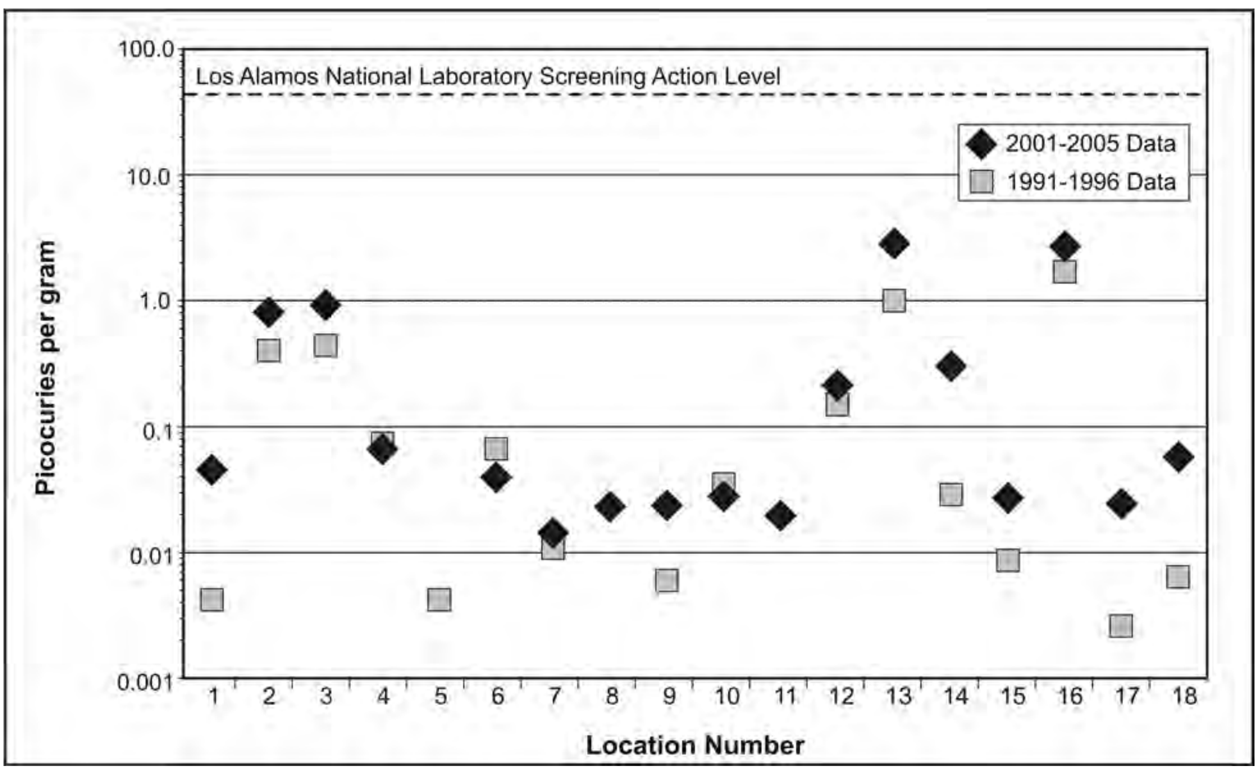


Figure F–10 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Sediment

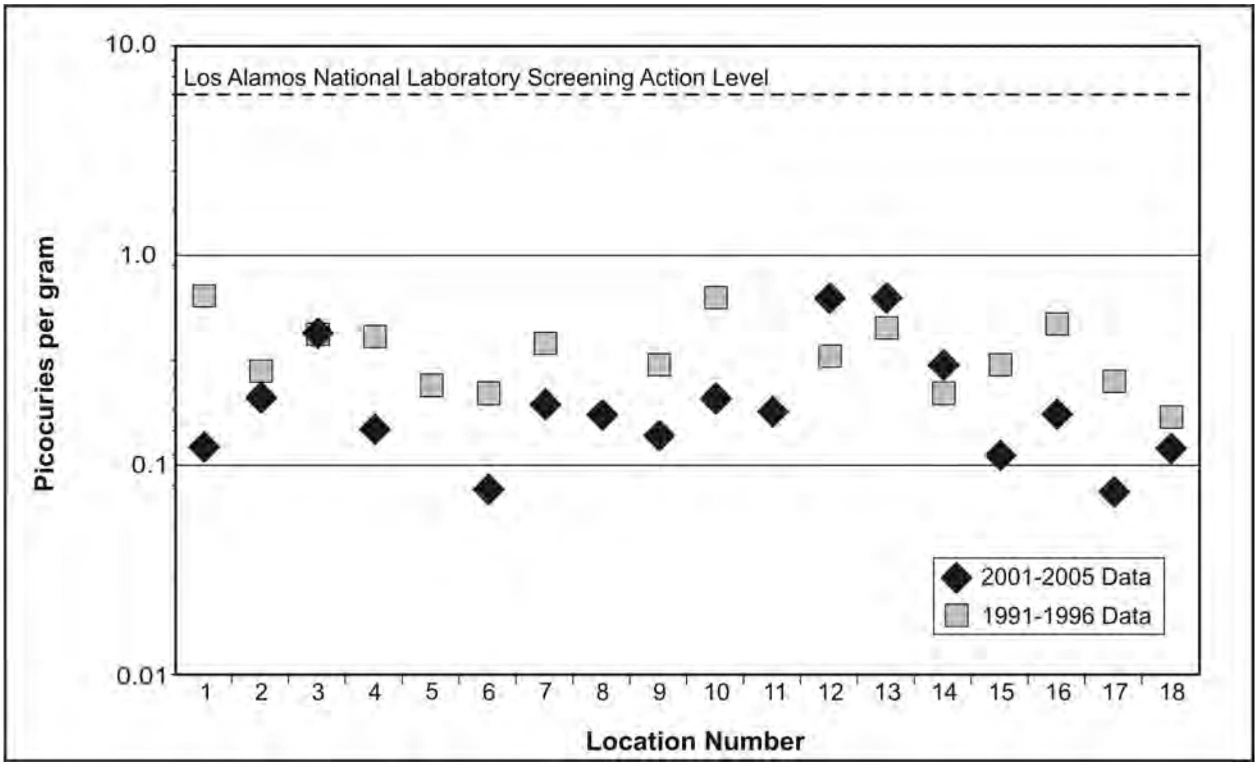


Figure F–11 Strontium-90 Measured Mean Concentration Value for Sediment

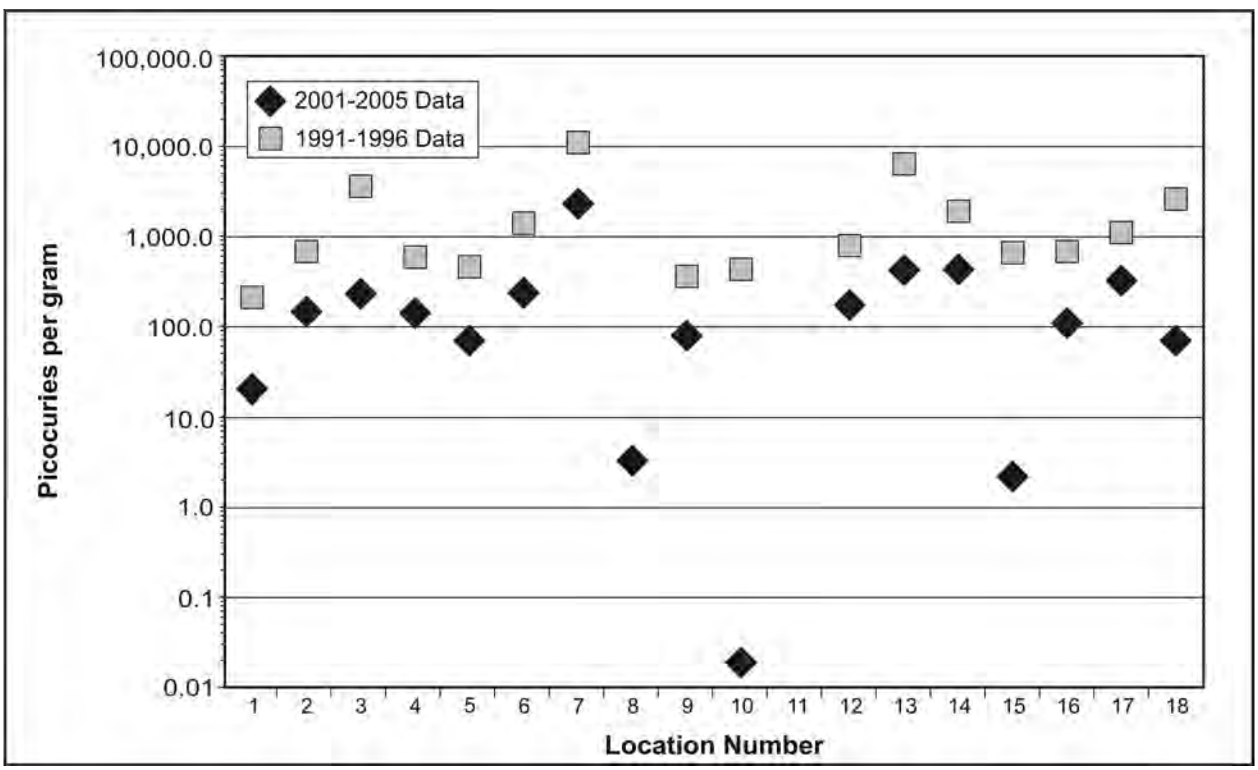


Figure F–12 Tritium Measured Mean Concentration Value for Sediment

Figures F–13 through **F–18** are graphs for stormwater runoff data for each measured isotope. Data points are in the canyon order provided in **Table F–3**. Table F–3 also indicates the Section F.3 data table that corresponds to the 2001 through 2005 data sets. The 1991 through 1996 data include Cañada del Buey and Chaquehui Canyons (unlike the 2001 through 2005 data). Cesium-137 data are not available for Chaquehui Canyon from 1991 through 1996. Plutonium-239 and plutonium-240 data are not available for Ancho Canyon from 2001 through 2005 data. Strontium-90 data are not available for Guaje Canyon from 1991 through 1996 and for Ancho Canyon for 2001 through 2005.

Table F–3 Runoff Data Set Comparison

Location Number	*1991 through 1996 Data Set Identifier*	*2001 through 2005*	
		Data Set Identifier	*Data from Table*
1	Regional Stations	Regional Canyons	F–22
2	Perimeter Stations	Perimeter Canyons	F–22
3	Onsite Stations	Onsite Canyons	F–22
4	Ancho Canyon	Ancho Canyon	F–22
5	Cañada del Buey Canyon	Not measured	Not applicable
6	Chaquehui Canyon	Not measured	Not applicable
7	Frijoles Canyon	Frijoles Canyon	F–22
8	Guaje Canyon	Guaje Canyon	F–22
9	Los Alamos Canyon	Los Alamos Canyon	F–22
10	Mortandad Canyon	Mortandad Canyon	F–22
11	Pajarito Canyon	Pajarito Canyon	F–22
12	Pueblo Canyon	Pueblo Canyon	F–22
13	Sandia Canyon	Sandia Canyon	F–22
14	Water Canyon	Water Canyon	F–22

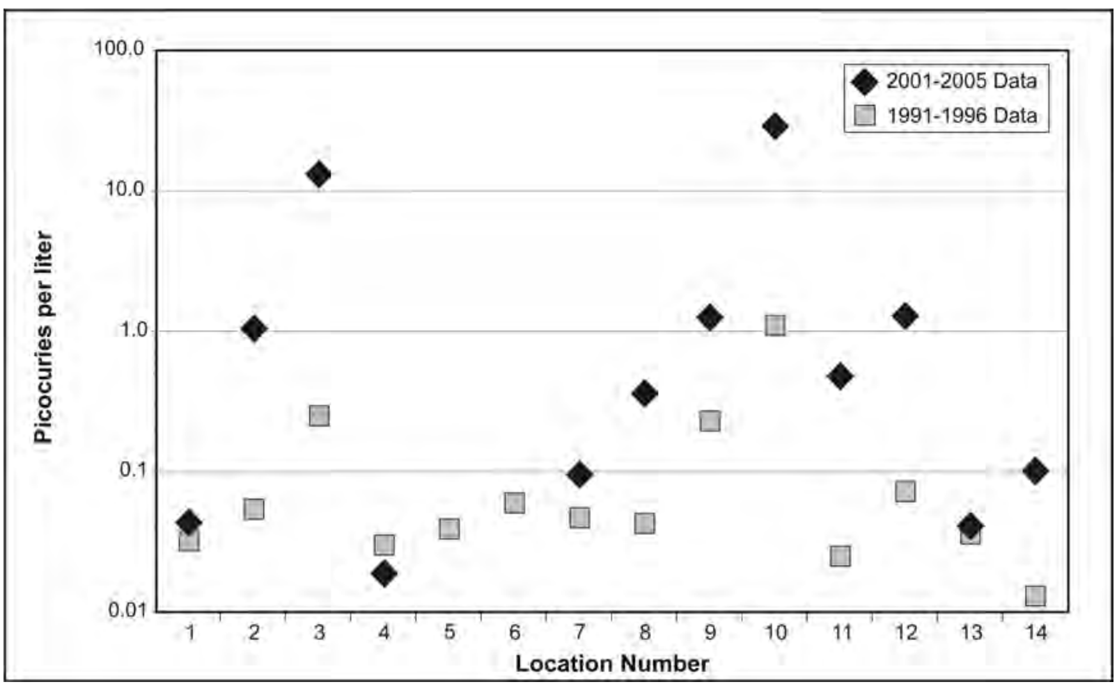


Figure F–13 Americium-241 Measured Mean Concentration Value for Runoff

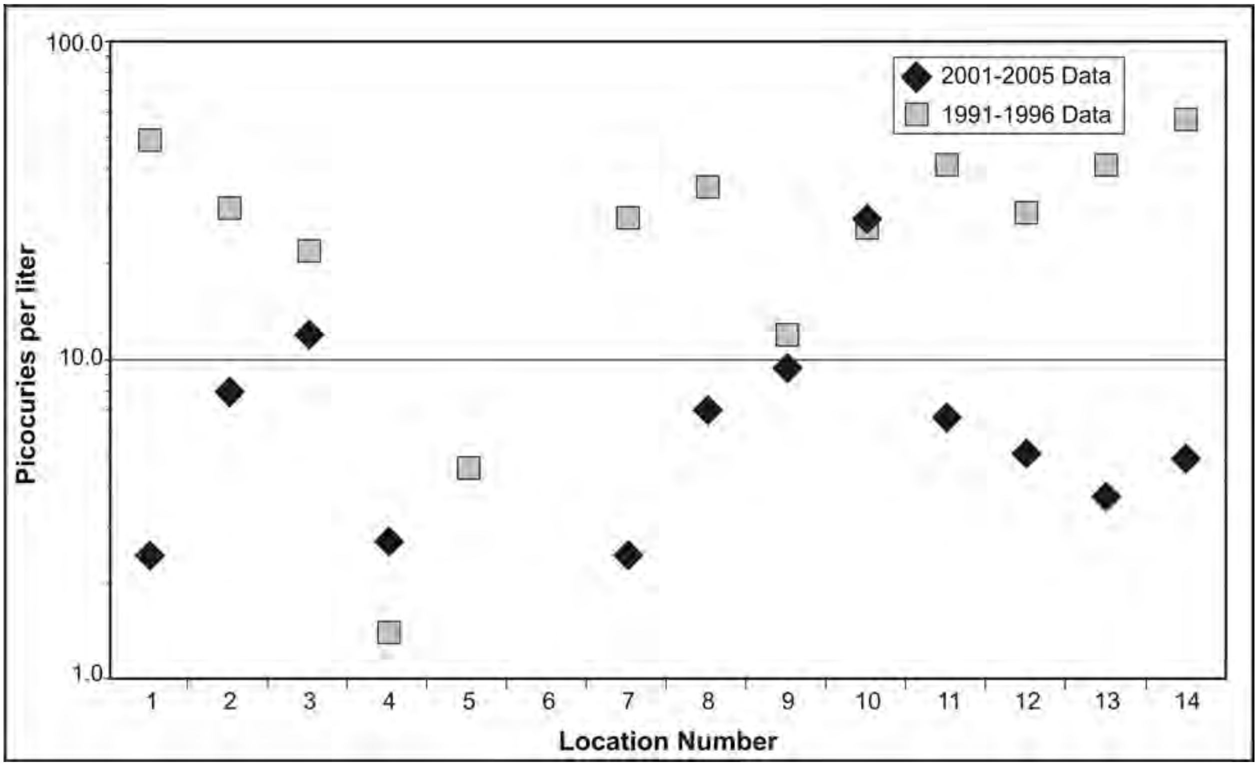


Figure F–14 Cesium-137 Measured Mean Concentration Value for Runoff

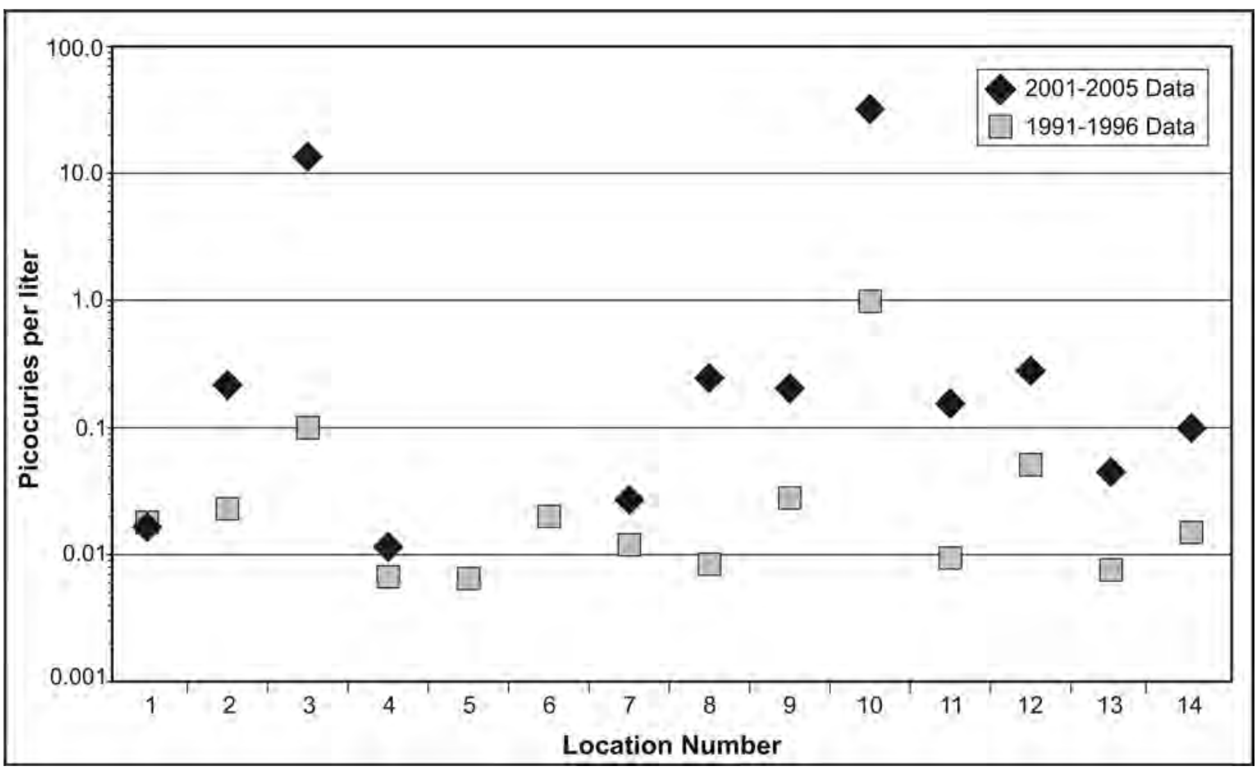


Figure F–15 Plutonium-238 Measured Mean Concentration Value for Runoff

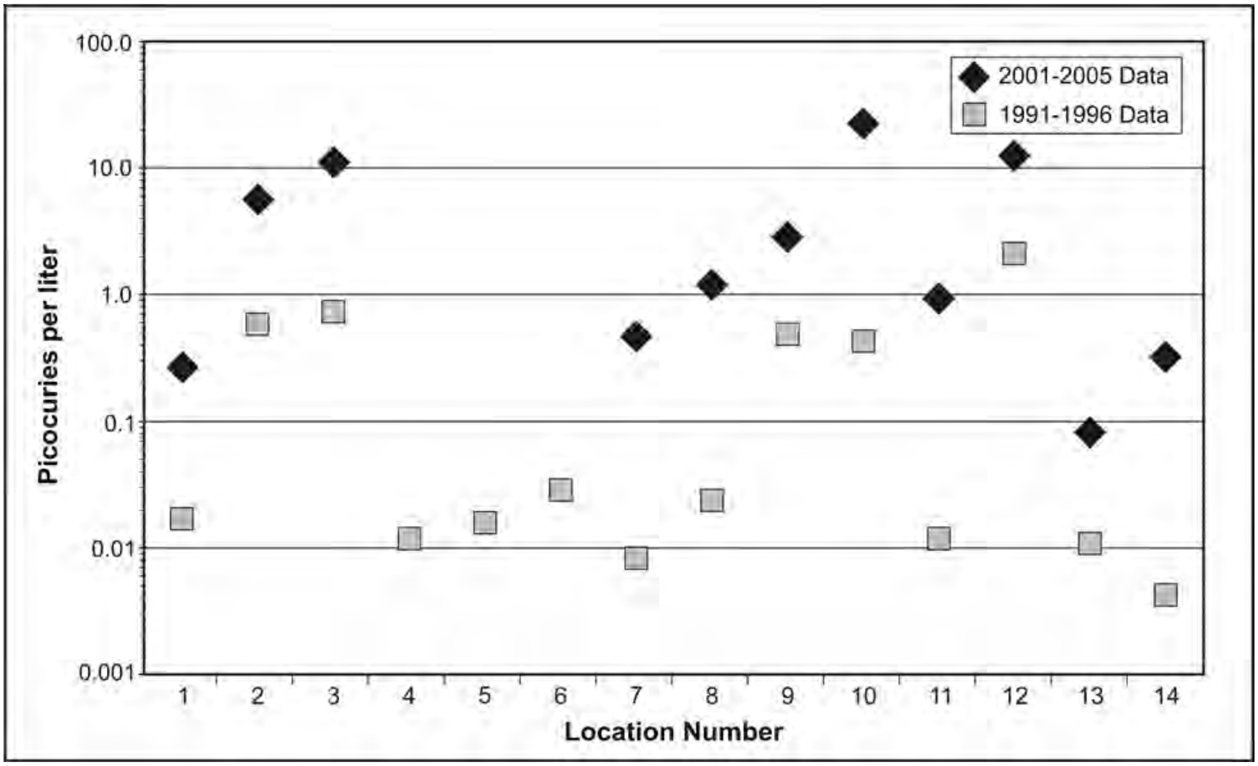


Figure F–16 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Runoff

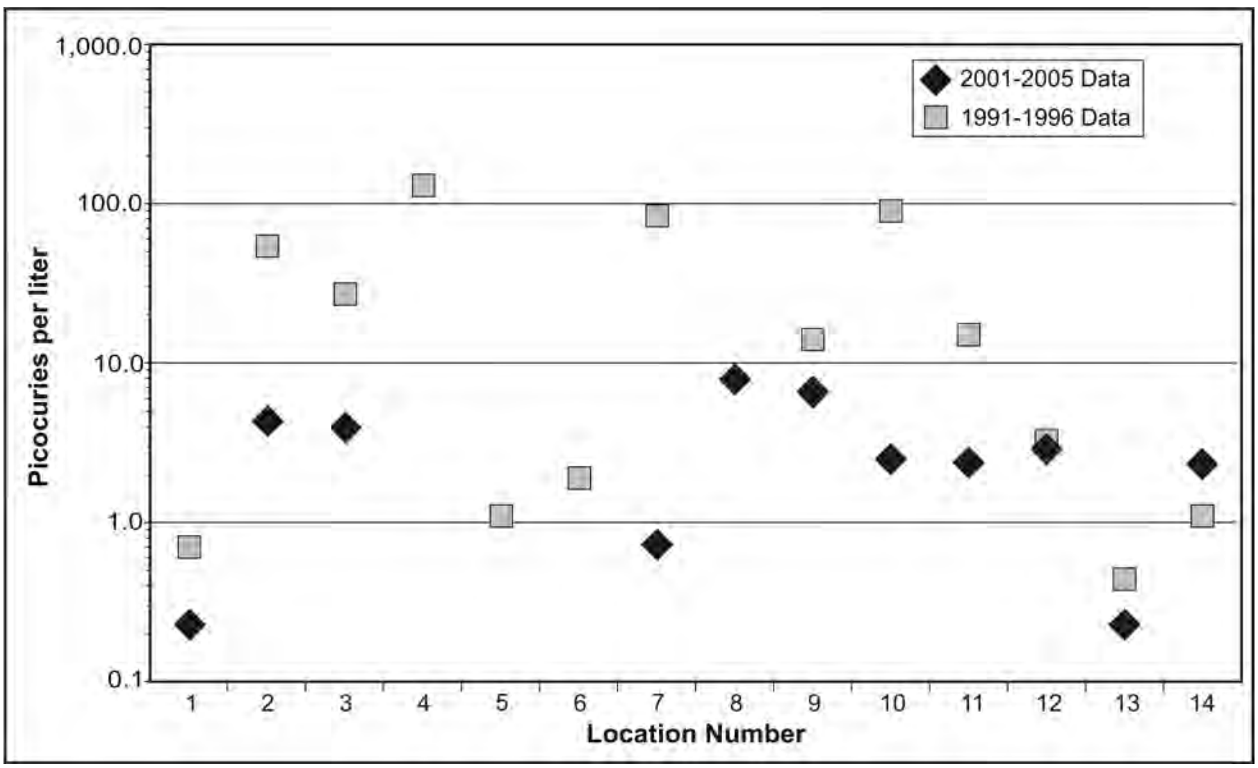


Figure F–17 Strontium-90 Measured Mean Concentration Value for Runoff

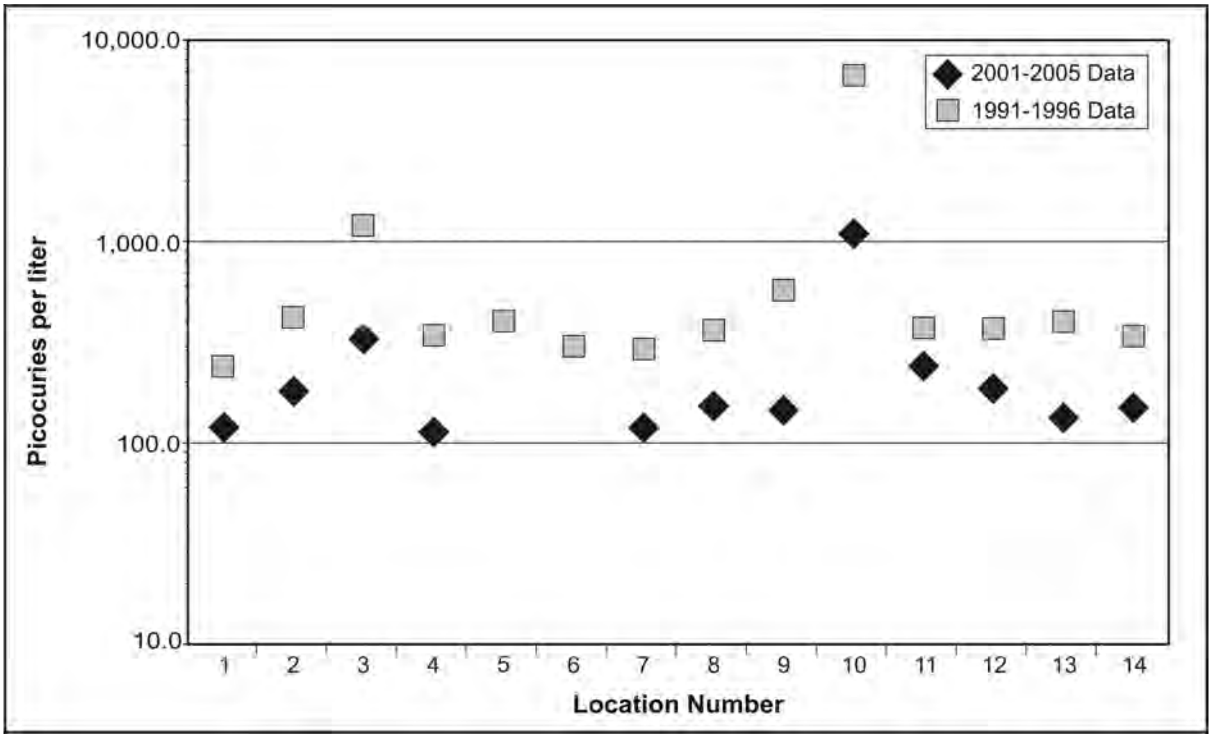


Figure F–18 Tritium Measured Mean Concentration Value for Runoff

Figures F–19 through **F–23** show graphs for soils for each measured isotope. The data are grouped into the three principal regions of interest of Regional, Perimeter, and Onsite. The corresponding data are presented in Section F.3, Table F–23.

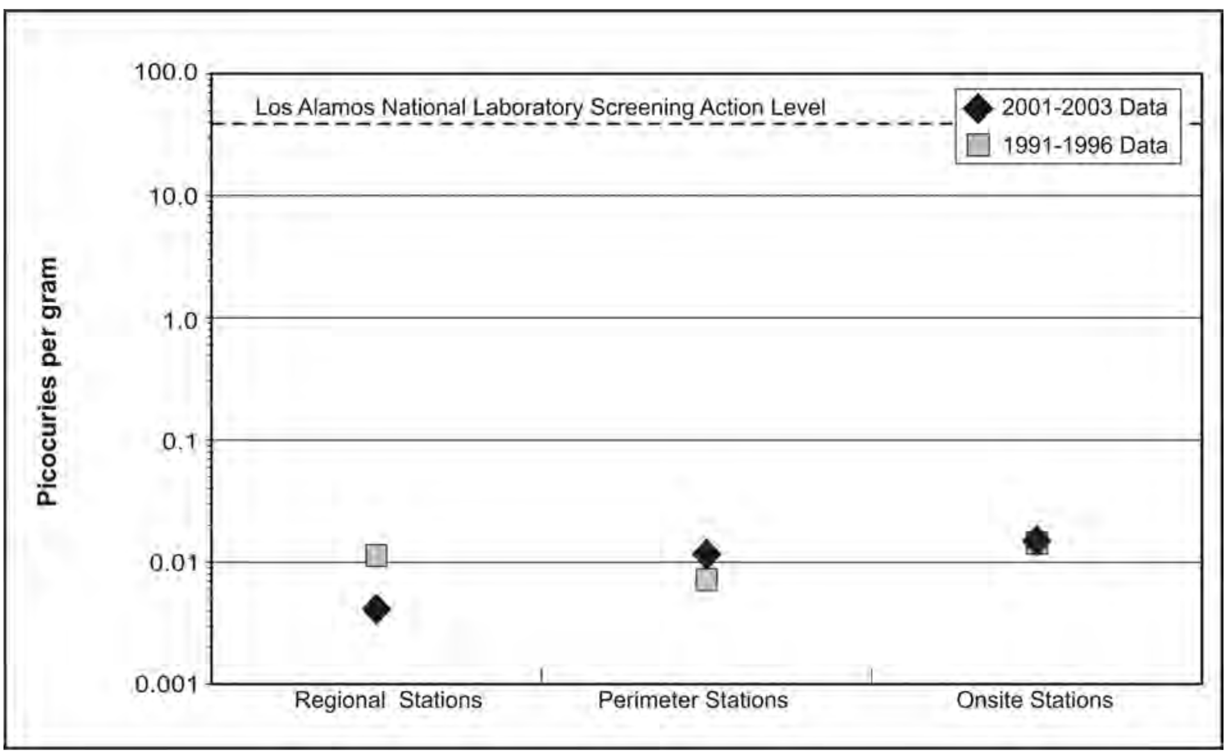


Figure F–19 Americium-241 Measured Mean Concentration Value for Soils

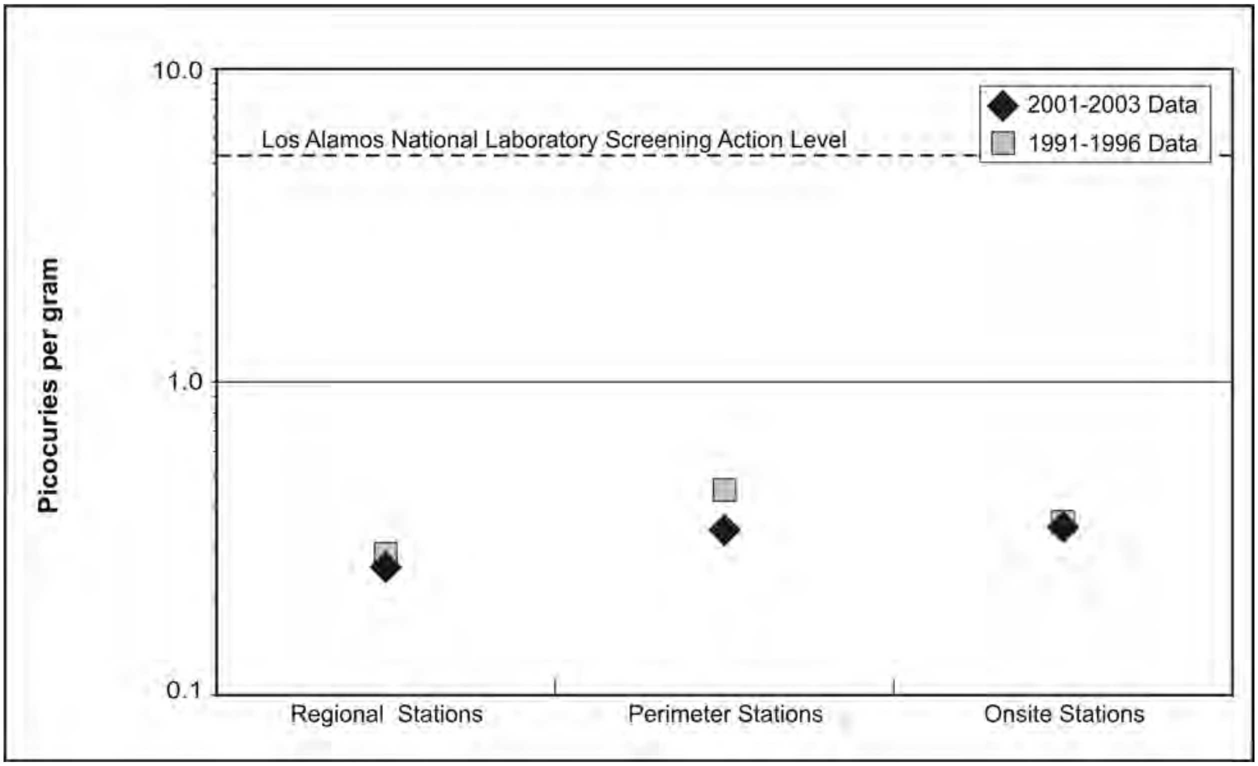


Figure F–20 Cesium-137 Measured Mean Concentration Value for Soils

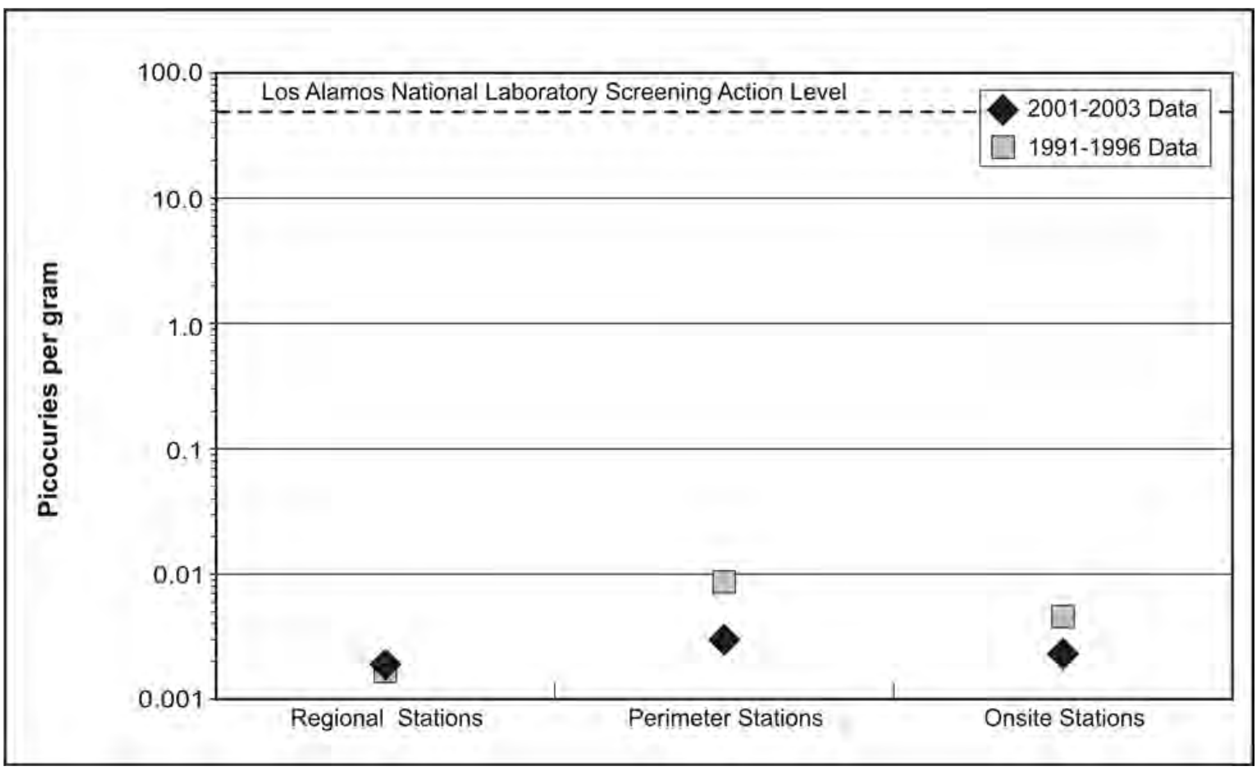


Figure F–21 Plutonium-238 Measured Mean Concentration Value for Soils

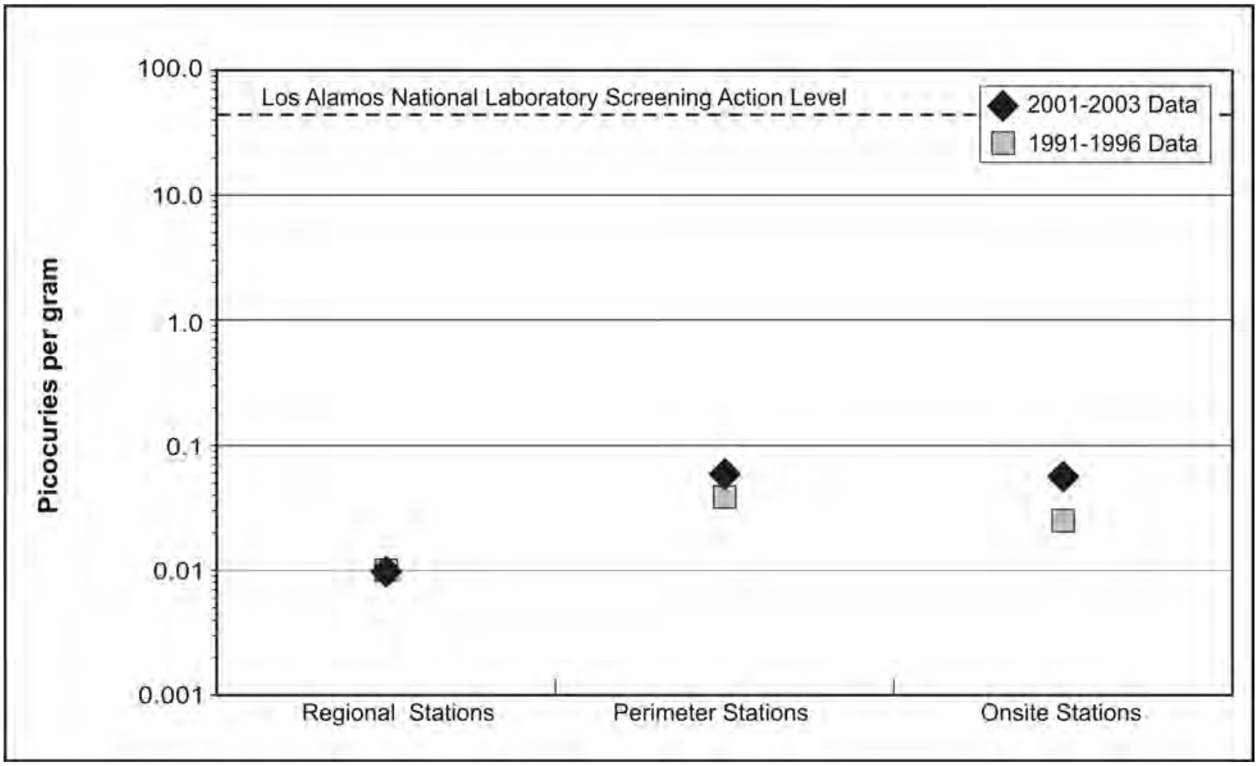


Figure F–22 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Soils

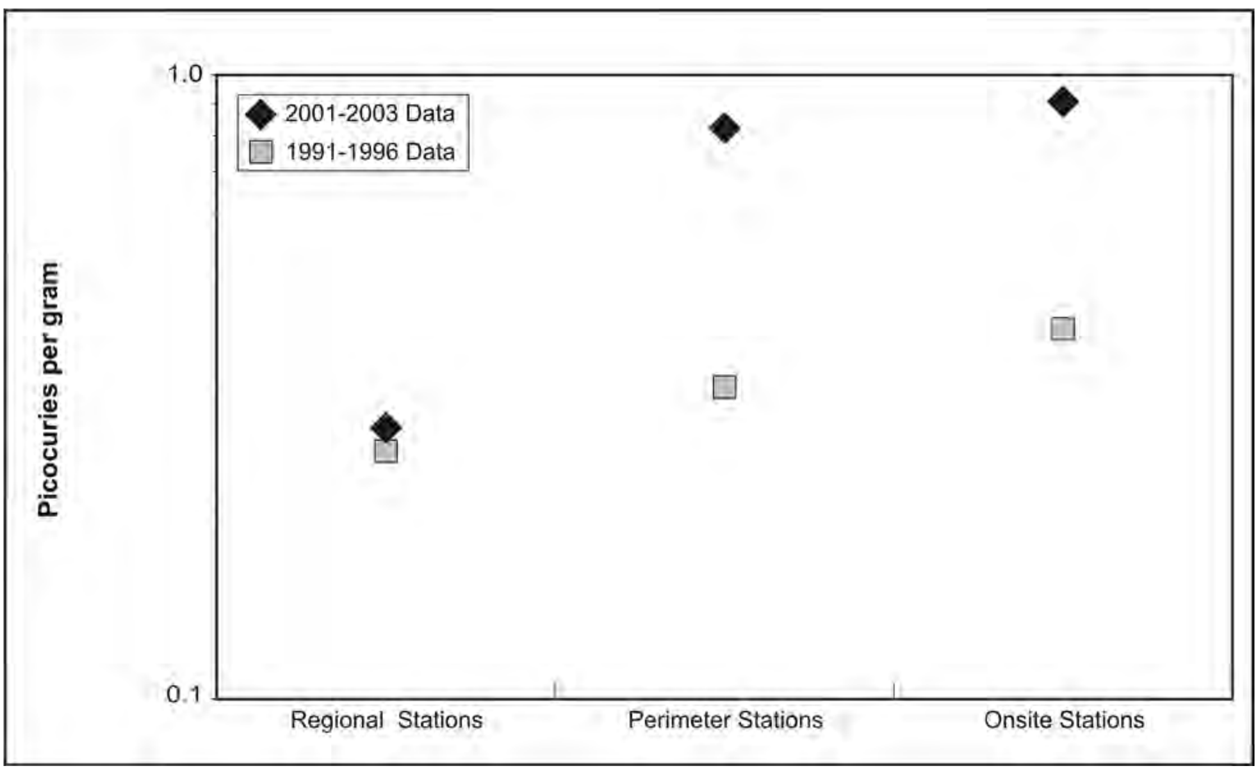


Figure F–23 Tritium Measured Mean Concentration Value for Soils

Groundwater data show a more marked shift in the transuranics toward higher concentrations in the 1991 through 1996 data than in the runoff or sediment data (see **Table F–4**). Unlike runoff and sediment, groundwater is much more slowly diluted or replenished, especially in the LANL region. Groundwater is also a potential source of drinking water for residences that use wells. In general, both transuranics and lighter radioisotopes showed higher concentrations in groundwater in the 1991 through 1996 data than in the 2001 through 2005 data. No measurements exceeded applicable (tritium and strontium-90) EPA limits for drinking water (40 CFR 141.66).

Table F–4 Comparison of Measured 2001 through 2005 Radioisotope Groundwater Data to 1991 through 1996 Data

Radioisotope	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Other than one data point, both the 1991 through 1996 data and the 2001 through 2005 data are concentrated over one order of magnitude (0.01 to 0.1 picocuries per liter). The maximum data point of about 3 picocuries per liter is from 1991 through 1996, and is much higher than the largest 2001 through 2005 data point of 0.5 picocuries per liter. Most of the 2001 through 2005 data points are slightly lower than or equal to the 1991 through 1996 data points.
Cesium-137	1991 through 1996	All 2001 through 2005 data points are significantly lower in value than the 1991 through 1996 data points by as much as a factor of 10 to 20.
Plutonium-238	Equivalent	Both data sets are closely clustered over the same two orders of magnitude. The highest 2001 through 2005 data point is about 0.45 picocuries per liter; the largest 1991 through 1996 data point is about 0.08 picocuries per liter.
Plutonium-239, Plutonium-240	Equivalent	Both sets of data show a small spread over the same two orders of magnitude.
Strontium-90	1991 through 1996	Some (six out of eight data points) of the 2001 through 2005 data are lower in value than the 1991 through 1996 data by factors of 2 to 10.
Tritium	1991 through 1996	Most of the 2001 through 2005 data points are a factor of 2 to 4 times lower in value than the comparable 1991 through 1996 data points. It should be noted that the largest mean values for the 1991 through 1996 data and the 2001 through 2005 data are smaller than the U.S. Environmental Protection Agency annual drinking water limit of 20,000 picocuries per liter (assumed to be equivalent to a total body dose of 4 millirem) (40 CFR 141.66).

In qualitatively evaluating the graphical presentation of measured radioisotope concentrations in and around LANL between the 1991 through 1996 and 2001 through 2005 periods, only general observations can be made. More specific conclusions would require much more extensive statistical and measurement methodology analysis and would only quantify results in a statistical framework, which might not convey any more information to the reader. **Table F–5** presents the assessment of the differences between the two data sets for sediment.

As previously stated, qualitative interpretation of the data presented graphically for LANL sediment radioisotope concentrations is limited by the extent of this evaluation. However, some general conclusions can be drawn (see Table F–5). Transuranic isotope concentrations all have increased from the 1991 through 1996 period to the 2001 through 2005 period, while lower atomic weight radioisotopes have decreased. Because sediments are subject to the actions of water over time, it is reasonable to assume that the lighter weight radioisotopes (strontium-90, cesium-137, and tritium) would have been preferentially carried with the rainwater and

Table F–5 Comparison of Measured 2001 through 2005 Radioisotope Sediment Data to 1991 through 1996 Data

Radioisotope	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Two 2001 through 2005 data points are about a factor of 10 times larger than the 1991 through 1996 data points. All other data points are close to each other. All data are below the LANL SAL.
Cesium-137	Equivalent	A third of the 2001 through 2005 data points are half the value of their 1991 through 1996 counterparts. Most of the data points from 2001 through 2005 are in the same range as the preponderance of 1991 through 1996 data points. All data are below the LANL SAL.
Plutonium-238	2001 through 2005	Both sets of data exhibit a similar large spread over three orders of magnitude, but 2001 through 2005 data points are greater than their 1991 through 1996 data points. All data are below the LANL SAL
Plutonium-239, Plutonium-240	2001 through 2005	Both sets of data showed a similar large spread of four orders of magnitude (from 0.001 to 10 picocuries per gram); all data are below the LANL SAL.
Strontium-90	1991 through 1996	Data points from both time periods are clustered over two orders of magnitude (from 0.01 to 1 picocurie per gram); nonetheless, all data are well below the LANL SAL. Most of the 2001 through 2005 data are lower than the 1991 through 1996 data by factors of 2 to 3. Three data points from 2001 through 2005 are greater than the 1991 through 1996 data points.
Tritium	1991 through 1996	The two sets of data are distinctly separate and are tightly confined to a narrow band. All of the 2001 through 2005 data points are a factor of 5 to 15,000 times smaller than the comparable 1991 through 1996 data points.

SAL = Screening Action Level.

surface runoff water, whereas a greater fraction of the heavier transuranics would have stayed in the sediment due to their higher density. It is also important to note that tritium is highly soluble, as tritiated water in rain and surface water. Another consideration is that the 12.2-year half-life of tritium would have resulted in the decay of a significant fraction of tritium between 1991 through 1996 and 2001 through 2005, which together represent a period of anywhere from 5 to 14 years. Assuming no dramatic changes in emissions of these measured radioisotopes from 1991 through 1996 to 2001 through 2005, the sediment data indicate that any radioactive material movement involving this sediment due to the Cerro Grande Fire was acted upon by the natural forces of rain and surface water that significantly depleted the sediment content of lighter-weight, more soluble radioisotopes.

Transuranic radioisotopes exist in larger concentrations in the 2001 through 2005 data than in the 1991 through 1996 data surface runoff; the opposite is true for all lighter radioisotopes such as tritium, strontium-90, and cesium-137 (see **Table F–6**). As in the case of sediment, the lighter radioisotopes would be transported farther by runoff than the heavier transuranic radioisotopes since the Cerro Grande Fire. As noted above, radioactive decay of tritium could also account for some of the difference in the data.

Table F–6 Comparison of Measured 2001 through 2005 Radioisotope Runoff Data to 1991 through 1996 Data

Radioisotope	*Noticeably Significant Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	2001 through 2005	The 2001 through 2005 data are spread out between four orders of magnitude, whereas the 1991 through 1996 data are spread out within two orders of magnitude (from 0.01 to 1 picocurie per liter). Most of the 2001 through 2005 data are 2 to 50 times higher than the corresponding 1991 through 1996 data points.
Cesium-137	1991 through 1996	A majority of the 2001 through 2005 data points are significantly lower than the 1991 through 1996 data points by as much as a factor of 20. Only 2 of the 11 data points from 2001 through 2005 are higher than the 1991 through 1996 data points.
Plutonium-238	2001 through 2005	The data sets exhibit a large spread over four orders of magnitude. The 1991 through 1996 data extend from 0.001 to 1 picocuries per liter and the 2001 through 2005 data extend from 0.01 to 100 picocuries per liter. Most 2001 through 2005 data points are factors of 3 to over 100 greater than the 1991 through 1996 data points.
Plutonium-239, Plutonium-240	2001 through 2005	Both sets of data showed a large spread over four orders of magnitude, but the 1991 through 1996 data are spread over a range of 0.001 to 10 picocuries per liter and the 2001 through 2005 data are spread over a range of 0.1 to 100 picocuries per liter. The 2001 through 2005 data points are 6 to 80 times greater than the 1991 through 1996 data points.
Strontium-90	1991 through 1996	A large amount (10 of 11 data points) of the 2001 through 2005 data are lower than the equivalent 1991 through 1996 data by factors of 2 to 100. No 2001 through 2005 data points exceeded 10 picocuries per liter, but seven 1991 through 1996 data points are between 10 and 200 picocuries per liter.
Tritium	1991 through 1996	All of the 2001 through 2005 data points are a factor of 2 to 10 times smaller than the comparable 1991 through 1996 data points. It should be noted that the largest mean values of less than 6,700 picocuries per liter for the 1991 through 1996 data and about 1,000 picocuries per liter for the 2001 through 2005 data are much lower than the U.S. Environmental Protection Agency drinking water limit of 20,000 picocuries per liter.

Unlike the sediment, surface runoff water, and groundwater data, the soil data show that the 2001 through 2003 measurements are at equivalent concentration for most radioisotopes to the 1991 through 1996 data (see **Table F–7**). The redistribution due to the Cerro Grande Fire of these radioisotopes, formerly present in vegetation and trees, to the soil is a possible explanation. A review of actual radiological emissions from LANL facilities' stacks from 1999 through 2005 does not show any significant increase in emissions of these radioisotopes.

Table F–7 Comparison of Measured 2001 through 2003 Radioisotope Soil Data to 1991 through 1996 Data

Radioisotope (average worldwide soil concentration)	*Noticeably Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241 (0.01 picocuries per gram)	Equivalent	All measurement values are more than a factor of 1,000 below the LANL SAL, and Regional station data are equivalent to average worldwide concentrations.
Cesium-137 (0.4 picocuries per gram)	Equivalent	Both data sets are almost identical with the 1991 through 1996 data slightly (10 percent to 50 percent) higher. All data are a factor of 10 below the SAL and at or near the worldwide measured level.
Plutonium-238 (0.01 to 0.1 picocuries per gram)	Equivalent	The 2001 through 2003 data are lower than the comparable 1991 through 1996 data at Onsite and Perimeter stations. The data are a factor of about 10,000 times lower than the LANL SAL. Data are at or below worldwide average concentrations.
Plutonium-239, Plutonium-240 (0.01 to 0.1 picocuries per gram)	Equivalent	All measurement values are more than a factor of 400 below the LANL SAL. All measurements are at or below worldwide average levels.
Tritium	2001 through 2003	The 2001 through 2003 data are significantly higher for the Onsite and Perimeter stations by as much as a factor of 2 compared to the 1991 through 1996 data.

SAL = Screening Action Level.
Sources: ANL 2005a, 2005b, 2005c, 2005d, 2005e.

Table F–8 presents several key parameters for radioisotopes measured by LANL including typical background concentrations, EPA drinking water limits, relative solubility, and soil adhesion characteristics.

Table F–8 Key Parameters of Radioisotopes Measured in the Los Alamos National Laboratory Environment

Radioisotope	*Background Concentration (EPA Drinking Water Limit)*	*Water Solubility*	*Soil Adhesion Characteristics (LANL soil is generally sandy-loam)*
Americium-241	0.01 picocuries per gram soil	Very insoluble	Ratio of sandy soil to water adhesion equals 1,900. Ratio of loam/clay to water adhesion is greater than 1,900.
Cesium-137	0.1 to 1 picocuries per gram soil; average 0.4 picocuries per gram	Very insoluble	Ratio of sandy soil to water adhesion equals 280. Ratio of clay/loam soil to water adhesion equals 2,000 to 4,000.
Plutonium-238, Plutonium-239, Plutonium-240	0.01 to 0.1 picocuries per gram soil	Very insoluble	Radio of sediment/soil to water adhesion equals 2,000.
Strontium-90	0.1 picocuries per gram soil (36 picocuries per liter)	Soluble	Ratio of sandy soil to water adhesion equals 15. Ratio of clay soil to water adhesion equals 110.
Tritium	10 to 30 picocuries per liter surface water (20,000 picocuries per liter)	Very soluble	No adhesion to soil; chemically identical to water.

EPA = U.S. Environmental Protection Agency.
Sources: ANL 2005a, 2005b, 2005c, 2005d, 2005e.

Several general and qualitative conclusions can be drawn by examination of the graphically presented environmental surveillance data on radioisotopes in and around the LANL site.

- Most radioisotopes measured in and around LANL exist in concentrations equivalent to worldwide averages based on non-LANL atmospheric releases.

- Many monitored radioisotope concentrations in groundwater decreased after 2000.
- All 2001 through 2005 tritium data for surface water and stormwater runoff and groundwater are 10 to 100 times lower than the EPA drinking water limit.
- The largest difference in data between 1991 through 1996 and 2001 through 2005 is that the 2001 through 2005 sediment tritium concentration data are 1,000 to 100,000 times smaller than the 1991 through 1996 data.
- In general, transuranic concentrations in sediment and surface water or stormwater runoff increased after 2000, while lighter radioisotope (strontium-90, cesium-137, and tritium) concentrations in sediments and surface water or stormwater runoff decreased after 2000.
- Changes in radioisotope concentration in surface water or stormwater runoff and sediment from 1991 through 1996 to 2001 through 2005 coincide with the radioisotopes that are much more soluble in water.
- Both sets of data show tritium in surface water or stormwater runoff at LANL from all the data at concentrations 10 to 100 times greater than the worldwide average.
- Most soil radioisotope concentrations increased after 2000 (possibly attributable to the redistribution of radioisotopes in biologic material that burned during the Cerro Grande Fire).
- The 2001 through 2003 soil data show a plutonium-238 concentration about 100 times greater than the 1991 through 1996 data and 10 to 100 times greater than worldwide averages.
- All 2001 through 2003 soil data are much lower (by orders of magnitude) than the relevant LANL SAL.

These aforementioned observations are based on a qualitative assessment of plots of mean measured radioisotope concentration data. Differences in measurement technique or instrument accuracy between the 1991 through 1996 data and the 2001 through 2005 data are not accounted for, nor are differences in LANL stack emissions from 1991 through 2005 incorporated. This evaluation has not accounted for other radioisotopes or hazardous chemicals. Spatial variations in measured concentrations are not included in this assessment.

F.3 Environmental Sample Data

Groundwater, sediment, and stormwater runoff data are collected and analyzed for individual canyons. Soil data are grouped under three regions of interest: regional locations, perimeter locations, and onsite locations. The measured values of radioisotope and radioactivity that are presented are derived from environmental surveillance analytical data. Groundwater, sediment, stormwater runoff, and soil values from annual environmental surveillance data tables are used to calculate “Detected per ESR,” “Used in This SWEIS,” “Analyzed,” “Minimum,” “Mean,” “Standard Deviation,” “Maximum,” and “95 percent Upper Confidence Limit (UCL)” values.

Analytical data are identified in a number of categories in this appendix. The “Analyzed” value is the total number of samples for which analyses were performed for a particular isotope or chemical. The “Detected per ESR” value is the number of analyzed samples that are determined to have detectable contamination as reported in the LANL environmental surveillance reports. The "Used in This SWEIS" value is the number of analyzed samples, in accordance with the guidanceprocess below, that are used in the following statistical analysis. The "Minimum" value is the smallest, positive measured analytical result for an isotope or chemical. The "Maximum" value is the greatest measured analytical result for an isotope or chemical. The "Mean" value is the average of the "Used in This SWEIS" samples for an isotope or chemical. The "Standard Deviation" value is a statistical measure of the amount by which each sample deviates from the mean. The "95 Percent UCL" value is a statistical representation of the concentration of a specific measured radioisotope, radioactivity, or chemical that is equal to or greater than 95 percent of all the expected measured values assuming a normal distribution.

Measurement of each parameter involves obtaining a known sample volume or mass, transporting it to an analytical laboratory, and subjecting the sample to the detection of a specific type and energy of radiation, which is detected and counted by an instrument for a set time. Each radioisotope has a unique set of radiation emission energies that identifies it just as fingerprints identify each human individual. A chemical or isotope is considered to be detected if it exceeds the lowest concentration that can be measured in a sample and reported with 99 percent confidence. It depends on the sample matrix, the instrument used, and the operator skill. For purposes of this SWEIS, the analytical results were evaluated in accordance with the following process:

- Any "Analyzed" sample for which the analytical result is less than zero is eliminated from further consideration.

- An "Analyzed" sample (in the following tables) for which the analytical result plus two standard deviations exceeds the instrument's minimum detectable activity is "Used in This SWEIS."

In applying the above process, analytical results below the instrument's minimum detectable activity are included as part of the conservative assessment approach to data treatment in this SWEIS, but will not be continued in future SWEIS updates. Future data treatments will include only those analytical results exceeding the minimum detectable activity.

The following process is then applied to the analytical results that are identified as "Used in This SWEIS."

- A minimum of two data values is required to calculate and present a Mean, Minimum, and Maximum value.

- A minimum of three data values is required to calculate and present a Standard Deviation and 95 Percent UCL value.

- The 95 Percent UCL value is calculated by first calculating the Mean and Standard Deviation on the Mean of the Used in This SWEIS data, then adding two Standard Deviations to the Mean Value.

Measured concentrations are in terms of picocuries per liter (pCi/L), picocuries per gram (pCi/g), micrograms per gram (µg/g) or micrograms per liter (µg/L) depending on whether the sample medium is solid or liquid and whether the parameter is measured in terms of radioactivity or mass.

The numbers of groundwater, sediment, surface water or stormwater runoff, and soil data samples from 2001 through 2005 that meet the criteria for "Used in This SWEIS" are shown in **Table F–9**. Table F–9 also shows the numbers of samples with "Detected" activity. The statistical analysis of measured samples (LANL 2002, 2004a, 2004b, 2005, 2006b) is presented in **Tables F–10** through **F–20** for groundwater (2001 to 2005), **Table F–21** for sediments (2001 to 2005), **Table F–22** for surface water or stormwater runoff (2001 to 2005), and **Table F–23** for soil (2001 to 2003). The most recent soil survey data available at the time of this analysis was from 2003.

The LANL environmental surveillance program uses statistical criteria to determine whether a particular radioisotope is actually detected in a sample. For a radioisotope to be detected, the sample measurement (the number of radioactive emissions counted in a given time period by a detector) must be equal to or greater than the minimum detectable activity and also must be equal to or greater than three times the total propagated uncertainty, which accounts for both the measurement instrumentation uncertainty as well as the sample background uncertainty. These criteria, which have been used for groundwater, sediment, surface water, and soil from 2001 through 2005, provide a high degree of confidence (99.7 percent) that a measurement result classified as detected is actually present in the sample. This is not the case for a number of the values indicated as "Used in This SWEIS." The number of detected measurements for each analyte, as reported in the Environmental Surveillance Reports, is presented in Tables F–10 through F–23 under the column heading of "Detected per ESR". The number of usable measurements for the purpose of this SWEIS is delineated under the column "Used in This SWEIS" in Tables F–10 through F–23. The number of usable measurements for each analyte is equal or greater than the LANL detected measurements because of the different method that was used in the SWEIS to select measurements. The method used in this SWEIS allows comparison with the environmental surveillance data presented in the *1999 SWEIS* (DOE 1999) which used a similar statistical approach to select usable measurements from the 1991 through 1996 environmental surveillance data. A usable measurement (Used in This SWEIS) in Tables F–10 through F–23 does not indicate that the analyte actually exists in the sample at a level greater than the analytical instrument was able to detect, but only that the measurement met the previously described guidance. There is a large difference between the number of environmental samples analyzed that are reported as detected and the number of samples that are reported as "Used in This SWEIS" for uranium. Uranium is a naturally occurring element in the LANL environment. The criterion for detected samples eliminates uranium concentrations below the 5 microcuries per gram whereas the "Used in This SWEIS" data do not screen out background uranium concentrations in environmental samples and therefore results in a higher number of numerical values. Only the usable measurements were used to develop the mean values and 95 percent UCL values shown in Tables F–10 through F–23. The 95 percent UCL values are used in Appendix C of this SWEIS to estimate human health impacts.

Table F–9 Number of Detectable Radiological Data Samples at Los Alamos National Laboratory Exceeding Analytical Thresholds

Radioisotope	Number of Samples Exceeding Analytical Thresholds (2001 through 2005)							
	Groundwater		Sediment		Surface Water or Stormwater Runoff		Soil (2001 through 2003)	
	Detected per ESR	Used in This SWEIS	Detected per ESR	Used in This SWEIS	Detected per ESR	Used in This SWEIS	Detected per ESR	Used in This SWEIS
Americium-241	84	237	132	353	63	499	75	75
Cesium-137	14	134	82	570	0	273	76	76
Plutonium-238	25	135	77	246	23	325	61	61
Plutonium-239, Plutonium-240	37	132	212	363	78	483	76	76
Strontium-90	133	328	33	231	45	518	73	73
Tritium	105	190	11	201	15	303	71	71
Uranium-234	47	675	23	599	37	693	51	51
Uranium-235, Uranium-236	3	414	4	508	3	546	–	–
Uranium-238	19	635	1	599	34	706	51	51

ESR = Environmental Surveillance Reports.

Table F–10 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Aquifer Wells Composite [a]									
Americium-241	pCi/L	7	64	311	0.002	0.027	0.009	0.157	0.03
Cesium-137	pCi/L	4	45	322	0.021	2.97	1.84	16.3	3.51
Cobalt-60	pCi/L	2	30	198	0.264	2.1	0.545	7.83	2.3
Iodine-129	pCi/L	0	5	37	0.339	0.562	0.167	0.794	0.709
Neptunium-237	pCi/L	0	29	166	2.02	12.2	0.622	28.4	12.4
Plutonium-238	pCi/L	0	28	310	0.0	0.014	0.009	0.038	0.017
Plutonium-239, Plutonium-240	pCi/L	4	26	310	0.0	0.068	0.068	0.601	0.094
Potassium-40	pCi/L	5	168	198	0.47	31.1	3.04	105	31.5
Radium-226	pCi/L	26	57	79	0.123	0.42	0.12	1.17	0.451
Sodium-22	pCi/L	0	11	198	1.04	1.99	0.028	2.74	2
Strontium-90	pCi/L	8	122	447	0.004	0.123	0.045	0.434	0.131
Technetium-99	pCi/L	1	11	48	1.27	2.44	1.23	5.24	3.17
Tritium	pCi/L	17	50	216	0.0	136	81.3	874	158
Uranium-234	pCi/L	0	265	306	0.009	0.473	0.111	2.66	0.486
Uranium-235, Uranium-236	pCi/L	0	138	307	0.005	0.043	0.023	0.181	0.047
Uranium-238	pCi/L	0	253	307	0.008	0.205	0.105	1.53	0.218
Uranium (calculated)	µg/L	0	333	342	0.01	0.627	0.131	4.6	0.641
Uranium (measured)	µg/L	0	80	80	0.02	0.63	0.038	3.46	0.639
Gross Alpha	pCi/L	4	134	285	0.173	1.55	0.567	14.5	1.65

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	0	234	284	0.504	3.38	0.499	15.6	3.44
Gross Gamma	pCi/L	0	84	258	44.1	141	29.1	1,920	147

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Composite includes data from Hydrogeologic Characterization Wells (Table F–11), Test Wells (Table F–12), Water Supply Wells (Table F–13). The corresponding data set identifier is indicated in Table F–1.
Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–11 Radiochemical Statistical Analysis of Groundwater – Hydrogeologic Characterization Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Hydrogeologic Characterization Wells [a] Composite									
Americium-241	pCi/L	4	30	193	0.002	0.025	0.009	0.047	0.029
Cesium-137	pCi/L	0	23	196	0.251	2.95	1.61	14.6	3.6
Cobalt-60	pCi/L	2	21	147	0.264	2.07	0.517	7.83	2.29
Iodine-129	pCi/L	0	5	37	0.339	0.562	0.167	0.794	0.709
Neptunium-237	pCi/L	0	14	114	5.24	10.1	0.553	21	10.4
Plutonium-238	pCi/L	0	4	197	0.006	0.017	0.017	0.038	0.034
Plutonium-239, Plutonium-240	pCi/L	4	6	197	0.011	0.138	0.09	0.601	0.21
Potassium-40	pCi/L	5	124	147	0.471	35.7	10.8	105	37.6
Radium-226	pCi/L	15	29	37	0.149	0.437	0.146	1.17	0.49
Sodium-22	pCi/L	0	10	147	1.04	1.94	0.095	2.74	2
Strontium-90	pCi/L	4	45	191	0.078	0.167	0.02	0.434	0.172
Technetium-99	pCi/L	1	11	48	1.27	2.44	1.23	5.24	3.17
Tritium	pCi/L	4	20	94	63.4	137	32.2	523	151
Uranium-234	pCi/L	0	161	193	0.009	0.392	0.144	2.66	0.414
Uranium-235, Uranium-236	pCi/L	0	86	194	0.016	0.047	0.011	0.164	0.049
Uranium-238	pCi/L	0	151	194	0.01	0.215	0.061	1.53	0.225
Uranium (calculated)	µg/L	0	235	244	0.01	0.486	0.153	4.6	0.506
Uranium (measured)	µg/L	0	46	46	0.02	0.627	0.065	2.03	0.646
Gross Alpha	pCi/L	3	74	157	0.268	1.92	0.91	14.5	2.13
Gross Beta	pCi/L	0	122	157	0.504	3.8	0.795	15.6	3.94
Gross Gamma	pCi/L	0	52	167	44.1	158	66.7	1,920	177
***Ancho Canyon* [b]**									
Americium-241	pCi/L	0	0	8	–	–	–	–	–
Cesium-137	pCi/L	0	1	8	–	2.03	–	–	–
Cobalt-60	pCi/L	0	3	8	0.801	2.09	1.15	3	3.39
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	8	–	15.1	–	–	–
Plutonium-238	pCi/L	0	0	8	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	8	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Potassium-40	pCi/L	0	7	8	15.1	33.2	14.7	55.8	44.1
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	8	–	–	–	–	–
Strontium-90	pCi/L	1	1	8	–	0.228	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	4	–	122	–	–	–
Uranium-234	pCi/L	0	8	8	0.058	0.236	0.23	0.618	0.395
Uranium-235, Uranium-236	pCi/L	0	2	8	0.03	0.031	–	0.033	–
Uranium-238	pCi/L	0	7	8	0.047	0.163	0.16	0.398	0.281
Uranium (calculated)	µg/L	0	8	8	0.083	0.4	0.406	1.1	0.682
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	5	8	0.873	2.33	1.33	4.28	3.49
Gross Beta	pCi/L	0	8	8	2.35	4.52	1.81	6.44	5.77
Gross Gamma	pCi/L	0	3	8	73.5	92.7	20.3	114	116
Cañada del Buey [b]									
Americium-241	pCi/L	0	13	57	0.002	0.025	0.01	0.039	0.03
Cesium-137	pCi/L	0	7	60	1.24	2.89	1.39	7.29	3.91
Cobalt-60	pCi/L	0	4	33	0.304	0.95	0.914	1.75	1.85
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	33	5.24	12.3	5.71	21	17.3
Plutonium-238	pCi/L	0	1	58	–	0.038	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	2	58	0.025	0.026	–	0.026	–
Potassium-40	pCi/L	1	31	33	4.2	42.5	16.6	103	48.3
Radium-226	pCi/L	0	7	8	0.216	0.373	0.188	0.752	0.512
Sodium-22	pCi/L	0	2	33	1.7	2.12	–	2.53	–
Strontium-90	pCi/L	0	8	56	0.099	0.147	0.018	0.248	0.16
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	1	4	30	77	247	241	523	483
Uranium-234	pCi/L	0	42	58	0.009	0.361	0.171	2.1	0.413
Uranium-235, Uranium-236	pCi/L	0	21	58	0.016	0.042	0.02	0.129	0.05
Uranium-238	pCi/L	0	38	58	0.01	0.218	0.109	1.31	0.253
Uranium (calculated)	µg/L	0	55	58	0.01	0.471	0.398	3.8	0.577
Uranium (measured)	µg/L	0	14	14	0.02	0.494	0.089	2.03	0.541
Gross Alpha	pCi/L	0	23	56	0.35	1.82	0.468	3.55	2.01
Gross Beta	pCi/L	0	36	56	1.18	4.94	0.972	10.3	5.26
Gross Gamma	pCi/L	0	21	61	49.2	217	134	1,920	274
Los Alamos Canyon [b]									
Americium-241	pCi/L	1	7	27	0.019	0.029	0.006	0.047	0.033
Cesium-137	pCi/L	0	5	29	0.251	2.65	2.336	5.51	4.7
Cobalt-60	pCi/L	0	2	16	3.14	5.49	–	7.83	–
Iodine-129	pCi/L	0	1	5	–	0.524	–	–	–
Neptunium-237	pCi/L	0	0	12	–	–	–	–	–
Plutonium-238	pCi/L	0	2	26	0.006	0.013	–	0.019	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-239, Plutonium-240	pCi/L	1	2	26	0.011	0.031	–	0.051	–
Potassium-40	pCi/L	0	10	16	6.41	31.4	17.2	73.4	42.1
Radium-226	pCi/L	2	8	10	0.316	0.415	0.14	1.17	0.512
Sodium-22	pCi/L	0	1	16	–	2.74	–	–	–
Strontium-90	pCi/L	2	10	25	0.124	0.164	0.039	0.278	0.188
Technetium-99	pCi/L	0	0	5	–	–	–	–	–
Tritium	pCi/L	0	4	12	63.4	94.2	3.57	120	97.7
Uranium-234	pCi/L	0	21	26	0.036	0.496	0.304	1.72	0.626
Uranium-235, Uranium-236	pCi/L	0	16	27	0.016	0.057	0.025	0.137	0.070
Uranium-238	pCi/L	0	20	27	0.024	0.293	0.214	0.962	0.386
Uranium (calculated)	µg/L	0	21	23	0.019	0.642	0.401	3	0.813
Uranium (measured)	µg/L	0	5	5	0.02	0.78	0.229	1.8	0.981
Gross Alpha	pCi/L	1	16	23	0.268	2.28	2.21	13.5	3.37
Gross Beta	pCi/L	0	19	23	1.08	3.48	1.08	6.79	3.97
Gross Gamma	pCi/L	0	4	25	66.6	137	91.5	243	227
Mortandad Canyon [b]									
Americium-241	pCi/L	0	4	42	0.011	0.012	0.001	0.014	0.014
Cesium-137	pCi/L	0	3	42	1.26	2.53	1.19	3.62	3.88
Cobalt-60	pCi/L	1	6	39	0.576	1.61	0.7	2.42	2.17
Iodine-129	pCi/L	0	3	14	0.339	0.55	0.229	0.79	0.81
Neptunium-237	pCi/L	0	5	27	5.44	6.75	2.01	10.3	8.52
Plutonium-238	pCi/L	0	0	44	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	1	44	–	0.601	–	–	–
Potassium-40	pCi/L	3	36	39	0.471	33.2	13.2	92	37.5
Radium-226	pCi/L	7	9	12	0.162	0.389	0.258	0.926	0.558
Sodium-22	pCi/L	0	3	39	1.04	1.48	0.381	1.71	1.91
Strontium-90	pCi/L	1	10	43	0.079	0.183	0.051	0.434	0.215
Technetium-99	pCi/L	1	6	25	1.27	2.56	1.42	5.24	3.7
Tritium	pCi/L	1	6	22	88.4	139	48.3	210	178
Uranium-234	pCi/L	0	39	42	0.051	0.336	0.126	0.892	0.376
Uranium-235, Uranium-236	pCi/L	0	21	42	0.028	0.046	0.005	0.084	0.048
Uranium-238	pCi/L	0	38	42	0.07	0.169	0.061	0.395	0.189
Uranium (calculated)	µg/L	0	43	43	0.05	0.491	0.137	1.1	0.532
Uranium (measured)	µg/L	0	8	8	0.315	0.394	0.04	0.463	0.422
Gross Alpha	pCi/L	1	11	30	0.647	1.59	1.33	14.5	2.37
Gross Beta	pCi/L	0	26	30	0.504	2.29	1.98	14.1	3.05
Gross Gamma	pCi/L	0	11	31	44.1	157	85.8	778	207
Pajarito Canyon [b]									
Americium-241	pCi/L	2	2	16	0.008	0.019	–	0.031	–
Cesium-137	pCi/L	0	2	16	1.08	7.84	–	14.6	–
Cobalt-60	pCi/L	0	0	16	–	–	–	–	–

Measured Radiochemical		2001 through 2005 Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	16	6.7	13	–	19.2	–
Plutonium-238	pCi/L	0	0	16	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	16	–	–	–	–	–
Potassium-40	pCi/L	0	11	16	10.9	28.1	13.3	49.3	35.9
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	1	16	–	2.01	–	–	–
Strontium-90	pCi/L	0	2	16	0.088	0.17	–	0.252	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	8	–	–	–	–	–
Uranium-234	pCi/L	0	12	16	0.061	0.317	0.193	0.582	0.426
Uranium-235, Uranium-236	pCi/L	0	5	16	0.033	0.043	0.011	0.061	0.053
Uranium-238	pCi/L	0	12	16	0.033	0.162	0.089	0.269	0.212
Uranium (calculated)	µg/L	0	16	16	0.05	0.294	0.301	0.98	0.442
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	1	6	16	0.574	1.76	1.86	5.37	3.25
Gross Beta	pCi/L	0	13	16	1.52	3.55	2.08	8.67	4.68
Gross Gamma	pCi/L	0	8	16	45.5	77.3	29.8	139	98
Potrillo Canyon [b]									
Americium-241	pCi/L	0	1	9	–	0.035	–	–	–
Cesium-137	pCi/L	0	2	9	1.77	2.39	–	3	–
Cobalt-60	pCi/L	0	1	9	–	0.264	-	-	-
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	9	–	–	–	–	–
Plutonium-238	pCi/L	0	0	11	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	1	11	–	0.163	–	–	–
Potassium-40	pCi/L	0	6	9	3.25	26.1	12.8	60.3	36.3
Radium-226	pCi/L	0	2	3	0.149	0.176	–	0.202	–
Sodium-22	pCi/L	0	2	9	1.87	2.23	–	2.58	–
Strontium-90	pCi/L	0	4	9	0.167	0.215	0.061	0.282	0.275
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	5	–	67.7	–	–	–
Uranium-234	pCi/L	0	9	9	0.215	0.476	0.012	0.918	0.484
Uranium-235, Uranium-236	pCi/L	0	4	9	0.035	0.077	0.025	0.104	0.102
Uranium-238	pCi/L	0	9	9	0.076	0.237	0.013	0.669	0.245
Uranium (calculated)	µg/L	0	9	9	0.26	0.628	0.1	1.44	0.693
Uranium (measured)	µg/L	0	8	8	0.02	0.678	0.225	1.89	0.834
Gross Alpha	pCi/L	0	4	9	0.924	2.39	1.16	4.99	3.53
Gross Beta	pCi/L	0	8	9	1.11	3.27	1.2	6.34	4.1
Gross Gamma	pCi/L	0	0	9	–	–	–	–	–

Measured Radiochemical		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
		2001 through 2005							
Pueblo Canyon [b]									
Americium-241	pCi/L	0	0	7	–	–	–	–	–
Cesium-137	pCi/L	0	0	7	–	–	–	–	–
Cobalt-60	pCi/L	0	1	7	–	2.19	–	–	–
Iodine-129	pCi/L	0	0	7	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	7	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	7	–	–	–	–	–
Potassium-40	pCi/L	0	5	7	22.8	30.3	4.44	33.7	34.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	7	–	–	–	–	–
Strontium-90	pCi/L	0	1	7	–	0.121	–	–	–
Technetium-99	pCi/L	0	2	7	2.18	3.13	–	4.07	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Uranium-234	pCi/L	0	6	7	0.493	0.638	0.129	0.846	0.741
Uranium-235, Uranium-236	pCi/L	0	2	7	0.048	0.053	–	0.057	–
Uranium-238	pCi/L	0	6	7	0.183	0.261	0.04	0.289	0.293
Uranium (calculated)	µg/L	0	13	13	0.05	0.689	0.246	1.1	0.823
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	0	–	–	–	–	–
Gross Beta	pCi/L	0	0	0	–	–	–	–	–
Gross Gamma	pCi/L	0	0	0	–	–	–	–	–
Sandia Canyon [b]									
Americium-241	pCi/L	1	3	21	0.016	0.02	0.005	0.025	0.025
Cesium-137	pCi/L	0	3	19	1.08	3.31	2.16	2.48	5.75
Cobalt-60	pCi/L	0	2	13	2.4	2.4	–	2.4	–
Iodine-129	pCi/L	0	1	7	–	0.634	–	–	–
Neptunium-237	pCi/L	0	1	7	–	9.68	–	–	–
Plutonium-238	pCi/L	0	1	21	–	0.03	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	21	–	–	–	–	–
Potassium-40	pCi/L	1	12	13	6.5	38	25	105	52.2
Radium-226	pCi/L	2	3	4	0.208	0.48	0.269	0.745	0.784
Sodium-22	pCi/L	0	1	13	–	2.04	–	–	–
Strontium-90	pCi/L	0	9	21	0.078	0.128	0.044	0.247	0.156
Technetium-99	pCi/L	0	3	7	1.36	1.73	0.590	2.41	2.4
Tritium	pCi/L	0	4	10	110	111	0.0	112	–
Uranium-234	pCi/L	0	18	21	0.016	0.713	0.274	2.66	0.839
Uranium-235, Uranium-236	pCi/L	0	14	21	0.017	0.06	0.017	0.164	0.069
Uranium-238	pCi/L	0	16	21	0.022	0.404	0.09	1.53	0.448
Uranium (calculated)	µg/L	0	23	27	0.05	1.19	0.246	4.6	1.29
Uranium (measured)	µg/L	0	7	7	0.051	1.1	0.058	1.64	1.15

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Alpha	pCi/L	0	9	13	0.614	1.36	0.32	2.49	1.57
Gross Beta	pCi/L	0	10	13	1.32	4.23	2.19	15.6	5.59
Gross Gamma	pCi/L	0	3	15	70.2	114	61.3	220	183
Water Canyon [b]									
Americium-241	pCi/L	0	0	6	–	–	–	–	–
Cesium-137	pCi/L	0	0	6	–	–	–	–	–
Cobalt-60	pCi/L	1	2	6	3.12	4.81	–	6.5	–
Iodine-129	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	0	6	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	6	–	–	–	–	–
Potassium-40	pCi/L	0	6	6	10.6	20.4	9.86	37.2	28.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	6	–	–	–	–	–
Strontium-90	pCi/L	0	0	6	–	–	–	–	–
Technetium-99	pCi/L	0	0	4	–	–	–	–	–
Tritium	pCi/L	0	0	3	–	–	–	–	–
Uranium-234	pCi/L	0	6	6	0.048	0.225	0.09	0.297	0.298
Uranium-235, Uranium-236	pCi/L	0	1	6	–	0.031	–	–	–
Uranium-238	pCi/L	0	5	6	0.121	0.135	0.012	0.151	0.145
Uranium (calculated)	µg/L	0	47	47	0.05	0.234	0.187	0.54	0.288
Uranium (measured)	µg/L	0	4	4	0.046	0.388	0.278	0.727	0.66
Gross Alpha	pCi/L	0	0	2	–	–	–	–	–
Gross Beta	pCi/L	0	2	2	1.89	1.97	–	2.04	–
Gross Gamma	pCi/L	0	2	2	94.1	102	–	109	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–12 Radiochemical Statistical Analysis of Groundwater – Test Wells

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Test Wells [a] Composite									
Americium-241	pCi/L	1	17	54	0.003	0.026	0.008	0.066	0.03
Cesium-137	pCi/L	3	12	60	0.132	3.12	2	16.3	4.25
Cobalt-60	pCi/L	0	3	25	1.71	2.84	1.14	3.99	4.13
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	7	26	8.51	13.45	2.04	21.2	15

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	0	12	53	0.0	0.009	0.005	0.015	0.012
Plutonium-239, Plutonium-240	pCi/L	0	8	53	0.005	0.017	0.009	0.027	0.023
Potassium-40	pCi/L	0	22	25	1.91	30.1	5.67	68	32.5
Radium-226	pCi/L	4	11	16	0.173	0.496	0.087	0.904	0.548
Sodium-22	pCi/L	0	1	25	–	2.06	–	–	–
Strontium-90	pCi/L	3	26	71	0.004	0.129	0.07	0.238	0.156
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	6	19	50	0.0	133	70.7	303	165
Uranium-234	pCi/L	0	45	53	0.035	0.562	0.139	2.14	0.602
Uranium-235, Uranium-236	pCi/L	0	16	53	0.006	0.067	0.046	0.181	0.089
Uranium-238	pCi/L	0	43	53	0.008	0.254	0.141	1.18	0.296
Uranium (calculated)	µg/L	0	49	49	0.011	0.649	0.064	3.6	0.666
Uranium (measured)	µg/L	0	20	20	0.02	0.491	0.235	3.46	0.593
Gross Alpha	pCi/L	0	24	52	0.173	1.37	0.49	4.73	1.56
Gross Beta	pCi/L	0	45	52	0.708	2.34	0.535	5.75	2.5
Gross Gamma	pCi/L	0	14	44	52.3	88.4	42.9	271	111
Ancho Canyon [b]									
Americium-241	pCi/L	1	7	28	0.003	0.029	0.011	0.066	0.036
Cesium-137	pCi/L	0	3	25	1.9	4.52	3.59	7.06	8.59
Cobalt-60	pCi/L	0	1	12	–	2.82	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	13	8.51	9.89	1.96	13.1	12.1
Plutonium-238	pCi/L	0	5	27	0.0	0.006	0.005	0.009	0.01
Plutonium-239, Plutonium-240	pCi/L	0	5	27	0.005	0.016	0.01	0.027	0.024
Potassium-40	pCi/L	0	11	12	11.3	33.1	1.08	57.7	33.7
Radium-226	pCi/L	3	4	6	0.22	0.61	0.286	0.904	0.89
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	1	10	28	0.004	0.124	0.07	0.233	0.167
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	7	22	0.0	154	148	303	263
Uranium-234	pCi/L	0	23	27	0.086	0.271	0.069	0.644	0.299
Uranium-235, Uranium-236	pCi/L	0	6	27	0.027	0.043	0.006	0.054	0.048
Uranium-238	pCi/L	0	22	27	0.021	0.098	0.048	0.31	0.118
Uranium (calculated)	µg/L	0	27	27	0.011	0.322	0.116	0.67	0.365
Uranium (measured)	µg/L	0	10	10	0.02	0.28	0.04	0.547	0.305
Gross Alpha	pCi/L	0	10	24	0.173	0.858	0.499	1.9	1.17
Gross Beta	pCi/L	0	19	24	0.8	1.61	0.411	2.97	1.79
Gross Gamma	pCi/L	0	5	22	52.3	81.5	15.9	99.2	95.5

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	4	11	0.01	0.015	0.009	0.028	0.024
Cesium-137	pCi/L	3	5	14	0.132	4.36	4.91	16.3	8.66
Cobalt-60	pCi/L	0	1	5	–	3.99	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	5	–	–	–	–	–
Plutonium-238	pCi/L	0	3	11	0.0	0.007	0.007	0.015	0.015
Plutonium-239, Plutonium-240	pCi/L	0	2	11	0.012	0.02	–	0.027	–
Potassium-40	pCi/L	0	3	5	10.6	25.6	6.4	31.5	32.8
Radium-226	pCi/L	0	2	5	0.173	0.399	–	0.625	–
Sodium-22	pCi/L	0	1	5	–	2.06	–	–	–
Strontium-90	pCi/L	0	5	14	0.057	0.133	0.085	0.226	0.207
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	9	53.1	84.8	44.8	117	136
Uranium-234	pCi/L	0	9	11	0.049	0.209	0.191	0.444	0.333
Uranium-235, Uranium-236	pCi/L	0	0	11	–	–	–	–	–
Uranium-238	pCi/L	0	8	11	0.02	0.062	0.067	0.18	0.108
Uranium (calculated)	µg/L	0	9	9	0.041	0.283	0.247	0.55	0.444
Uranium (measured)	µg/L	0	4	4	0.02	0.337	0.413	0.629	0.742
Gross Alpha	pCi/L	0	3	12	0.381	0.63	0.217	0.774	0.876
Gross Beta	pCi/L	0	11	12	0.708	2.53	1.17	5.26	3.22
Gross Gamma	pCi/L	0	5	7	55	69.2	13.3	99.8	80.9
Mortandad Canyon [b]									
Americium-241	pCi/L	0	1	4	–	0.009	–	–	–
Cesium-137	pCi/L	0	2	8	2.16	2.23	–	2.3	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	2	9.62	15.4	–	21.2	–
Plutonium-238	pCi/L	0	1	4	–	0.0	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	2	2	28.8	31.2	–	33.6	–
Radium-226	pCi/L	0	1	1	–	0.268	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	3	11	0.004	0.132	0.119	0.238	0.266
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	7	0.0	40.5	–	80.9	–
Uranium-234	pCi/L	0	4	4	0.264	0.377	0.042	0.412	0.418

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	2	4	0.038	0.044	–	0.049	–
Uranium-238	pCi/L	0	4	4	0.023	0.125	0.089	0.194	0.212
Uranium (calculated)	µg/L	0	4	4	0.39	0.486	0.083	0.6	0.567
Uranium (measured)	µg/L	0	5	5	0.52	0.66	0.167	0.845	0.806
Gross Alpha	pCi/L	0	3	4	0.96	1.08	0.132	1.22	1.23
Gross Beta	pCi/L	0	3	4	2.36	2.7	0.445	3.01	3.2
Gross Gamma	pCi/L	0	0	5	–	–	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	5	11	0.015	0.024	0.009	0.04	0.032
Cesium–137	pCi/L	0	2	13	0.971	1.5	–	2.03	–
Cobalt-60	pCi/L	0	1	6	–	1.71	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	6	15.5	18.3	–	21.1	–
Plutonium-238	pCi/L	0	3	11	0.0	0.009	0.007	0.014	0.017
Plutonium-239, Plutonium-240	pCi/L	0	1	11	–	0.005	–	–	–
Potassium-40	pCi/L	0	6	6	1.91	24.6	15.5	68	37.1
Radium-226	pCi/L	1	4	4	0.176	0.411	0.16	0.629	0.568
Sodium-22	pCi/L	0	0	6	–	–	–	–	–
Strontium-90	pCi/L	2	8	18	0.017	0.099	0.08	0.19	0.155
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	4	7	12	53.4	151	33.6	208	176
Uranium-234	pCi/L	0	9	11	0.035	1.74	0.441	2.14	2.03
Uranium-235, Uranium-236	pCi/L	0	8	11	0.006	0.098	0.073	0.181	0.148
Uranium-238	pCi/L	0	9	11	0.008	0.832	0.441	1.18	1.12
Uranium (calculated)	µg/L	0	9	9	0.018	2.19	0.715	3.6	2.66
Uranium (measured)	µg/L	0	1	1	–	3.46	–	–	–
Gross Alpha	pCi/L	0	8	12	0.429	2.38	0.818	4.73	2.95
Gross Beta	pCi/L	0	12	12	1.85	3.44	0.672	5.75	3.82
Gross Gamma	pCi/L	0	4	10	53.9	98	70	271	167

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–13 Radiochemical Statistical Analysis of Groundwater – Water Supply Wells

Measured Radiochemical		*2001 through 2005*							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Water Supply Wells [a] Composite									
Americium-241	pCi/L	2	17	64	0.003	0.033	0.03	0.157	0.047
Cesium-137	pCi/L	1	10	66	0.021	2.73	2.59	15.2	4.33
Cobalt-60	pCi/L	0	6	26	1.35	2.12	0.502	3.53	2.52
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	8	26	2.02	13.3	3.77	28.4	15.9
Plutonium-238	pCi/L	0	12	60	0.004	0.012	0.001	0.019	0.013
Plutonium-239, Plutonium-240	pCi/L	0	12	60	0.0	0.017	0.014	0.031	0.024
Potassium-40	pCi/L	0	22	26	0.47	27.3	5.88	63.9	29.8
Radium-226	pCi/L	7	17	26	0.123	0.338	0.124	0.671	0.397
Sodium-22	pCi/L	0	0	26	–	–	–	–	–
Strontium-90	pCi/L	1	51	185	0.035	0.116	0.043	0.272	0.127
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	7	11	72	60.8	204	180	874	311
Uranium-234	pCi/L	0	59	60	0.13	0.523	0.082	1.29	0.544
Uranium-235, Uranium-236	pCi/L	0	36	60	0.005	0.048	0.017	0.142	0.054
Uranium-238	pCi/L	0	59	60	0.017	0.226	0.11	0.642	0.254
Uranium (calculated)	µg/L	0	49	49	0.025	0.82	0.053	1.78	0.835
Uranium (measured)	µg/L	0	14	14	0.02	0.849	0.547	1.77	1.14
Gross Alpha	pCi/L	1	36	76	0.528	1.48	0.669	9.09	1.69
Gross Beta	pCi/L	0	67	75	0.872	3.43	0.77	8.93	3.61
Gross Gamma	pCi/L	0	18	47	48.4	114	39.6	355	132
***Cañada del Buey* [b]**									
Americium-241	pCi/L	0	0	3	–	–	–	–	–
Cesium-137	pCi/L	0	2	3	0.021	1.04	–	2.05	–
Cobalt-60	pCi/L	0	1	1	–	1.35	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	1	–	–	–	–	–
Plutonium-238	pCi/L	0	1	3	–	0.017	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	1	1	–	26.6	–	–	–
Radium-226	pCi/L	0	1	1	–	0.242	–	–	–
Sodium-22	pCi/L	0	0	1	–	–	–	–	–
Strontium-90	pCi/L	1	2	7	0.085	0.154	–	0.224	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	3	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.213	0.247	0.031	0.275	0.283

Measured Radiochemical		2001 through 2005							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium-235, Uranium-236	pCi/L	0	1	3	–	0.035	–	–	–
Uranium-238	pCi/L	0	3	3	0.019	0.094	0.066	0.144	0.169
Uranium (calculated)	µg/L	0	2	2	0.37	0.39	–	0.41	–
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	1	3	–	1.94	–	–	–
Gross Beta	pCi/L	0	3	3	1.14	3.33	2.48	6.03	6.14
Gross Gamma	pCi/L	0	2	2	54.1	72.3	–	90.5	–
Guaje Canyon [b]									
Americium-241	pCi/L	0	5	29	0.006	0.018	0.0	0.032	0.018
Cesium-137	pCi/L	0	3	29	1.61	2.80	1.18	3.97	4.14
Cobalt-60	pCi/L	0	2	12	2.36	2.95	–	3.53	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	12	12.2	12.6	–	13	–
Plutonium-238	pCi/L	0	5	29	0.004	0.013	0.008	0.019	0.02
Plutonium-239, Plutonium-240	pCi/L	0	4	29	0.0	0.017	0.02	0.031	0.036
Potassium-40	pCi/L	0	10	12	0.47	30.1	5.19	40	33.3
Radium-226	pCi/L	5	9	12	0.139	0.355	0.11	0.608	0.427
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	0	24	83	0.035	0.108	0.046	0.272	0.127
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	7	8	30	67.8	257	255	874	434
Uranium-234	pCi/L	0	28	29	0.254	0.415	0.043	0.627	0.431
Uranium-235, Uranium-236	pCi/L	0	19	29	0.005	0.038	0.009	0.068	0.042
Uranium-238	pCi/L	0	28	29	0.019	0.198	0.098	0.347	0.235
Uranium (calculated)	µg/L	0	24	24	0.025	0.661	0.074	1.05	0.69
Uranium (measured)	µg/L	0	7	7	0.02	0.589	0.284	0.858	0.799
Gross Alpha	pCi/L	0	15	36	0.528	0.955	0.378	1.84	1.15
Gross Beta	pCi/L	0	31	36	1.32	2.72	0.743	6.25	2.98
Gross Gamma	pCi/L	0	9	25	48.4	91.2	18.1	123	103
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	0	4	–	–	–	–	–
Cesium-137	pCi/L	0	0	5	–	–	–	–	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	2	5.77	10.7	–	15.6	–
Plutonium-238	pCi/L	0	1	4	–	0.017	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	1	4	–	0.016	–	–	–
Potassium-40	pCi/L	0	2	2	31.1	33.8	–	36.4	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Radium-226	pCi/L	1	1	2	–	0.349	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	4	15	0.067	0.086	0.019	0.104	0.104
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	6	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.516	0.585	0.053	0.641	0.638
Uranium-235, Uranium-236	pCi/L	0	2	4	0.031	0.063	–	0.095	–
Uranium-238	pCi/L	0	4	4	0.028	0.211	0.125	0.31	0.334
Uranium (calculated)	µg/L	0	3	3	0.74	0.814	0.108	0.937	0.935
Uranium (measured)	µg/L	0	1	1	–	0.784	–	–	–
Gross Alpha	pCi/L	0	3	5	1.02	1.28	0.304	1.49	1.62
Gross Beta	pCi/L	0	5	5	2.66	3.7	0.952	4.94	4.54
Gross Gamma	pCi/L	0	1	3	–	120	–	–	–
Mortandad Canyon [b]									
Americium-241	pCi/L	1	2	5	0.012	0.085	–	0.157	–
Cesium-137	pCi/L	1	1	5	–	15.2	–	–	–
Cobalt-60	pCi/L	0	1	2	–	2.52	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	2	–	17.4	–	–	–
Plutonium-238	pCi/L	0	0	4	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	1	2	–	16.6	–	–	–
Radium-226	pCi/L	0	2	2	0.23	0.306	–	0.382	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	3	13	0.115	0.135	0.028	0.194	0.166
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	6	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.228	0.332	0.076	0.391	0.407
Uranium-235, Uranium-236	pCi/L	0	2	4	0.039	0.041	–	0.044	–
Uranium-238	pCi/L	0	4	4	0.019	0.143	0.086	0.218	0.227
Uranium (calculated)	µg/L	0	3	3	0.43	0.487	0.05	0.521	0.544
Uranium (measured)	µg/L	0	1	1	–	0.553	–	–	–
Gross Alpha	pCi/L	0	1	5	–	0.665	–	–	–
Gross Beta	pCi/L	0	5	5	1.71	2.69	0.963	4.01	3.53
Gross Gamma	pCi/L	0	0	3	–	–	–	–	–
Pajarito Canyon [b]									
Americium-241	pCi/L	0	3	5	0.016	0.031	0.008	0.059	0.041
Cesium-137	pCi/L	0	2	5	1.53	1.71	–	1.88	–
Cobalt-60	pCi/L	0	1	2	–	2.59	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	2	–	28.4	–	–	–
Plutonium-238	pCi/L	0	1	4	–	0.01	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	1	4	–	0.003	–	–	–
Potassium-40	pCi/L	0	2	2	20.9	42.4	–	63.9	–
Radium-226	pCi/L	0	1	2	–	0.466	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	0	5	16	0.073	0.1	0.007	0.11	0.106
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	7	–	–	–	–	–
Uranium-234	pCi/L	0	4	4	0.13	0.201	0.054	0.257	0.253
Uranium-235, Uranium-236	pCi/L	0	2	4	0.018	0.025	–	0.033	–
Uranium-238	pCi/L	0	4	4	0.017	0.076	0.039	0.099	0.115
Uranium (calculated)	μg/L	0	3	3	0.266	0.296	0.028	0.320	0.328
Uranium (measured)	μg/L	0	1	1	–	0.236	–	–	–
Gross Alpha	pCi/L	0	1	5	–	1.03	–	–	–
Gross Beta	pCi/L	0	4	5	0.872	2.08	1.17	3.55	3.23
Gross Gamma	pCi/L	0	1	3	–	281	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	1	4	8	0.018	0.055	0.057	0.121	0.111
Cesium-137	pCi/L	0	0	7	–	–	–	–	–
Cobalt-60	pCi/L	0	0	3	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	3	–	2.02	–	–	–
Plutonium-238	pCi/L	0	2	7	0.012	0.015	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	3	7	0.002	0.006	0.004	0.009	0.01
Potassium-40	pCi/L	0	3	3	3.3	27.6	15	38.2	44.5
Radium-226	pCi/L	0	1	3	–	0.123	–	–	–
Sodium-22	pCi/L	0	0	3	–	–	–	–	–
Strontium-90	pCi/L	0	4	19	0.06	0.074	0.004	0.09	0.078
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	7	60.8	79.7	–	98.5	–
Uranium-234	pCi/L	0	7	7	0.753	0.891	0.108	1.04	0.971
Uranium-235, Uranium-236	pCi/L	0	4	7	0.027	0.101	0.064	0.142	0.163
Uranium-238	pCi/L	0	7	7	0.044	0.409	0.245	0.594	0.591
Uranium (calculated)	μg/L	0	6	6	1.33	1.5	0.079	1.56	1.56
Uranium (measured)	μg/L	0	2	2	1.72	1.75	–	1.77	–
Gross Alpha	pCi/L	0	6	8	0.691	1.62	0.604	2.21	2.1

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	0	8	8	2.46	3.74	0.632	6.1	4.18
Gross Gamma	pCi/L	0	2	4	91.3	104	–	116	–
Sandia Canyon [b]									
Americium-241	pCi/L	0	3	10	0.003	0.023	0.021	0.037	0.046
Cesium-137	pCi/L	0	2	12	0.322	1.59	–	2.85	–
Cobalt-60	pCi/L	0	1	4	–	1.76	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	4	–	11.8	–	–	–
Plutonium-238	pCi/L	0	2	9	0.01	0.010	–	0.011	–
Plutonium-239, Plutonium-240	pCi/L	0	3	9	0.0	0.008	0.011	0.016	0.02
Potassium-40	pCi/L	0	3	4	8.37	12.4	3.28	21.1	16.1
Radium-226	pCi/L	1	2	4	0.234	0.453	–	0.671	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	9	32	0.05	0.106	0.052	0.178	0.14
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	13	–	96.4	–	–	–
Uranium-234	pCi/L	0	9	9	0.595	0.957	0.125	1.29	1.04
Uranium-235, Uranium-236	pCi/L	0	6	9	0.047	0.078	0.015	0.125	0.09
Uranium-238	pCi/L	0	9	9	0.039	0.336	0.2	0.642	0.467
Uranium (calculated)	µg/L	0	8	8	0.860	1.18	0.234	1.78	1.34
Uranium (measured)	µg/L	0	2	2	0.931	1.35	–	1.77	–
Gross Alpha	pCi/L	1	9	14	0.696	2.24	1.16	9.09	3
Gross Beta	pCi/L	0	11	13	2.47	5.57	1.55	8.93	6.48
Gross Gamma	pCi/L	0	3	7	81.7	167	73.1	355	249

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.
[b] Italicized subheadings identify individual canyons whose data are included in the composite.
Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–14 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Springs

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Aquifer Springs [a] Composite									
Americium-241	pCi/L	3	25	119	0.005	0.018	0.004	0.037	0.02
Cesium-137	pCi/L	0	15	120	1.21	2.18	0.738	3.98	2.55
Cobalt-60	pCi/L	0	3	61	0.353	1.82	1.61	3.55	3.65
Iodine-129	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
		2001 through 2005							
Neptunium-237	pCi/L	0	11	62	2.71	14	4.43	29.6	16.6
Plutonium-238	pCi/L	2	12	118	0.0	0.032	0.019	0.074	0.042
Plutonium-239, Plutonium-240	pCi/L	0	7	118	0.005	0.014	0.005	0.021	0.018
Potassium-40	pCi/L	3	43	61	0.4	30.5	1.33	65.4	30.9
Radium-226	pCi/L	5	18	28	0.118	1.22	1.11	3.45	1.73
Sodium-22	pCi/L	0	2	61	2.04	2.44	–	2.84	–
Strontium-90	pCi/L	2	22	113	0.056	0.162	0.028	0.3	0.174
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	17	25	117	54.8	171	113	588	216
Uranium-234	pCi/L	7	107	117	0.044	1.04	0.412	7.22	1.12
Uranium-235, Uranium-236	pCi/L	0	68	116	0.009	0.077	0.03	0.552	0.084
Uranium-238	pCi/L	0	107	117	0.019	0.563	0.28	4.4	0.616
Uranium (calculated)	µg/L	0	111	112	0.008	1.76	0.553	11.8	1.86
Uranium (measured)	µg/L	0	67	67	0.02	3.98	2.98	19.6	4.7
Gross Alpha	pCi/L	9	65	118	0.625	2.87	0.957	11.5	3.1
Gross Beta	pCi/L	0	96	117	0.649	3.36	1.32	17.0	3.63
Gross Gamma	pCi/L	0	27	104	50.4	198	67.9	1,420	224
Sandia Canyon [b]									
Americium-241	pCi/L	1	1	9	–	0.035	–	–	–
Cesium-137	pCi/L	0	1	9	–	3.17	–	–	–
Cobalt-60	pCi/L	0	0	5	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	29.6	–	–	–
Plutonium-238	pCi/L	0	2	9	0.002	0.005	–	0.007	–
Plutonium-239, Plutonium-240	pCi/L	0	0	9	–	–	–	–	–
Potassium-40	pCi/L	0	3	5	30.3	41	2.48	48.1	43.8
Radium-226	pCi/L	1	2	2	0.381	1.32	–	2.25	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	1	2	9	0.114	0.127	–	0.14	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	3	9	122	194	88.8	293	294
Uranium-234	pCi/L	0	8	9	0.264	0.589	0.239	0.99	0.754
Uranium-235, Uranium-236	pCi/L	0	4	9	0.031	0.118	0.106	0.193	0.222
Uranium-238	pCi/L	0	8	9	0.042	0.279	0.163	0.634	0.392
Uranium (calculated)	µg/L	0	8	8	0.05	0.862	0.256	1.21	1.04
Uranium (measured)	µg/L	0	1	1	–	0.62	–	–	–
Gross Alpha	pCi/L	0	5	9	0.839	1.13	0.196	1.62	1.3
Gross Beta	pCi/L	0	8	9	1.8	3.21	1.22	4.85	4.06

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Gamma	pCi/L	0	2	7	105	237	–	369	–
White Rock Canyon and Rio Grande [b]									
Americium-241	pCi/L	2	24	110	0.005	0.018	0.004	0.037	0.02
Cesium-137	pCi/L	0	14	111	1.21	2.14	0.738	3.98	2.53
Cobalt-60	pCi/L	0	3	56	0.353	1.82	1.61	3.55	3.65
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	10	57	2.71	12.6	6.33	28.2	16.6
Plutonium-238	pCi/L	2	10	109	0.0	0.032	0.018	0.074	0.044
Plutonium-239, Plutonium-240	pCi/L	0	7	109	0.005	0.014	0.005	0.021	0.018
Potassium-40	pCi/L	3	40	56	0.4	29.8	1.28	65.4	30.2
Radium-226	pCi/L	4	16	26	0.118	1.16	1.02	3.45	1.66
Sodium-22	pCi/L	0	2	56	2.04	2.44	–	2.84	–
Strontium-90	pCi/L	1	20	104	0.056	0.167	0.035	0.3	0.182
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	15	22	108	54.8	182	124	588	234
Uranium-234	pCi/L	7	99	108	0.044	1.07	0.438	7.22	1.16
Uranium-235, Uranium-236	pCi/L	0	64	107	0.009	0.078	0.031	0.552	0.085
Uranium-238	pCi/L	0	99	108	0.019	0.586	0.293	4.4	0.644
Uranium (calculated)	µg/L	0	103	104	0.008	1.83	0.585	11.8	1.94
Uranium (measured)	µg/L	0	66	66	0.02	4.01	2.94	19.6	4.72
Gross Alpha	pCi/L	9	60	109	0.625	3.03	1.1	11.5	3.31
Gross Beta	pCi/L	0	88	108	0.649	3.39	1.35	17	3.67
Gross Gamma	pCi/L	0	25	97	50.4	193	65.3	1,420	218

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier is indicated in Table F–1.

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–15 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Wells [a]

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Canyon Alluvial Wells [a] Composite									
Americium-241	pCi/L	72	109	152	0.0	0.422	0.402	3.98	0.497
Cesium-137	pCi/L	7	35	149	0.0	3.46	1.82	16.5	4.06
Cobalt-60	pCi/L	0	9	80	1.03	2.16	0.142	4.29	2.25
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	11	80	1.39	11.7	1.79	20.9	12.8

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	21	65	151	0.0	0.422	0.432	2.19	0.528
Plutonium-239, Plutonium-240	pCi/L	30	67	151	0.0	0.239	0.157	1.96	0.277
Potassium-40	pCi/L	10	70	80	0.535	41.7	12.5	154	44.6
Radium-226	pCi/L	39	49	51	0.137	0.803	0.441	2.27	0.927
Sodium-22	pCi/L	1	31	80	1.47	3.8	0.367	6.48	3.93
Strontium-90	pCi/L	107	121	149	0.1	17.4	5	81.6	18.3
Technetium-99	pCi/L	19	19	23	6.25	12.8	4.8	23.1	14.9
Tritium	pCi/L	56	74	108	84.2	2,200	441	8,770	2,300
Uranium-234	pCi/L	0	134	152	0.014	0.515	0.212	3.24	0.55
Uranium-235, Uranium-236	pCi/L	0	92	152	0.0	0.059	0.017	0.222	0.063
Uranium-238	pCi/L	0	131	152	0.0	0.248	0.084	1.53	0.263
Uranium (calculated)	µg/L	0	163	166	0.0	0.821	0.481	28.5	0.895
Uranium (measured)	µg/L	0	64	64	0.02	0.475	0.228	1.6	0.531
Gross Alpha	pCi/L	11	107	150	0.512	2.85	0.758	19.3	3
Gross Beta	pCi/L	79	142	148	1.93	51.2	15.5	262	53.8
Gross Gamma	pCi/L	0	41	118	55	201.7	133	2,340	242
Los Alamos Canyon [b]									
Americium-241	pCi/L	9	29	51	0.0	0.035	0.014	0.273	0.04
Cesium-137	pCi/L	1	11	50	0.0	2.62	1.67	4.9	3.6
Cobalt-60	pCi/L	0	3	14	1.32	1.8	0.371	2.06	2.22
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	14	6.62	10	0.007	13.4	10
Plutonium-238	pCi/L	3	20	51	0.0	0.103	0.142	0.313	0.165
Plutonium-239, Plutonium-240	pCi/L	2	21	51	0.0	0.023	0.01	0.103	0.027
Potassium-40	pCi/L	3	13	14	0.535	46.5	41.1	154	68.9
Radium-226	pCi/L	9	14	14	0.137	0.589	0.397	1.78	0.797
Sodium-22	pCi/L	0	0	14	–	–	–	–	–
Strontium-90	pCi/L	38	44	50	0.1	15.29	2.94	71.5	16.2
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	14	26	40	84.2	173	40.89	399	189
Uranium-234	pCi/L	0	41	51	0.017	0.227	0.194	1.39	0.286
Uranium-235, Uranium-236	pCi/L	0	25	51	0.007	0.056	0.048	0.222	0.075
Uranium-238	pCi/L	0	38	51	0.009	0.084	0.049	0.243	0.1
Uranium (calculated)	µg/L	0	43	44	0.01	0.239	0.08	1.12	0.263
Uranium (measured)	µg/L	0	30	30	0.02	0.234	0.064	0.653	0.257
Gross Alpha	pCi/L	0	22	49	0.512	1.3	0.453	3.08	1.49
Gross Beta	pCi/L	22	45	49	3.19	36.2	7.6	107	38.4
Gross Gamma	pCi/L	0	12	31	55	410	528	2,340	709

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Mortandad Canyon [b]									
Americium-241	pCi/L	62	64	69	0.012	0.728	0.651	3.98	0.888
Cesium-137	pCi/L	5	19	68	0.8	5	3.26	16.5	6.47
Cobalt-60	pCi/L	0	5	54	1.03	2.78	1.21	4.29	3.84
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	6	54	9.34	12.87	2.09	20	14.5
Plutonium-238	pCi/L	18	34	68	0.01	0.601	0.611	2.19	0.807
Plutonium-239, Plutonium-240	pCi/L	19	29	68	0.01	0.436	0.385	1.96	0.576
Potassium-40	pCi/L	5	47	54	3.1	33.5	3.2	77	34.4
Radium-226	pCi/L	24	27	29	0.242	1.02	0.436	2.27	1.18
Sodium-22	pCi/L	1	31	54	1.47	3.80	0.367	6.48	3.93
Strontium-90	pCi/L	53	57	69	0.214	31	11.1	81.6	33.8
Technetium-99	pCi/L	19	19	23	6.25	12.78	4.8	23.1	14.9
Tritium	pCi/L	42	44	45	108	4,240	1,420	8,770	4,660
Uranium-234	pCi/L	0	67	69	0.088	1.04	0.392	3.24	1.13
Uranium-235, Uranium-236	pCi/L	0	60	69	0.025	0.072	0.016	0.212	0.076
Uranium-238	pCi/L	0	67	69	0.044	0.432	0.102	1.53	0.456
Uranium (calculated)	µg/L	0	49	49	0.0	1.5	0.55	28.5	1.66
Uranium (measured)	µg/L	0	25	25	0.529	0.927	0.093	1.6	0.964
Gross Alpha	pCi/L	10	62	67	0.777	4.01	1.87	12.4	4.47
Gross Beta	pCi/L	56	66	67	4.97	104	33.4	262	111
Gross Gamma	pCi/L	0	23	66	59.1	146	92.1	1,480	184
Pajarito Canyon [b]									
Americium-241	pCi/L	0	7	12	0.005	0.037	0.02	0.058	0.052
Cesium-137	pCi/L	1	1	12	–	9.39	–	–	–
Cobalt-60	pCi/L	0	0	5	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	20.9	–	–	–
Plutonium-238	pCi/L	0	6	12	0.0	0.004	0.01	0.024	0.012
Plutonium-239, Plutonium-240	pCi/L	0	5	12	0.005	0.01	0.006	0.02	0.015
Potassium-40	pCi/L	1	4	5	10.2	34.3	19.7	53.9	53.7
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	2	6	11	0.197	0.344	0.075	0.491	0.404
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	6	161	180	–	199	–
Uranium-234	pCi/L	0	10	12	0.014	0.272	0.205	1.08	0.399
Uranium-235, Uranium-236	pCi/L	0	3	12	0.0	0.045	0.039	0.069	0.089

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-238	pCi/L	0	9	12	0.0	0.209	0.146	0.869	0.305
Uranium (calculated)	µg/L	0	12	13	0.0	0.553	0.335	2.62	0.743
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	8	12	0.807	1.5	0.607	3.07	1.92
Gross Beta	pCi/L	0	12	12	1.93	6.19	0.045	12.9	6.21
Gross Gamma	pCi/L	0	1	5	–	76.9	–	–	–
***Pueblo Canyon* [b]**									
Americium-241	pCi/L	0	7	14	0.014	0.025	0.01	0.04	0.033
Cesium-137	pCi/L	0	2	13	0.577	0.635	–	0.693	–
Cobalt-60	pCi/L	0	1	5	–	1.11	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	1	5	–	1.39	–	–	–
Plutonium-238	pCi/L	0	4	14	0.004	0.023	0.021	0.045	0.044
Plutonium-239, Plutonium-240	pCi/L	9	11	14	0.03	0.114	0.062	0.276	0.15
Potassium-40	pCi/L	1	5	5	3.66	21.9	9.34	42.5	30.1
Radium-226	pCi/L	4	6	6	0.202	0.556	0.102	1.04	0.637
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	14	14	14	0.275	0.777	0.346	1.42	0.958
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	2	11	115	130	–	145	–
Uranium-234	pCi/L	0	13	14	0.053	0.189	0.117	0.407	0.253
Uranium-235, Uranium-236	pCi/L	0	2	14	0.013	0.03	–	0.046	–
Uranium-238	pCi/L	0	14	14	0.02	0.11	0.075	0.278	0.15
Uranium (calculated)	µg/L	0	10	10	0.061	0.35	0.256	0.83	0.508
Uranium (measured)	µg/L	0	9	9	0.109	0.201	0.121	0.31	0.28
Gross Alpha	pCi/L	0	8	14	0.718	1.3	0.389	2.97	1.57
Gross Beta	pCi/L	0	14	14	4.9	12.8	4.69	19.5	15.2
Gross Gamma	pCi/L	0	4	11	63.1	97.8	30.2	156	127
***Water Canyon* [b]**									
Americium-241	pCi/L	0	0	2	–	–	–	–	–
Cesium-137	pCi/L	0	0	2	–	–	–	–	–
Cobalt-60	pCi/L	0	0	2	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	0	2	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	2	–	–	–	–	–
Potassium-40	pCi/L	0	1	2	–	31.1	–	–	–
Radium-226	pCi/L	2	2	2	0.45	0.74	–	1.03	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Strontium-90	pCi/L	0	0	2	–	–	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	0	2	–	–	–	–	–
Uranium-235, Uranium-236	pCi/L	0	0	2	–	–	–	–	–
Uranium-238	pCi/L	0	0	2	–	–	–	–	–
Uranium (calculated)	µg/L	0	46	46	0.027	1.37	3.28	16.6	2.32
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	2	2	0.766	0.882	–	0.998	–
Gross Beta	pCi/L	0	2	2	2.45	3.04	–	3.63	–
Gross Gamma	pCi/L	0	1	2	–	1,070	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Canyon Alluvial Wells (Table F–15) and Canyon Alluvial Springs (Table F–16).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–16 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Springs

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Canyon Alluvial Wells [a] Composite									
Americium-241	pCi/L	1	6	14	0.011	0.046	0.039	0.091	0.077
Cesium-137	pCi/L	0	4	15	0.044	0.666	0.803	2.39	1.45
Cobalt-60	pCi/L	0	2	12	1.4	2	–	2.6	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	12	3.74	10.6	–	17.5	–
Plutonium-238	pCi/L	0	2	14	0.013	0.016	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	4	14	0.007	0.02	0.01	0.026	0.029
Potassium-40	pCi/L	1	8	12	7.71	35.6	20.3	49.9	49.6
Radium-226	pCi/L	2	3	4	0.36	0.505	0.138	0.602	0.661
Sodium-22	pCi/L	0	0	12	–	–	–	–	–
Strontium-90	pCi/L	5	8	14	0.101	68.5	42.1	115	97.7
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	5	9	105	276	160	455	416
Uranium-234	pCi/L	0	7	14	0.067	0.392	0.246	0.977	0.574
Uranium-235, Uranium-236	pCi/L	0	5	14	0.011	0.045	0.048	0.104	0.087
Uranium-238	pCi/L	0	10	14	0.028	0.073	0.03	0.14	0.092
Uranium (calculated)	µg/L	0	12	12	0.05	0.183	0.088	0.3	0.233

Measured Radiochemical		2001 through 2005 Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (measured)	µg/L	0	3	3	0.119	0.168	0.07	0.22	0.247
Gross Alpha	pCi/L	0	10	14	0.248	2.04	1.44	3.88	2.93
Gross Beta	pCi/L	5	12	14	3.37	97.2	96.2	228	152
Gross Gamma	pCi/L	0	8	13	53.3	78.8	1.19	138	79.7
***Los Alamos Canyon* [b]**									
Americium-241	pCi/L	1	5	5	0.017	0.048	0.037	0.091	0.08
Cesium-137	pCi/L	0	2	5	0.044	0.398	–	0.753	–
Cobalt-60	pCi/L	0	1	2	–	1.4	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	2	–	–	–	–	–
Plutonium-238	pCi/L	0	2	5	0.013	0.016	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	0	4	5	0.007	0.02	0.01	0.026	0.029
Potassium-40	pCi/L	0	2	2	29.7	29.8	–	29.9	–
Radium-226	pCi/L	1	1	2	–	0.602	–	–	–
Sodium-22	pCi/L	0	0	2	–	–	–	–	–
Strontium-90	pCi/L	5	5	5	60.5	83.8	27.4	115	108
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	2	3	349	402	–	455	–
Uranium-234	pCi/L	0	5	5	0.378	0.599	0.326	0.977	0.885
Uranium-235, Uranium-236	pCi/L	0	5	5	0.011	0.045	0.048	0.104	0.087
Uranium-238	pCi/L	0	5	5	0.028	0.081	0.051	0.14	0.125
Uranium (calculated)	µg/L	0	3	3	0.09	0.176	0.122	0.262	0.314
Uranium (measured)	µg/L	0	1	1	–	0.119	–	–	–
Gross Alpha	pCi/L	0	4	5	1.43	2.8	0.953	3.88	3.73
Gross Beta	pCi/L	5	5	5	123	161	52.8	228	207
Gross Gamma	pCi/L	0	1	3	–	104	–	–	–
***Pajarito Canyon* [b]**									
Americium-241	pCi/L	0	1	9	–	0.011	–	–	–
Cesium-137	pCi/L	0	2	10	0.382	1.39	–	2.39	–
Cobalt-60	pCi/L	0	1	10	–	2.6	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	10	3.74	10.6	–	17.5	–
Plutonium-238	pCi/L	0	0	9	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	9	–	–	–	–	–
Potassium-40	pCi/L	1	6	10	7.71	33.8	22.7	49.9	52
Radium-226	pCi/L	1	2	2	0.36	0.407	–	0.454	–
Sodium-22	pCi/L	0	0	10	–	–	–	–	–
Strontium-90	pCi/L	0	3	9	0.101	0.131	0.033	0.166	0.168
Technetium-99	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Tritium	pCi/L	0	3	6	105	125	28.6	146	158
Uranium-234	pCi/L	0	2	9	0.067	0.07	–	0.073	–
Uranium-235, Uranium-236	pCi/L	0	0	9	–	–	–	–	–
Uranium-238	pCi/L	0	5	9	0.048	0.081	0.006	0.109	0.086
Uranium (calculated)	µg/L	0	9	9	0.05	0.189	0.092	0.3	0.249
Uranium (measured)	µg/L	0	2	2	0.215	0.218	–	0.22	–
Gross Alpha	pCi/L	0	6	9	0.248	0.756	0.231	1.97	0.941
Gross Beta	pCi/L	0	7	9	3.37	5.76	0.158	9.09	5.88
Gross Gamma	pCi/L	0	7	10	53.3	76.8	1.67	138	78.1

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Canyon Alluvial Wells (Table F–15) and Canyon Alluvial Springs (Table F–16).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–17 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Wells

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Intermediate Perched Wells [a] Composite									
Americium-241	pCi/L	0	12	77	0.012	0.02	0.005	0.033	0.023
Cesium-137	pCi/L	2	11	77	0.395	6.11	2.06	7.39	7.33
Cobalt-60	pCi/L	0	10	60	1.22	3.31	1.88	6.48	4.48
Iodine-129	pCi/L	0	1	8	–	0.818	–	–	–
Neptunium-237	pCi/L	0	12	50	5.79	13.9	1.14	30.1	14.6
Plutonium-238	pCi/L	1	8	77	0.0	0.024	0.027	0.111	0.043
Plutonium-239, Plutonium-240	pCi/L	2	8	77	0.014	0.333	0.611	3.65	0.756
Potassium-40	pCi/L	5	51	60	1.26	289	353	19,000	386
Radium-226	pCi/L	10	21	31	0.137	0.743	0.608	3.28	1
Sodium-22	pCi/L	0	3	60	1.2	5.62	5.57	9.56	11.9
Strontium-90	pCi/L	2	14	78	0.091	0.776	1.28	10.3	1.45
Technetium-99	pCi/L	9	11	22	2.34	4.26	1.61	7.86	5.21
Tritium	pCi/L	15	24	61	78.7	2,650	4,340	23,500	4,380
Uranium-234	pCi/L	1	55	73	0.046	8.22	15.6	1,210	12.3
Uranium-235, Uranium-236	pCi/L	2	32	75	0.017	0.791	1.49	53.3	1.31
Uranium-238	pCi/L	1	55	75	0.031	8.45	16.4	1,210	12.8
Uranium (calculated)	µg/L	0	69	73	0.0	0.543	0.356	6.9	0.627
Uranium (measured)	µg/L	0	41	41	0.02	0.54	0.015	2.97	0.545

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Alpha	pCi/L	0	26	67	0.574	1.48	0.423	4.04	1.64
Gross Beta	pCi/L	3	51	67	0.829	4.78	2.59	42.6	5.49
Gross Gamma	pCi/L	0	26	63	45.6	121	73.8	1,560	149
Los Alamos Canyon [b]									
Americium-241	pCi/L	0	2	21	0.022	0.023	–	0.024	–
Cesium-137	pCi/L	2	6	22	1.29	5.95	2.5	7.39	7.95
Cobalt-60	pCi/L	0	3	17	2.43	4.09	2.34	6.48	6.73
Iodine-129	pCi/L	0	1	4	–	0.818	–	–	–
Neptunium-237	pCi/L	0	3	11	13	19.3	8.2	25.1	28.6
Plutonium-238	pCi/L	0	2	20	0.012	0.012	–	0.012	–
Plutonium-239, Plutonium-240	pCi/L	0	2	20	0.04	1.85	–	3.65	–
Potassium-40	pCi/L	2	16	17	1.68	970	1,340	19,000	1,630
Radium-226	pCi/L	4	7	10	0.143	0.453	0.197	0.592	0.599
Sodium-22	pCi/L	0	1	17	–	9.56	–	–	–
Strontium-90	pCi/L	2	6	22	0.091	1.82	2.93	10.3	4.16
Technetium-99	pCi/L	1	1	7	–	2.34	–	–	–
Tritium	pCi/L	4	11	15	117	186	7.04	348	190
Uranium-234	pCi/L	1	16	20	0.048	40.8	70.4	1,210	75.3
Uranium-235, Uranium-236	pCi/L	2	12	20	0.018	3.01	5.16	53.3	5.93
Uranium-238	pCi/L	1	15	20	0.09	45.2	78.1	1,210	84.8
Uranium (calculated)	µg/L	0	15	17	0.019	1.012	1.21	6.9	1.62
Uranium (measured)	µg/L	0	12	12	0.02	0.322	0.075	0.785	0.365
Gross Alpha	pCi/L	0	6	16	0.735	1.55	1.11	4.04	2.44
Gross Beta	pCi/L	1	12	16	2.8	5.89	1.91	23.9	6.97
Gross Gamma	pCi/L	0	6	16	45.6	84.5	34.6	146	112
Mortandad Canyon [b]									
Americium-241	pCi/L	0	1	16	–	0.033	–	–	–
Cesium-137	pCi/L	0	2	16	0.395	1.19	–	1.99	–
Cobalt-60	pCi/L	0	5	16	1.22	1.82	0.634	2.8	2.38
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	16	8.91	12.9	3.53	15.6	16.9
Plutonium-238	pCi/L	0	0	16	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	16	–	–	–	–	–
Potassium-40	pCi/L	1	14	16	3.48	22.9	13.1	47.8	29.7
Radium-226	pCi/L	4	6	8	0.302	1.43	1.36	3.28	2.51
Sodium-22	pCi/L	0	1	16	–	2.17	–	–	–
Strontium-90	pCi/L	0	1	16	–	0.22	–	–	–
Technetium-99	pCi/L	8	10	11	2.63	4.45	1.56	7.86	5.42
Tritium	pCi/L	9	9	9	4,310	12,000	5,610	23,500	15,700
Uranium-234	pCi/L	0	16	16	0.096	0.26	0.142	0.441	0.33

Measured Radiochemical		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
		2001 through 2005							
Uranium-235, Uranium-236	pCi/L	0	8	16	0.028	0.043	0.015	0.069	0.054
Uranium-238	pCi/L	0	16	16	0.032	0.114	0.065	0.219	0.146
Uranium (calculated)	µg/L	0	8	8	0.12	0.33	0.157	0.5	0.438
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	3	16	1.12	1.81	0.599	2.2	2.49
Gross Beta	pCi/L	0	15	16	1.01	4.8	4.25	14.7	6.95
Gross Gamma	pCi/L	0	5	16	57.9	86.5	37.7	151	120
Pajarito Canyon [b]									
Americium-241	pCi/L	0	0	4	–	–	–	–	–
Cesium-137	pCi/L	0	1	4	–	2.89	–	–	–
Cobalt-60	pCi/L	0	1	4	–	2.34	–	–	–
Iodine-129	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	4	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	4	–	–	–	–	–
Potassium-40	pCi/L	0	3	4	15.7	41.6	27.9	71.1	73.2
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	1	4	–	0.176	–	–	–
Technetium-99	pCi/L	0	0	4	–	–	–	–	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Uranium-234	pCi/L	0	3	4	0.233	0.248	0.013	0.257	0.262
Uranium-235, Uranium-236	pCi/L	0	1	4	–	0.050	–	–	–
Uranium-238	pCi/L	0	3	4	0.108	0.13	0.021	0.15	0.154
Uranium (calculated)	µg/L	0	7	7	0.05	0.294	0.11	0.36	0.376
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	0	–	–	–	–	–
Gross Beta	pCi/L	0	0	0	–	–	–	–	–
Gross Gamma	pCi/L	0	0	0	–	–	–	–	–
Potrillo Canyon [b]									
Americium-241	pCi/L	0	0	3	–	–	–	–	–
Cesium-137	pCi/L	0	0	3	–	–	–	–	–
Cobalt-60	pCi/L	0	1	3	–	2.44	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	3	–	–	–	–	–
Plutonium-238	pCi/L	0	0	3	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	2	3	10.6	24.8	-	38.9	-
Radium-226	pCi/L	0	0	1	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Sodium-22	pCi/L	0	0	3	–	–	–	–	–
Strontium-90	pCi/L	0	0	3	–	–	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.228	0.276	0.068	0.332	0.353
Uranium-235, Uranium-236	pCi/L	0	2	3	0.021	0.057	–	0.093	–
Uranium-238	pCi/L	0	3	3	0.105	0.124	0.027	0.171	0.154
Uranium (calculated)	μg/L	0	3	3	0.24	0.284	0.055	0.322	0.346
Uranium (measured)	μg/L	0	3	3	0.027	0.204	0.098	0.273	0.314
Gross Alpha	pCi/L	0	1	3	–	3.51	–	–	–
Gross Beta	pCi/L	0	1	3	–	0.829	–	–	–
Gross Gamma	pCi/L	0	0	3	–	–	–	–	–
Pueblo Canyon [b]									
Americium-241	pCi/L	0	4	9	0.015	0.022	0.007	0.029	0.029
Cesium-137	pCi/L	0	2	8	6.58	6.84	–	7.1	–
Cobalt-60	pCi/L	0	0	4	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	4	–	–	–	–	–
Plutonium-238	pCi/L	1	4	10	0.0	0.026	0.034	0.111	0.059
Plutonium-239, Plutonium-240	pCi/L	1	2	10	0.033	0.036	–	0.039	–
Potassium-40	pCi/L	0	3	4	45.5	57.8	17	69.8	77
Radium-226	pCi/L	1	3	4	0.23	0.364	0.188	0.765	0.577
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	0	2	9	0.093	0.178	–	0.263	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	2	3	13	78.7	711	554	1,110	1,340
Uranium-234	pCi/L	0	7	8	0.046	0.936	0.453	1.83	1.27
Uranium-235, Uranium-236	pCi/L	0	5	8	0.019	0.105	0.045	0.153	0.144
Uranium-238	pCi/L	0	6	8	0.034	0.688	0.234	1.12	0.875
Uranium (calculated)	μg/L	0	6	6	0.0	1.41	1.23	3.08	2.4
Uranium (measured)	μg/L	0	5	5	0.02	2.3	0.455	2.97	2.7
Gross Alpha	pCi/L	0	3	8	2.3	2.67	0.473	3.2	3.2
Gross Beta	pCi/L	0	6	8	1.45	8.53	1.76	12.6	9.93
Gross Gamma	pCi/L	0	3	6	79	89.1	17.2	109	109
Sandia Canyon [b]									
Americium-241	pCi/L	0	0	13	–	–	–	–	–
Cesium-137	pCi/L	0	0	13	–	–	–	–	–
Cobalt-60	pCi/L	0	0	8	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	4	8	8.16	14.4	10.5	30.1	24.7

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	0	0	13	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	13	–	–	–	–	–
Potassium-40	pCi/L	1	6	8	10	45.6	16.5	103	58.8
Radium-226	pCi/L	0	5	6	0.137	0.239	0.061	0.288	0.292
Sodium-22	pCi/L	0	0	8	–	–	–	–	–
Strontium-90	pCi/L	0	1	13	–	0.099	–	–	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	1	13	–	170	–	–	–
Uranium-234	pCi/L	0	2	13	0.306	0.306	–	0.306	–
Uranium-235, Uranium-236	pCi/L	0	1	13	–	0.031	–	–	–
Uranium-238	pCi/L	0	3	13	0.052	0.125	0.035	0.15	0.165
Uranium (calculated)	µg/L	0	11	13	0.006	0.109	0.051	0.446	0.14
Uranium (measured)	µg/L	0	11	11	0.026	0.195	0.022	0.557	0.208
Gross Alpha	pCi/L	0	4	13	0.627	0.986	0.076	1.17	1.06
Gross Beta	pCi/L	0	8	13	1.47	2.27	0.185	3.49	2.4
Gross Gamma	pCi/L	0	10	13	46.3	323	430	1,560	590
Water Canyon [b]									
Americium-241	pCi/L	0	5	11	0.012	0.018	0.003	0.022	0.021
Cesium-137	pCi/L	0	0	11	–	–	–	–	–
Cobalt-60	pCi/L	0	0	8	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	8	5.79	9.45	–	13.1	–
Plutonium-238	pCi/L	0	2	11	0.007	0.012	–	0.018	–
Plutonium-239, Plutonium-240	pCi/L	1	4	11	0.014	0.032	0.024	0.059	0.055
Potassium-40	pCi/L	1	7	8	1.26	33.1	7.35	53.9	38.5
Radium-226	pCi/L	0	0	2	–	–	–	–	–
Sodium-22	pCi/L	0	1	8	–	1.2	–	–	–
Strontium-90	pCi/L	0	3	11	0.134	0.158	0.033	0.183	0.195
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	9	–	–	–	–	–
Uranium-234	pCi/L	0	8	9	0.052	0.263	0.155	0.733	0.370
Uranium-235, Uranium-236	pCi/L	0	3	11	0.017	0.055	0.045	0.086	0.105
Uranium-238	pCi/L	0	9	11	0.031	0.143	0.128	0.455	0.227
Uranium (calculated)	µg/L	0	19	19	0.05	0.28	0.201	0.74	0.37
Uranium (measured)	µg/L	0	10	10	0.02	0.425	0.013	0.706	0.434
Gross Alpha	pCi/L	0	9	11	0.574	1.41	0.547	3.09	1.77

Measured Radiochemical		2001 through 2005							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Gross Beta	pCi/L	2	9	11	1.05	7.05	9.85	42.6	13.5
Gross Gamma	pCi/L	0	2	9	71.2	92.1	–	113	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Intermediate Perched Wells (Table F–17) and Intermediate Perched Springs (Table F–18).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–18 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Springs

Measured Radiochemical		2001 through 2005							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Intermediate Perched Springs [a] Composite									
Americium-241	pCi/L	0	9	30	0.012	0.023	0.006	0.034	0.027
Cesium-137	pCi/L	0	4	31	0.847	2.72	1.64	4.25	4.32
Cobalt-60	pCi/L	0	1	22	–	2.45	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	22	6.33	14.4	5.79	33.4	19.5
Plutonium-238	pCi/L	1	2	30	0.003	0.03	–	0.058	–
Plutonium-239, Plutonium-240	pCi/L	2	4	30	0.018	0.034	0.013	0.045	0.047
Potassium-40	pCi/L	3	18	22	4.34	24.8	1.29	56.6	25.4
Radium-226	pCi/L	4	8	10	0.154	0.563	0.403	1.31	0.843
Sodium-22	pCi/L	0	1	22	–	2.89	–	–	–
Strontium-90	pCi/L	3	11	33	0.066	0.313	0.213	0.611	0.438
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	22	70	93.6	14.7	104	110
Uranium-234	pCi/L	0	23	31	0.031	0.328	0.23	0.673	0.422
Uranium-235, Uranium-236	pCi/L	0	9	31	0.011	0.045	0.039	0.113	0.071
Uranium-238	pCi/L	0	19	31	0.022	0.22	0.136	0.425	0.281
Uranium (calculated)	µg/L	0	69	69	0.023	0.559	0.439	1.31	0.663
Uranium (measured)	µg/L	0	10	10	0.02	0.626	0.364	1.4	0.852
Gross Alpha	pCi/L	0	15	31	0.595	1.23	0.725	2.51	1.59
Gross Beta	pCi/L	0	28	31	0.796	7.04	5.23	15.7	8.98
Gross Gamma	pCi/L	0	11	29	61.7	99	15.3	293	108
***Los Alamos Canyon* [b]**									
Americium-241	pCi/L	0	4	9	0.014	0.026	0.007	0.034	0.033
Cesium-137	pCi/L	0	2	9	1.13	2.02	–	2.91	–
Cobalt-60	pCi/L	0	1	3	–	2.45	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/L	0	0	3	–	–	–	–	–
Plutonium-238	pCi/L	1	2	9	0.003	0.03	–	0.058	–
Plutonium-239, Plutonium-240	pCi/L	2	4	9	0.018	0.034	0.013	0.045	0.047
Potassium-40	pCi/L	0	3	3	9.04	24.8	13.7	34.5	40.3
Radium-226	pCi/L	0	2	3	0.154	0.216	–	0.278	–
Sodium-22	pCi/L	0	1	3	–	2.89	–	–	–
Strontium-90	pCi/L	2	4	10	0.119	0.340	0.221	0.611	0.556
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	8	–	–	–	–	–
Uranium-234	pCi/L	0	8	10	0.237	0.442	0.197	0.673	0.579
Uranium-235, Uranium-236	pCi/L	0	5	10	0.016	0.054	0.039	0.113	0.089
Uranium-238	pCi/L	0	8	10	0.148	0.283	0.126	0.425	0.371
Uranium (calculated)	µg/L	0	8	8	0.023	0.794	0.372	1.31	1.05
Uranium (measured)	µg/L	0	3	3	0.02	0.883	0.748	1.34	1.73
Gross Alpha	pCi/L	0	5	9	0.628	1.37	0.784	2.51	2.05
Gross Beta	pCi/L	0	8	9	1.43	8.33	5.05	15.7	11.8
Gross Gamma	pCi/L	0	4	8	61.7	81.7	12.1	93.3	93.6
Pajarito Canyon [b]									
Americium-241	pCi/L	0	4	18	0.012	0.02	0.001	0.025	0.021
Cesium-137	pCi/L	0	1	19	–	0.847	–	–	–
Cobalt-60	pCi/L	0	0	19	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	5	19	6.33	14.4	5.79	33.4	19.5
Plutonium-238	pCi/L	0	0	18	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	18	–	–	–	–	–
Potassium-40	pCi/L	3	15	19	4.34	25.3	1.15	56.6	25.9
Radium-226	pCi/L	4	6	7	0.374	0.964	0.367	1.31	1.26
Sodium-22	pCi/L	0	0	19	–	–	–	–	–
Strontium-90	pCi/L	0	5	19	0.066	0.154	0.07	0.252	0.215
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	3	12	70	93.6	14.7	104	110
Uranium-234	pCi/L	0	12	18	0.05	0.099	0.022	0.191	0.111
Uranium-235, Uranium-236	pCi/L	0	2	18	0.017	0.029	–	0.041	–
Uranium-238	pCi/L	0	9	18	0.032	0.076	0.011	0.141	0.083
Uranium (calculated)	µg/L	0	18	18	0.028	0.14	0.059	0.428	0.168
Uranium (measured)	µg/L	0	7	7	0.058	0.368	0.478	1.4	0.722
Gross Alpha	pCi/L	0	10	19	0.595	0.907	0.023	1.25	0.922
Gross Beta	pCi/L	0	18	19	0.796	3.31	0.341	5.1	3.47

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Gamma	pCi/L	0	6	18	64.3	136	90	293	208
Water Canyon [b]									
Americium-241	pCi/L	0	1	3	–	0.02	–	–	–
Cesium-137	pCi/L	0	1	3	–	4.25	–	–	–
Cobalt-60	pCi/L	0	0	0	–	–	–	–	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	0	0	–	–	–	–	–
Plutonium-238	pCi/L	0	0	3	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	3	–	–	–	–	–
Potassium-40	pCi/L	0	0	0	–	–	–	–	–
Radium-226	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	0	–	–	–	–	–
Strontium-90	pCi/L	1	2	4	0.166	0.279	–	0.392	–
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	0	2	–	–	–	–	–
Uranium-234	pCi/L	0	3	3	0.031	0.056	0.028	0.087	0.088
Uranium-235, Uranium-236	pCi/L	0	2	3	0.011	0.018	–	0.026	–
Uranium-238	pCi/L	0	2	3	0.022	0.025	–	0.028	–
Uranium (calculated)	μg/L	0	43	43	0.023	0.192	0.186	0.65	0.248
Uranium (measured)	μg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	0	3	–	–	–	–	–
Gross Beta	pCi/L	0	2	3	1.99	2.24	–	2.49	–
Gross Gamma	pCi/L	0	1	3	–	101	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, μg/L = micrograms per liter.

[a] Composite of canyon data. The corresponding data set identifier on Table F–1 includes data from Intermediate Perched Wells (Table F–17) and Intermediate Perched Springs (Table F–18).

[b] Italicized subheadings identify individual canyons whose data are included in the composite.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–19 Radiochemical Statistical Analysis of Groundwater – San Ildefonso Pueblo Water Supply Wells [a]

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	1	11	46	0.005	0.022	0.009	0.034	0.027
Cesium-137	pCi/L	1	6	46	0.575	2.22	2.11	6.4	3.91
Cobalt-60	pCi/L	0	3	17	1.62	2.11	0.427	2.42	2.59
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	2	17	9.11	11.2	–	13.3	–
Plutonium-238	pCi/L	0	17	62	0.0	0.023	0.029	0.044	0.037

Measured Radiochemical		2001 through 2005							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Plutonium-239, Plutonium-240	pCi/L	0	14	62	0.0	0.01	0.009	0.017	0.015
Potassium-40	pCi/L	2	14	17	0.971	29.1	3.11	63.3	30.7
Radium-226	pCi/L	4	10	16	0.14	0.737	0.567	2.18	1.09
Sodium-22	pCi/L	0	3	17	2.7	3.26	0.788	4.86	4.15
Strontium-90	pCi/L	6	20	59	0.051	0.247	0.121	1.69	0.3
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	4	44	52.8	88.9	24.3	116	113
Uranium-234	pCi/L	18	38	43	0.022	5.342	0.815	13	5.6
Uranium-235, Uranium-236	pCi/L	0	33	44	0.021	0.297	0.110	0.909	0.335
Uranium-238	pCi/L	6	36	44	0.087	3.11	0.557	8.23	3.29
Uranium (calculated)	μg/L	0	33	35	0.017	8.67	1.66	24.8	9.23
Uranium (measured)	μg/L	0	12	12	0.02	8.35	0.526	24.3	8.65
Gross Alpha	pCi/L	20	33	44	0.324	7.47	3.23	19.7	8.58
Gross Beta	pCi/L	0	34	44	1.47	5.34	2	18.4	6.01
Gross Gamma	pCi/L	0	8	37	50.2	97.9	45.9	184	130

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, μg/L = micrograms per liter.

[a] The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–20 Radiochemical Statistical Analysis of Groundwater – Santa Fe Water Supply Wells [a]

Measured Radiochemical		2001 through 2005							
		Detected per ESR	*Used In This SWEIS*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Americium-241	pCi/L	0	1	18	–	0.011	–	–	–
Cesium-137	pCi/L	0	14	28	0.018	7.03	6.77	14.2	10.6
Cobalt-60	pCi/L	0	2	6	1.41	1.64	–	1.87	–
Iodine-129	pCi/L	0	0	0	–	–	–	–	–
Neptunium-237	pCi/L	0	3	6	9.84	10.4	0.057	10.8	10.4
Plutonium-238	pCi/L	0	1	18	–	0.004	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	2	18	0.0	0.005	–	0.009	–
Potassium-40	pCi/L	2	5	6	12	30.6	7.05	61.1	36.8
Radium-226	pCi/L	5	6	8	0.557	2.3	0.842	3.96	2.97
Sodium-22	pCi/L	0	1	6	–	1.59	–	–	–
Strontium-90	pCi/L	0	10	35	0.081	0.147	0.047	0.226	0.176
Technetium-99	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/L	0	5	17	0.125	71.5	51.5	123	117
Uranium-234	pCi/L	21	46	47	0.005	20.6	18.2	97.2	25.9

Measured Radiochemical		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
		2001 through 2005							
Uranium-235, Uranium-236	pCi/L	1	37	40	0.003	1.44	1.26	7.79	1.85
Uranium-238	pCi/L	12	24	26	2.03	21.3	18.7	84.8	28.8
Uranium (calculated)	µg/L	0	21	22	0.0	70.3	53	255	93
Uranium (measured)	µg/L	0	4	4	6.41	14.3	5.36	18.4	19.5
Gross Alpha	pCi/L	16	16	17	6.31	33.3	33.2	192	49.5
Gross Beta	pCi/L	3	16	17	0.167	11.3	4.94	51.5	13.7
Gross Gamma	pCi/L	0	0	16	–	–	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] The corresponding data set identifier is indicated in Table F–1.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–21 Radiochemical Statistical Analysis of Sediment from 2001 through 2005

Measured Radiochemical		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
		2001 through 2005							
Regional Stations									
Americium-241	pCi/g	0	41	91	0.002	0.015	0.005	0.116	0.017
Cesium-137	pCi/g	7	86	88	0.015	0.196	0.084	1.09	0.213
Cobalt-60	pCi/g	0	6	25	0.018	0.054	0.033	0.087	0.08
Neptunium-237	pCi/g	0	24	25	0.096	0.703	0.186	1.21	0.777
Plutonium-238	pCi/g	1	25	92	0.0	0.021	0.023	0.118	0.03
Plutonium-239, Plutonium-240	pCi/g	3	43	92	0.0	0.045	0.032	0.450	0.055
Potassium-40	pCi/g	0	25	25	13.8	19.7	0.94	32.9	20
Sodium-22	pCi/g	0	0	25	–	–	–	–	–
Strontium-90	pCi/g	2	27	93	0.043	0.122	0.02	0.247	0.13
Tritium	pCi/L	1	4	15	80.6	160	113	465	271
Tritium	pCi/g	0	12	35	0.032	0.081	0.027	0.135	0.097
Uranium-234	pCi/g	0	91	91	0.282	0.863	0.106	1.74	0.885
Uranium-235, Uranium-236	pCi/g	0	79	91	0.022	0.075	0.01	0.174	0.077
Uranium-238	pCi/g	0	91	91	0.295	0.858	0.128	1.65	0.884
Uranium (calculated)	µg/g	0	51	51	0.1	1.48	1.15	4.48	1.79
Gross Alpha	pCi/g	13	90	90	2.85	13.5	1.3	30.9	13.8
Gross Beta	pCi/g	13	90	90	12.2	24.2	0.838	36.7	24.3
Gross Gamma	pCi/g	0	55	56	3.87	7.96	1.61	25.8	8.39
Perimeter Stations									
Americium-241	pCi/g	15	115	225	0.0	0.104	0.079	3.08	0.118
Cesium-137	pCi/g	8	211	228	0.0	0.237	0.172	3.16	0.26
Cobalt-60	pCi/g	0	5	86	0.02	0.036	0.002	0.056	0.038

Measured Radiochemical		***2001 through 2005***							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	86	86	0.091	0.606	0.008	2.04	0.608
Plutonium-238	pCi/g	4	80	224	0.0	0.016	0.007	0.325	0.018
Plutonium-239, Plutonium-240	pCi/g	34	120	224	0.0	0.774	0.377	12.5	0.841
Potassium-40	pCi/g	0	86	86	13.7	26.8	1.57	35	27.1
Sodium-22	pCi/g	0	11	85	0.013	0.035	0.008	0.106	0.039
Strontium-90	pCi/g	0	89	223	0.031	0.21	0.080	3.24	0.226
Tritium	pCi/L	4	27	52	0.0	804	189	2,300	875
Tritium	pCi/g	0	42	169	0.0	14.1	27.4	145	22.4
Uranium-234	pCi/g	2	227	227	0.05	0.903	0.068	2.71	0.912
Uranium-235, Uranium-236	pCi/g	0	185	227	0.0	0.078	0.02	0.414	0.08
Uranium-238	pCi/g	0	227	227	0.056	0.878	0.072	2.66	0.887
Uranium (calculated)	µg/g	0	148	148	0.09	1.95	1.46	7.51	2.19
Gross Alpha	pCi/g	13	230	230	2	13.1	1.44	38.2	13.2
Gross Beta	pCi/g	22	230	230	15.2	32.8	3.04	63.3	33.2
Gross Gamma	pCi/g	0	181	182	1.46	9.2	2.13	145	9.51
Onsite Stations									
Americium-241	pCi/g	117	197	288	0.004	1.07	0.231	13.7	1.1
Cesium-137	pCi/g	67	273	280	0.005	1.54	0.625	28.6	1.61
Cobalt-60	pCi/g	0	11	89	0.021	0.055	0.008	0.137	0.06
Neptunium-237	pCi/g	0	89	89	0.157	0.659	0.039	1.61	0.667
Plutonium-238	pCi/g	72	141	285	0.0	0.638	0.25	11.5	0.679
Plutonium-239, Plutonium-240	pCi/g	175	200	285	0.003	0.919	0.223	13.4	0.95
Potassium-40	pCi/g	0	89	89	18.1	28	0.448	33.8	28.1
Sodium-22	pCi/g	0	6	89	0.022	0.055	0.038	0.082	0.086
Strontium-90	pCi/g	31	115	286	0.024	0.414	0.056	2.64	0.425
Tritium	pCi/L	71	74	81	82.5	1,450	430	9,930	1,550
Tritium	pCi/g	11	74	194	0.0	0.719	0.472	5.1	0.826
Uranium-234	pCi/g	21	281	281	0.042	0.874	0.081	1.91	0.883
Uranium-235, Uranium-236	pCi/g	4	244	281	0.011	0.081	0.03	0.214	0.084
Uranium-238	pCi/g	1	281	281	0.037	0.901	0.083	2.16	0.911
Uranium (calculated)	µg/g	0	188	188	0.11	1.99	1.5	6.51	2.2
Gross Alpha	pCi/g	154	274	275	1.7	16.7	2.43	59.3	17
Gross Beta	pCi/g	268	276	276	6.64	37.6	2.91	74.3	37.9
Gross Gamma	pCi/g	0	199	202	1.48	10.5	1.5	36.6	10.7
Ancho Canyon [a]									
Americium-241	pCi/g	7	21	50	0.0	0.042	0.039	0.239	0.059
Cesium-137	pCi/g	6	47	47	0.013	0.175	0.086	0.724	0.2
Cobalt-60	pCi/g	0	1	21	–	0.021	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	21	21	0.157	0.502	0.294	1.33	0.628
Plutonium-238	pCi/g	2	9	48	0.001	0.009	0.007	0.019	0.013
Plutonium-239, Plutonium-240	pCi/g	16	22	48	0.006	0.064	0.06	0.665	0.089
Potassium-40	pCi/g	0	21	21	18.1	26.7	1.88	31.4	27.5
Sodium-22	pCi/g	0	1	21	–	0.022	–	–	–
Strontium-90	pCi/g	5	20	50	0.054	0.149	0.022	0.375	0.158
Tritium	pCi/L	3	5	7	85.6	368	399	1,610	718
Tritium	pCi/g	1	17	41	0.0	12.4	22.7	134	23.2
Uranium-234	pCi/g	0	47	47	0.281	0.758	0.144	1.59	0.799
Uranium-235, Uranium-236	pCi/g	0	40	47	0.017	0.066	0.024	0.147	0.073
Uranium-238	pCi/g	0	47	47	0.225	0.845	0.204	2.01	0.903
Uranium (calculated)	µg/g	0	37	37	0.09	2.03	1.53	6.04	2.52
Gross Alpha	pCi/g	15	47	47	1.7	11	3.18	22.5	11.9
Gross Beta	pCi/g	37	47	47	12.4	29.3	6.3	42	31.1
Gross Gamma	pCi/g	0	42	43	4.88	7.84	1.2	16.7	8.2
Bayo Canyon [b]									
Americium-241	pCi/g	0	4	11	0.007	0.018	0.013	0.049	0.031
Cesium-137	pCi/g	0	9	11	0.012	0.038	0.011	0.09	0.046
Cobalt-60	pCi/g	0	0	4	–	–	–	–	–
Neptunium-237	pCi/g	0	4	4	0.383	0.525	0.083	0.583	0.606
Plutonium-238	pCi/g	0	2	11	0.0	0.01	-	0.02	-
Plutonium-239, Plutonium-240	pCi/g	0	0	11	–	–	–	–	–
Potassium-40	pCi/g	0	4	4	24.5	25.6	0.66	28.3	26.2
Sodium-22	pCi/g	0	2	4	0.013	0.019	–	0.024	–
Strontium-90	pCi/g	0	0	10	–	–	–	–	–
Tritium	pCi/L	1	2	2	139	325	–	510	–
Tritium	pCi/g	0	1	7	–	0.003	–	–	–
Uranium-234	pCi/g	0	11	11	0.625	0.959	0.24	1.3	1.1
Uranium-235, Uranium-236	pCi/g	0	11	11	0.031	0.084	0.043	0.144	0.11
Uranium-238	pCi/g	0	11	11	0.597	0.989	0.262	1.41	1.14
Uranium (calculated)	µg/g	0	8	8	0.22	2.27	1.81	4.23	3.52
Gross Alpha	pCi/g	2	10	10	5.78	10.7	3.03	16.8	12.6
Gross Beta	pCi/g	2	10	10	23	30.3	4.42	36.5	33.1
Gross Gamma	pCi/g	0	10	10	5.96	8.39	2.3	13.6	9.82
Cañada del Buey Canyon [c]									
Americium-241	pCi/g	2	6	11	0.018	0.035	0.013	0.083	0.045
Cesium-137	pCi/g	0	12	12	0.017	0.094	0.052	0.293	0.123
Cobalt-60	pCi/g	0	0	5	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	5	5	0.163	0.432	0.302	0.879	0.697
Plutonium-238	pCi/g	0	6	11	0.0	0.059	0.057	0.140	0.105
Plutonium-239, Plutonium-240	pCi/g	1	8	11	0.013	0.04	0.009	0.075	0.047
Potassium-40	pCi/g	0	5	5	26.5	28.6	0.271	31.5	28.9
Sodium-22	pCi/g	0	0	5	–	–	–	–	–
Strontium-90	pCi/g	0	2	12	0.057	0.077	–	0.096	–
Tritium	pCi/L	2	2	2	943	977	–	1,010	–
Tritium	pCi/g	0	7	9	0.0	0.025	0.02	0.053	0.04
Uranium-234	pCi/g	0	11	11	0.675	0.977	0.115	1.39	1.05
Uranium-235, Uranium-236	pCi/g	0	9	11	0.027	0.096	0.09	0.414	0.155
Uranium-238	pCi/g	0	11	11	0.59	0.928	0.096	1.44	0.984
Uranium (calculated)	µg/g	0	6	6	0.27	1.89	1.41	2.97	3.02
Gross Alpha	pCi/g	1	12	12	10	17.7	2.81	24.1	19.3
Gross Beta	pCi/g	2	12	12	15.8	39	10.8	63.3	45.1
Gross Gamma	pCi/g	0	9	9	6.2	8.25	1.39	10.7	9.16
Chaquehui Canyon [b]									
Americium-241	pCi/g	0	2	4	0.003	0.008	–	0.013	–
Cesium-137	pCi/g	1	4	4	0.128	0.312	0.291	0.746	0.597
Cobalt-60	pCi/g	0	0	2	–	–	–	–	–
Neptunium-237	pCi/g	0	2	2	0.635	0.796	–	0.956	–
Plutonium-238	pCi/g	0	1	4	–	0.009	–	–	–
Plutonium-239, Plutonium-240	pCi/g	1	3	4	0.008	0.015	0.006	0.02	0.021
Potassium-40	pCi/g	0	2	2	13.7	17.5	–	21.3	–
Sodium-22	pCi/g	0	0	2	–	–	–	–	–
Strontium-90	pCi/g	0	3	4	0.113	0.195	0.08	0.272	0.285
Tritium	pCi/L	1	1	1	–	2,300	–	–	–
Tritium	pCi/g	0	0	3	–	–	–	–	–
Uranium-234	pCi/g	1	4	4	1.03	1.55	0.761	2.67	2.29
Uranium-235, Uranium-236	pCi/g	0	4	4	0.058	0.086	0.035	0.135	0.12
Uranium-238	pCi/g	0	4	4	0.884	1.35	0.517	2.07	1.85
Uranium (calculated)	µg/g	0	3	3	0.34	3.27	2.94	6.211	6.6
Gross Alpha	pCi/g	2	4	4	7.19	17.8	8.87	26.1	26.5
Gross Beta	pCi/g	2	4	4	23.7	32	8.17	42.9	40
Gross Gamma	pCi/g	0	3	3	7.16	8.01	1	9.11	9.14
Fence Canyon [c]									
Americium-241	pCi/g	1	4	8	0.014	0.018	0.005	0.032	0.023
Cesium-137	pCi/g	1	8	8	0.044	0.208	0.209	0.574	0.353
Cobalt-60	pCi/g	0	1	4	–	0.026	–	–	–

Measured Radiochemical		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
		2001 through 2005							
Neptunium-237	pCi/g	0	4	4	0.6	0.928	0.229	1.09	1.15
Plutonium-238	pCi/g	0	1	8	–	0.003	–	–	–
Plutonium-239, Plutonium-240	pCi/g	1	2	8	0.016	0.023	–	0.03	–
Potassium-40	pCi/g	0	4	4	25.7	26.3	0.801	27.1	27.1
Sodium-22	pCi/g	0	0	4	–	–	–	–	–
Strontium-90	pCi/g	0	2	8	0.163	0.174	–	0.185	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	2	6	1.46	3.28	–	5.1	–
Uranium-234	pCi/g	0	8	8	0.683	0.98	0.062	1.12	1.02
Uranium-235, Uranium-236	pCi/g	0	8	8	0.055	0.09	0.04	0.199	0.118
Uranium-238	pCi/g	0	8	8	0.743	1.023	0.059	1.27	1.06
Uranium (calculated)	µg/g	0	6	6	0.32	2.14	1.57	3.8	3.4
Gross Alpha	pCi/g	0	8	8	4.86	18.6	8.71	28.1	24.6
Gross Beta	pCi/g	2	8	8	20.7	35.1	9.97	46.3	42
Gross Gamma	pCi/g	0	6	7	7.9	10.4	1.2	11.4	11.4
Frijoles Canyon [a]									
Americium-241	pCi/g	2	5	16	0.016	0.022	0.005	0.026	0.027
Cesium-137	pCi/g	1	16	16	0.057	0.224	0.147	0.685	0.296
Cobalt-60	pCi/g	0	0	3	–	–	–	–	–
Neptunium-237	pCi/g	0	3	3	0.266	0.433	0.237	0.889	0.701
Plutonium-238	pCi/g	0	3	15	0.0	0.008	0.01	0.019	0.02
Plutonium-239, Plutonium-240	pCi/g	5	7	15	0.009	0.024	0.004	0.053	0.026
Potassium-40	pCi/g	0	3	3	17.6	27.6	5.94	31.8	34.3
Sodium-22	pCi/g	0	1	3	–	0.024	–	–	–
Strontium-90	pCi/g	0	7	15	0.059	0.138	0.002	0.223	0.14
Tritium	pCi/L	0	1	5	–	92.3	–	–	–
Tritium	pCi/g	1	2	11	0.031	72.5	–	145	–
Uranium-234	pCi/g	0	16	16	0.376	1.11	0.297	2.1	1.25
Uranium-235, Uranium-236	pCi/g	0	15	16	0.02	0.072	0.018	0.13	0.081
Uranium-238	pCi/g	0	16	16	0.43	1.08	0.259	2.14	1.21
Uranium (calculated)	µg/g	0	10	10	0.18	2.24	2	6.42	3.48
Gross Alpha	pCi/g	9	17	17	9.44	14.3	2.27	21.7	15.4
Gross Beta	pCi/g	15	17	17	18.4	31.9	4.86	42.6	34.2
Gross Gamma	pCi/g	0	12	12	1.46	8.71	1.84	13.2	9.75
Guaje Canyon [b]									
Americium-241	pCi/g	0	9	17	0.006	0.018	0.009	0.039	0.023
Cesium-137	pCi/g	3	14	18	0.013	0.27	0.232	0.883	0.392
Cobalt-60	pCi/g	0	0	9	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Neptunium-237	pCi/g	0	9	9	0.175	0.657	0.129	1.12	0.741
Plutonium-238	pCi/g	0	4	17	0.003	0.012	0.006	0.021	0.018
Plutonium-239, Plutonium-240	pCi/g	6	9	17	0.005	0.027	0.019	0.055	0.039
Potassium-40	pCi/g	0	9	9	24.3	28.2	1.39	33.1	29.2
Sodium-22	pCi/g	0	1	8	–	0.106	–	–	–
Strontium-90	pCi/g	0	6	18	0.13	0.207	0.07	0.396	0.263
Tritium	pCi/L	1	1	3	–	797	–	–	–
Tritium	pCi/g	0	2	9	0.014	0.019	–	0.024	–
Uranium-234	pCi/g	1	17	17	0.563	1.15	0.262	2.01	1.27
Uranium-235, Uranium-236	pCi/g	0	13	17	0.047	0.113	0.045	0.338	0.137
Uranium-238	pCi/g	0	17	17	0.623	1.14	0.207	1.75	1.24
Uranium (calculated)	µg/g	0	10	10	0.23	2.2	1.65	3.8	3.22
Gross Alpha	pCi/g	6	17	17	6.24	14	2.78	23	15.5
Gross Beta	pCi/g	9	17	17	24.1	33.2	5.03	53	35.6
Gross Gamma	pCi/g	0	15	15	6.29	9.85	1.63	15.7	10.7
Indio Canyon [c]									
Americium-241	pCi/g	0	2	5	0.011	0.019	–	0.027	–
Cesium-137	pCi/g	0	5	5	0.085	0.151	0.063	0.235	0.206
Cobalt-60	pCi/g	0	0	2	–	–	–	–	–
Neptunium-237	pCi/g	0	2	2	0.277	0.299	–	0.321	–
Plutonium-238	pCi/g	0	0	5	–	–	–	–	–
Plutonium-239, Plutonium-240	pCi/g	0	4	5	0.012	0.02	0.006	0.025	0.025
Potassium-40	pCi/g	0	2	2	25.2	28.1	–	31	–
Sodium-22	pCi/g	0	1	2	–	0.082	–	–	–
Strontium-90	pCi/g	0	1	6	–	0.18	–	–	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	0	4	–	–	–	–	–
Uranium-234	pCi/g	0	5	5	0.517	0.896	0.282	1.22	1.14
Uranium-235, Uranium-236	pCi/g	0	5	5	0.036	0.081	0.051	0.155	0.125
Uranium-238	pCi/g	0	5	5	0.501	0.925	0.303	1.27	1.19
Uranium (calculated)	µg/g	0	3	3	0.24	1.64	1.47	3.17	3.3
Gross Alpha	pCi/g	1	5	5	3.76	12.6	7.04	18.7	18.7
Gross Beta	pCi/g	2	5	5	18.5	33.3	9.31	43.2	41.5
Gross Gamma	pCi/g	0	4	4	5.7	7.44	1.77	9.9	9.17
Los Alamos Canyon [a]									
Americium-241	pCi/g	31	37	57	0.01	0.133	0.059	0.376	0.152
Cesium-137	pCi/g	14	55	55	0.023	0.484	0.165	1.96	0.528
Cobalt-60	pCi/g	0	1	18	–	0.02	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	18	18	0.321	0.589	0.124	1.15	0.647
Plutonium-238	pCi/g	5	22	57	0.0	0.02	0.007	0.053	0.023
Plutonium-239, Plutonium-240	pCi/g	47	48	57	0.013	0.212	0.067	1.26	0.231
Potassium-40	pCi/g	0	18	18	22.7	27.3	0.636	31.3	27.6
Sodium-22	pCi/g	0	0	18	–	–	–	–	–
Strontium-90	pCi/g	3	23	58	0.066	0.622	0.237	3.24	0.719
Tritium	pCi/L	7	12	16	0.0	426	603	3,030	767
Tritium	pCi/g	4	19	41	0.002	1.94	3.04	6.46	3.3
Uranium-234	pCi/g	0	56	56	0.334	0.822	0.1	1.39	0.849
Uranium-235, Uranium-236	pCi/g	0	49	56	0.018	0.07	0.036	0.152	0.08
Uranium-238	pCi/g	0	56	56	0.338	0.785	0.092	1.48	0.809
Uranium (calculated)	µg/g	0	38	38	0.16	1.56	1.12	4.29	1.92
Gross Alpha	pCi/g	24	57	57	4.05	12.1	2.15	29.9	12.7
Gross Beta	pCi/g	51	57	57	16.9	34.3	3.68	49.5	35.2
Gross Gamma	pCi/g	0	41	42	2.09	8.41	0.408	17	8.53
Mortandad Canyon [a]									
Americium-241	pCi/g	46	56	76	0.002	3.32	0.605	13.7	3.48
Cesium-137	pCi/g	28	65	73	0.005	5.22	2.57	28.6	5.84
Cobalt-60	pCi/g	0	7	24	0.023	0.07	0.006	0.137	0.074
Neptunium-237	pCi/g	0	24	24	0.162	0.71	0.12	1.57	0.758
Plutonium-238	pCi/g	47	53	74	0.002	1.61	0.597	11.5	1.77
Plutonium-239, Plutonium-240	pCi/g	42	53	74	0.003	2.85	0.694	13.4	3.03
Potassium-40	pCi/g	0	24	24	21.7	28.9	0.11	33.8	29
Sodium-22	pCi/g	0	5	24	0.02	0.027	0.005	0.032	0.031
Strontium-90	pCi/g	15	47	72	0.024	0.625	0.238	2.64	0.693
Tritium	pCi/L	14	18	21	226	1,860	317	5,940	2,000
Tritium	pCi/g	3	18	49	0.0	6.62	12.8	96.1	12.5
Uranium-234	pCi/g	16	75	75	0.042	0.857	0.233	1.91	0.91
Uranium-235, Uranium-236	pCi/g	2	61	75	0.019	0.081	0.033	0.214	0.09
Uranium-238	pCi/g	0	75	75	0.037	0.868	0.231	2.16	0.921
Uranium (calculated)	µg/g	0	48	48	0.11	1.98	1.55	6.51	2.42
Gross Alpha	pCi/g	44	71	71	2.18	21.5	4.49	59.3	22.5
Gross Beta	pCi/g	65	71	71	21.4	43.4	3.29	74.3	44.1
Gross Gamma	pCi/g	0	55	56	5.12	16.5	6.96	145	18.4
Pajarito Canyon [a]									
Americium-241	pCi/g	26	73	95	0.0	0.149	0.096	3.08	0.171
Cesium-137	pCi/g	7	94	96	0.005	0.521	0.29	5.87	0.579
Cobalt-60	pCi/g	0	2	33	0.049	0.052	–	0.054	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	33	33	0.252	0.803	0.151	1.61	0.855
Plutonium-238	pCi/g	15	57	96	0.0	0.12	0.047	1.31	0.132
Plutonium-239, Plutonium-240	pCi/g	50	74	96	0.002	0.299	0.147	3.81	0.333
Potassium-40	pCi/g	0	33	33	20.5	27.7	0.742	35	28
Sodium-22	pCi/g	0	1	33	–	0.043	–	–	–
Strontium-90	pCi/g	6	28	97	0.031	0.299	0.148	1.14	0.354
Tritium	pCi/L	27	27	32	197	2,070	530	9,930	2,270
Tritium	pCi/g	1	32	61	0.003	7.0	11.8	103	11.1
Uranium-234	pCi/g	4	95	95	0.31	0.921	0.077	1.69	0.937
Uranium-235, Uranium-236	pCi/g	1	85	95	0.0	0.079	0.029	0.196	0.085
Uranium-238	pCi/g	0	95	95	0.221	0.915	0.087	1.86	0.933
Uranium (calculated)	µg/g	0	61	61	0.13	2.12	1.62	5.53	2.53
Gross Alpha	pCi/g	31	95	95	2.37	16.8	1.7	34.4	17.2
Gross Beta	pCi/g	46	95	95	17.9	38.5	2.69	62.3	39.1
Gross Gamma	pCi/g	0	62	62	4.73	9.99	0.778	19.1	10.2
Potrillo Canyon [c]									
Americium-241	pCi/g	0	2	7	0.012	0.013	–	0.014	–
Cesium-137	pCi/g	0	7	7	0.024	0.111	0.069	0.207	0.162
Cobalt-60	pCi/g	0	0	3	–	–	–	–	–
Neptunium-237	pCi/g	0	3	3	0.368	0.508	0.198	0.755	0.732
Plutonium-238	pCi/g	0	1	7	–	0.016	–	–	–
Plutonium-239, Plutonium-240	pCi/g	0	1	7	–	0.027	–	–	–
Potassium-40	pCi/g	0	3	3	25.3	27.3	2.76	30.1	30.4
Sodium-22	pCi/g	0	0	3	–	–	–	–	–
Strontium-90	pCi/g	0	2	6	0.107	0.112	–	0.116	–
Tritium	pCi/L	0	0	0	–	–	–	–	–
Tritium	pCi/g	0	1	6	–	2.18	–	–	–
Uranium-234	pCi/g	0	7	7	0.364	0.766	0.256	1.09	0.956
Uranium-235, Uranium-236	pCi/g	0	7	7	0.033	0.084	0.05	0.153	0.121
Uranium-238	pCi/g	0	7	7	0.419	0.833	0.257	1.1	1.02
Uranium (calculated)	µg/g	0	5	5	0.33	1.41	1.12	2.61	2.39
Gross Alpha	pCi/g	1	6	6	3.59	12.1	5	16.3	16.1
Gross Beta	pCi/g	1	7	7	18.2	33.1	10.7	45.2	41
Gross Gamma	pCi/g	0	6	6	1.48	6.46	1.57	8.43	7.71
Pueblo Canyon [a]									
Americium-241	pCi/g	15	29	35	0.011	0.184	0.18	1.32	0.25
Cesium-137	pCi/g	4	36	37	0.0	0.378	0.348	2.11	0.491
Cobalt-60	pCi/g	0	0	13	–	–	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	13	13	0.261	0.709	0.032	1.51	0.726
Plutonium-238	pCi/g	4	18	35	0.005	0.018	0.01	0.046	0.022
Plutonium-239, Plutonium-240	pCi/g	27	30	35	0.015	2.7	1.37	12.5	3.19
Potassium-40	pCi/g	0	13	13	26	29.1	0.493	33.1	29.4
Sodium-22	pCi/g	0	1	13	–	0.021	–	–	–
Strontium-90	pCi/g	0	23	34	0.051	0.175	0.056	0.386	0.199
Tritium	pCi/L	1	6	7	160	325	–	544	–
Tritium	pCi/g	0	3	27	0.006	0.254	0.351	0.818	0.65
Uranium-234	pCi/g	0	35	35	0.343	1.08	0.245	2.32	1.16
Uranium-235, Uranium-236	pCi/g	0	29	35	0.012	0.086	0.021	0.149	0.093
Uranium-238	pCi/g	0	35	35	0.391	0.993	0.126	2.03	1.04
Uranium (calculated)	µg/g	0	23	23	0.13	1.93	1.39	4.47	2.5
Gross Alpha	pCi/g	3	36	36	3.13	15.4	3.54	28.3	16.6
Gross Beta	pCi/g	9	36	36	23.5	33.7	4.41	46	35.1
Gross Gamma	pCi/g	0	29	29	5.17	9.35	1.01	12.9	9.72
Sandia Canyon [a]									
Americium-241	pCi/g	0	11	30	0.002	0.015	0.005	0.022	0.018
Cesium-137	pCi/g	0	22	29	0.004	0.056	0.004	0.139	0.057
Cobalt-60	pCi/g	0	3	10	0.024	0.028	0.001	0.031	0.029
Neptunium-237	pCi/g	0	10	10	0.223	0.826	0.178	2.04	0.937
Plutonium-238	pCi/g	3	10	30	0.0	0.015	0.006	0.044	0.019
Plutonium-239, Plutonium-240	pCi/g	2	11	30	0.0	0.025	0.012	0.043	0.032
Potassium-40	pCi/g	0	10	10	21.4	27.6	0.707	34.8	28
Sodium-22	pCi/g	0	1	10	–	0.023	–	–	–
Strontium-90	pCi/g	0	6	27	0.042	0.074	0.027	0.111	0.096
Tritium	pCi/L	2	4	6	108	543	596	1,270	1,130
Tritium	pCi/g	0	2	24	0.053	0.374	–	0.696	–
Uranium-234	pCi/g	1	30	30	0.05	0.952	0.46	2.71	1.12
Uranium-235, Uranium-236	pCi/g	1	23	30	0.012	0.084	0.045	0.246	0.103
Uranium-238	pCi/g	1	30	30	0.056	0.933	0.479	2.66	1.11
Uranium (calculated)	µg/g	0	19	19	0.14	2.16	1.7	7.51	2.92
Gross Alpha	pCi/g	7	26	27	4.26	12.9	4.11	25.9	14.5
Gross Beta	pCi/g	15	27	27	6.64	33.4	4.56	52.9	35.1
Gross Gamma	pCi/g	0	26	26	5.08	9	0.758	17.3	9.3
Water Canyon [a]									
Americium-241	pCi/g	2	42	68	0.004	0.033	0.016	0.155	0.038
Cesium-137	pCi/g	10	66	66	0.007	0.22	0.102	1.14	0.245
Cobalt-60	pCi/g	0	1	16	–	0.056	–	–	–

Measured Radiochemical		Detected per ESR (2001 through 2005)	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/g	0	16	16	0.091	0.455	0.159	0.955	0.533
Plutonium-238	pCi/g	0	23	68	0.0	0.018	0.023	0.166	0.027
Plutonium-239, Plutonium-240	pCi/g	11	39	68	0.003	0.057	0.041	0.721	0.07
Potassium-40	pCi/g	0	16	16	24.5	28.3	0.725	32.9	28.7
Sodium-22	pCi/g	0	3	16	0.022	0.03	0.011	0.04	0.042
Strontium-90	pCi/g	2	30	68	0.044	0.12	0.034	0.285	0.133
Tritium	pCi/L	17	22	24	82.5	217	172	541	289
Tritium	pCi/g	1	8	68	0.0	2.13	2.20	6.59	3.66
Uranium-234	pCi/g	0	68	48	0.314	0.742	0.045	1.31	0.752
Uranium-235, Uranium-236	pCi/g	0	53	68	0.016	0.071	0.016	0.17	0.075
Uranium-238	pCi/g	0	68	68	0.273	0.786	0.09	1.74	0.808
Uranium (calculated)	µg/g	0	39	39	0.11	1.77	1.29	4.58	2.18
Gross Alpha	pCi/g	21	69	69	2.53	12.2	2.72	26.9	12.9
Gross Beta	pCi/g	32	69	69	8.22	33.1	2.62	50.5	33.7
Gross Gamma	pCi/g	0	42	42	5.45	7.98	0.94	12	8.27

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, pCi/g = picocuries per gram, µg/L = micrograms per liter.
[a] Canyon sampling stations are at both onsite and perimeter locations.
[b] Perimeter Stations. Canyon sampling stations are at perimeter locations.
[c] Canyon sampling stations are at onsite locations.
Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–22 Radiochemical Statistical Analysis of Runoff from 2001 through 2005

Measured Radiochemical		Detected per ESR (2001 through 2005)	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Stations									
Americium-241	pCi/L	0	6	34	0.003	0.043	0.045	0.116	0.08
Cesium-137	pCi/L	0	5	31	0.54	2.44	1.28	3.75	3.56
Cobalt-60	pCi/L	0	2	19	1.25	1.28	–	1.3	–
Neptunium-237	pCi/L	0	0	19	–	–	–	–	–
Plutonium-238	pCi/L	0	3	35	0.018	0.029	0.017	0.049	0.049
Plutonium-239, Plutonium-240	pCi/L	0	12	35	0.0	0.267	0.368	1.0	0.475
Potassium-40	pCi/L	0	16	19	7.19	42.5	27.5	90.2	56
Radium-226	pCi/L	0	3	5	0.245	1.77	2.56	4.72	4.66
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	1	19	–	2.51	–	–	–
Strontium-90	pCi/L	0	14	34	0.093	0.227	0.171	0.694	0.316
Tritium	pCi/L	0	5	24	74.8	118	21.5	199	137
Uranium-234	pCi/L	0	36	36	0.271	7.97	13.9	108	12.5

Measured Radiochemical		2001 through 2005							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium-235, Uranium-236	pCi/L	0	33	36	0.025	0.689	1.26	9.55	1.12
Uranium-238	pCi/L	0	36	36	0.173	7.85	14.5	111	12.6
Uranium (calculated)	µg/L	0	26	26	0.0	2.43	2.24	12.5	3.29
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	4	31	34	0.736	17.6	26.9	235	27.1
Gross Beta	pCi/L	0	34	34	1.34	32.3	51.9	298	49.7
Gross Gamma	pCi/L	0	10	29	59.3	201	202	499	326
Perimeter Stations									
Americium-241	pCi/L	25	139	215	0.005	1.05	0.378	11.6	1.11
Cesium-137	pCi/L	3	81	207	0.0	7.95	1.9	68.1	8.36
Cobalt-60	pCi/L	0	36	149	0.517	3.6	3.09	13.5	4.61
Neptunium-237	pCi/L	0	44	149	0.141	11.2	6	28.8	13
Plutonium-238	pCi/L	3	84	214	0.0	0.231	0.098	2.84	0.252
Plutonium-239, Plutonium-240	pCi/L	23	144	214	0.0	5.65	3.81	106	6.27
Potassium-40	pCi/L	0	137	148	1	69.4	67.3	327	80.7
Radium-226	pCi/L	0	10	15	0.161	0.365	0.069	0.6	0.407
Radium-228	pCi/L	0	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	0	8	149	0.216	2.37	0.347	3.56	2.61
Strontium-90	pCi/L	14	151	208	0.062	4.32	1.66	35.1	4.59
Tritium	pCi/L	2	90	182	50.9	179	58.1	1,410	191
Uranium-234	pCi/L	10	188	211	0.038	8.14	5.45	88.9	8.92
Uranium-235, Uranium-236	pCi/L	1	155	211	0.008	0.732	0.337	7.28	0.785
Uranium-238	pCi/L	8	188	211	0.022	8.37	5.46	91.9	9.15
Uranium (calculated)	µg/L	0	171	172	0.0	5.9	4.79	135	6.62
Uranium (measured)	µg/L	0	89	89	0.03	2.05	3.5	13.5	2.78
Gross Alpha	pCi/L	9	167	212	0.548	189	124	3,070	208
Gross Beta	pCi/L	8	201	212	0.636	251	189	4,630	278
Gross Gamma	pCi/L	0	16	61	57.6	186	148	1,110	259
Onsite Stations									
Americium-241	pCi/L	38	356	542	0.0	13.1	24.8	583	15.7
Cesium-137	pCi/L	3	188	498	0.0	12	5.81	104	12.9
Cobalt-60	pCi/L	0	66	289	0.033	4	3.54	10.7	4.84
Neptunium-237	pCi/L	0	75	287	1.96	12.1	7.75	40.3	13.9
Plutonium-238	pCi/L	20	240	531	0.0	13.7	28.5	685	17.3
Plutonium-239, Plutonium-240	pCi/L	55	330	531	0.0	11.1	17	775	13
Potassium-40	pCi/L	0	266	288	0.0	78.4	112	709	91.8
Radium-226	pCi/L	0	28	36	0.123	0.349	0.302	1.45	0.461

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Radium-228	pCi/L	0	5	6	0.537	1.55	0.994	2.83	2.42
Sodium-22	pCi/L	0	13	289	0.814	2.84	1.11	4.32	3.44
Strontium-90	pCi/L	31	355	502	0.052	3.95	1.28	78.8	4.08
Tritium	pCi/L	13	209	370	54.4	326	139	12,900	345
Uranium-234	pCi/L	27	472	506	0.013	10.6	3.67	354	10.9
Uranium-235, Uranium-236	pCi/L	2	360	513	0.0	0.947	0.218	65.5	0.97
Uranium-238	pCi/L	26	485	515	0.015	13.8	6.85	2,220	14.4
Uranium (calculated)	µg/L	0	465	465	0.0	7.62	8.54	249	8.4
Uranium (measured)	µg/L	0	212	212	0.025	7.05	22.8	238	10.1
Gross Alpha	pCi/L	26	411	495	0.193	162	91.4	2,600	171
Gross Beta	pCi/L	20	469	488	0.809	199	129	5,370	211
Gross Gamma	pCi/L	0	74	175	55	180	74.8	1,990	197
Ancho Canyon [b]									
Americium-241	pCi/L	0	2	7	0.017	0.019	–	0.021	–
Cesium-137	pCi/L	0	2	6	2.47	2.7	–	2.93	–
Cobalt-60	pCi/L	0	1	5	–	2.42	–	–	–
Neptunium-237	pCi/L	0	1	5	–	13.9	–	–	–
Plutonium-238	pCi/L	0	1	7	–	0.01	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	0	7	–	–	–	–	–
Potassium-40	pCi/L	0	2	5	15.8	29.5	–	43.2	–
Radium-226	pCi/L	0	0	1	–	–	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	5	–	–	–	–	–
Strontium-90	pCi/L	0	0	6	–	–	–	–	–
Tritium	pCi/L	0	1	5	–	112	–	–	–
Uranium-234	pCi/L	0	7	7	0.061	0.117	0.034	0.171	0.142
Uranium-235, Uranium-236	pCi/L	0	0	7	–	–	–	–	–
Uranium-238	pCi/L	0	6	7	0.037	0.054	0.008	0.103	0.06
Uranium (calculated)	µg/L	0	8	8	0.09	9.48	16.1	33.5	20.7
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	1	7	–	1.19	–	–	–
Gross Beta	pCi/L	0	3	7	1.11	1.89	0.392	2.12	2.34
Gross Gamma	pCi/L	0	1	6	–	78.3	–	–	–
Frijoles Canyon [b]									
Americium-241	pCi/L	0	5	16	0.018	0.095	0.098	0.542	0.181
Cesium-137	pCi/L	0	2	15	1.5	2.45	–	3.39	–
Cobalt-60	pCi/L	0	3	11	1.46	1.83	0.53	2.44	2.43
Neptunium-237	pCi/L	0	4	11	12.1	12.6	5.33	22.2	17.82
Plutonium-238	pCi/L	0	2	16	0.046	0.052	–	0.057	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-239, Plutonium-240	pCi/L	0	4	16	0.0	0.467	0.87	1.77	1.32
Potassium-40	pCi/L	0	8	11	2.49	22.3	15.3	43.2	32.8
Radium-226	pCi/L	0	1	3	–	0.161	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	11	–	–	–	–	–
Strontium-90	pCi/L	1	4	16	0.062	0.726	0.939	3.63	1.65
Tritium	pCi/L	0	7	16	58.3	118	47.3	219	153
Uranium-234	pCi/L	0	12	15	0.038	0.207	0.187	1.37	0.313
Uranium-235, Uranium-236	pCi/L	0	4	15	0.046	0.07	0.027	0.098	0.096
Uranium-238	pCi/L	0	12	15	0.027	0.166	0.219	1.39	0.29
Uranium (calculated)	µg/L	0	10	10	0.057	0.119	0.048	0.19	0.149
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	0	7	16	0.548	10	14.6	47.3	20.8
Gross Beta	pCi/L	0	15	16	0.636	9.91	13.1	128	16.6
Gross Gamma	pCi/L	0	3	13	57.6	68.5	15.3	92.6	85.8
Guaje Canyon [a]									
Americium-241	pCi/L	6	20	32	0.018	0.361	0.239	1.52	0.466
Cesium-137	pCi/L	3	20	30	0.0	6.98	3.2	15.8	8.39
Cobalt-60	pCi/L	0	0	4	–	–	–	–	–
Neptunium-237	pCi/L	0	0	4	–	–	–	–	–
Plutonium-238	pCi/L	0	8	32	0.065	0.361	0.011	0.699	0.369
Plutonium-239, Plutonium-240	pCi/L	7	18	32	0.012	1.2	1.32	3.93	1.81
Potassium-40	pCi/L	0	3	4	30.6	65.1	55.4	178	128
Radium-226	pCi/L	0	2	2	0.486	0.543	–	0.6	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	0	4	–	–	–	–	–
Strontium-90	pCi/L	12	28	31	0.212	7.84	5.14	26.8	9.74
Tritium	pCi/L	2	6	16	84.3	151	24.2	268	171
Uranium-234	pCi/L	8	31	34	0.039	30.9	26.4	354	40.2
Uranium-235, Uranium-236	pCi/L	1	27	33	0.0	1.82	1.28	15.2	2.3
Uranium-238	pCi/L	7	30	33	0.033	27.2	25.1	334	36.2
Uranium (calculated)	µg/L	0	28	28	0.059	13.3	17.4	137	19.7
Uranium (measured)	µg/L	0	0	0	–	–	–	–	–
Gross Alpha	pCi/L	7	25	31	0.9	343	385	3,070	494
Gross Beta	pCi/L	6	30	30	2.29	446	576	5,370	652
Gross Gamma	pCi/L	0	7	19	85.2	334	546	1,110	739

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Los Alamos Canyon [b]									
Americium-241	pCi/L	9	92	121	0.0	1.26	1.1	16.1	1.48
Cesium-137	pCi/L	0	51	115	0.685	9.43	2.86	68.1	10.2
Cobalt-60	pCi/L	0	22	80	0.033	2.97	1.46	5.87	3.58
Neptunium-237	pCi/L	0	27	80	3.41	11.6	5.79	26.7	13.8
Plutonium-238	pCi/L	2	62	117	0.0	0.212	0.09	1.4	0.235
Plutonium-239, Plutonium-240	pCi/L	23	90	117	0.002	2.87	0.592	19.6	2.99
Potassium-40	pCi/L	0	77	80	0.0	69.8	67.5	277	84.9
Radium-226	pCi/L	0	7	8	0.205	0.35	0.084	0.542	0.412
Radium-228	pCi/L	0	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	0	4	80	2.45	3.09	0.363	3.56	3.45
Strontium-90	pCi/L	0	92	113	0.115	6.55	4.37	78.8	7.44
Tritium	pCi/L	0	60	102	50.9	144	49.4	400	156
Uranium-234	pCi/L	2	104	115	0.048	6.09	4.87	149	7.03
Uranium-235, Uranium-236	pCi/L	0	92	115	0.017	0.567	0.216	6.04	0.611
Uranium-238	pCi/L	0	104	115	0.022	6.09	4.89	147	7.03
Uranium (calculated)	µg/L	0	122	122	0.02	8.23	5.63	102	9.23
Uranium (measured)	µg/L	0	66	66	0.03	2.71	4.43	21.6	3.78
Gross Alpha	pCi/L	2	94	114	0.575	120	107	848	142
Gross Beta	pCi/L	0	108	114	1.58	130	132	1,140	155
Gross Gamma	pCi/L	0	6	13	70.8	226	428	814	568
Mortandad Canyon [b]									
Americium-241	pCi/L	17	94	137	0.009	28.9	48.3	583	38.7
Cesium-137	pCi/L	3	53	125	0.22	27.5	24.2	104	34
Cobalt-60	pCi/L	0	22	98	1.13	1.88	1.92	7.99	2.68
Neptunium-237	pCi/L	0	32	98	1.98	12.1	8.2	40.3	14.9
Plutonium-238	pCi/L	11	84	132	0.0	32.4	64.5	685	46.2
Plutonium-239, Plutonium-240	pCi/L	19	89	133	0.0	22.5	44.3	608	31.7
Potassium-40	pCi/L	0	86	98	0.055	72.9	88.5	630	91.6
Radium-226	pCi/L	0	17	20	0.167	0.285	0.229	1.45	0.394
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	6	98	0.814	2.35	0.913	4.13	3.09
Strontium-90	pCi/L	9	87	128	0.1	2.5	2.42	43.9	3
Tritium	pCi/L	3	52	80	78	1,090	1,042	12,900	1,370
Uranium-234	pCi/L	4	118	124	0.03	3.76	4.74	55	4.62
Uranium-235, Uranium-236	pCi/L	0	95	124	0.0	0.354	0.484	4.6	0.451
Uranium-238	pCi/L	2	119	125	0.015	4	5.18	67.2	4.93
Uranium (calculated)	µg/L	0	64	64	0.018	3.93	4.32	45.8	4.99

Measured Radiochemical		2001 through 2005							
		Detected per ESR	***Used In This SWEIS***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium (measured)	µg/L	0	35	35	0.079	3.46	8.45	48.3	6.25
Gross Alpha	pCi/L	4	107	125	0.605	148	150	2,290	176
Gross Beta	pCi/L	2	119	123	1.6	120	109	2,210	139
Gross Gamma	pCi/L	0	20	54	58.4	335	266	1,990	451
Pajarito Canyon [b]									
Americium-241	pCi/L	9	134	214	0.004	0.479	0.425	10.1	0.551
Cesium-137	pCi/L	0	61	192	1.21	6.62	3.1	46.8	7.4
Cobalt-60	pCi/L	0	24	104	0.495	4.34	3.9	10.7	5.9
Neptunium-237	pCi/L	0	26	102	2.42	11.3	8.83	28	14.6
Plutonium-238	pCi/L	5	85	212	0.0	0.167	0.116	0.985	0.192
Plutonium-239, Plutonium-240	pCi/L	11	123	212	0.002	0.931	0.931	7.65	1.1
Potassium-40	pCi/L	0	97	103	4.31	79.2	117	709	102
Radium-226	pCi/L	0	5	8	0.14	0.312	0.16	0.566	0.453
Radium-228	pCi/L	0	4	4	0.537	1.68	1.1	2.83	2.76
Sodium-22	pCi/L	0	7	104	1.87	3	1.24	4.32	3.92
Strontium-90	pCi/L	11	133	197	0.052	2.37	1.71	71.9	2.66
Tritium	pCi/L	6	93	160	62.9	238	45.9	1,980	248
Uranium-234	pCi/L	14	181	198	0.013	9.5	5.05	331	10.2
Uranium-235, Uranium-236	pCi/L	2	129	206	0.0	1.16	0.878	65.5	1.31
Uranium-238	pCi/L	17	195	207	0.02	20.8	29	2,220	24.9
Uranium (calculated)	µg/L	0	170	170	0.0	6.24	9.65	249	7.69
Uranium (measured)	µg/L	0	88	88	0.03	7.75	29	238	13.8
Gross Alpha	pCi/L	10	158	194	0.193	121	73.5	1,630	132
Gross Beta	pCi/L	9	180	190	0.809	145	102	3,160	160
Gross Gamma	pCi/L	0	29	55	55	118	51.8	430	137
Pueblo Canyon [b]									
Americium-241	pCi/L	19	75	102	0.013	1.30	0.951	67.3	1.52
Cesium-137	pCi/L	0	42	97	0.0	5.1	3.17	28.3	6.06
Cobalt-60	pCi/L	0	13	66	2.21	5.44	5.08	13.5	8.2
Neptunium-237	pCi/L	0	15	66	0.141	10.5	4.01	24.5	12.6
Plutonium-238	pCi/L	3	43	99	0.0	0.282	0.31	5.55	0.375
Plutonium-239, Plutonium-240	pCi/L	16	84	99	0.009	12.5	11.55	775	15
Potassium-40	pCi/L	0	65	65	3.67	81	78	343	99.9
Radium-226	pCi/L	0	4	5	0.274	0.31	0.004	0.352	0.314
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	2	66	0.216	0.938	–	1.66	–
Strontium-90	pCi/L	2	82	96	0.086	2.88	3.12	21.3	3.56
Tritium	pCi/L	0	38	74	57.4	183	112	1,410	219
Uranium-234	pCi/L	2	93	97	0.038	8.86	9.64	88.9	10.8

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-235, Uranium-236	pCi/L	0	85	97	0.008	0.621	0.623	7.28	0.754
Uranium-238	pCi/L	1	93	97	0.066	8.68	9.8	91.9	10.7
Uranium (calculated)	µg/L	0	46	47	0.004	12.6	10.5	81.8	15.7
Uranium (measured)	µg/L	0	27	27	0.03	2.24	3.66	11.5	3.62
Gross Alpha	pCi/L	2	88	97	0.61	163	180	1,800	201
Gross Beta	pCi/L	2	96	97	1.54	267	320	3,010	331
Gross Gamma	pCi/L	0	9	25	58.4	152	137	820	241
Sandia Canyon [b]									
Americium-241	pCi/L	0	20	56	0.01	0.041	0.014	0.111	0.047
Cesium-137	pCi/L	0	10	57	1.62	3.74	1.71	9.61	4.8
Cobalt-60	pCi/L	0	9	39	1.04	3.39	1.38	5.63	4.29
Neptunium-237	pCi/L	0	11	39	1.96	13.7	0.387	22.9	13.9
Plutonium-238	pCi/L	0	9	57	0.025	0.051	0.011	0.097	0.058
Plutonium-239, Plutonium-240	pCi/L	0	20	57	0.005	0.083	0.034	0.331	0.097
Potassium-40	pCi/L	0	37	39	1.32	58.6	88.5	420	87.1
Radium-226	pCi/L	0	1	2	–	0.176	–	–	–
Radium-228	pCi/L	0	0	0	–	–	–	–	–
Sodium-22	pCi/L	0	2	39	2.1	2.22	–	2.33	–
Strontium-90	pCi/L	0	24	55	0.09	0.227	0.091	0.831	0.264
Tritium	pCi/L	2	26	49	54.4	132	49.4	533	151
Uranium-234	pCi/L	1	55	57	0.022	2.24	1.71	69.1	2.69
Uranium-235, Uranium-236	pCi/L	0	39	57	0.019	0.201	0.17	4.83	0.254
Uranium-238	pCi/L	1	51	57	0.045	2.36	1.79	70.9	2.85
Uranium (calculated)	µg/L	0	65	65	0.018	1.55	1.39	17.7	1.89
Uranium (measured)	µg/L	0	39	39	0.04	0.998	1.23	4	1.38
Gross Alpha	pCi/L	2	44	55	0.428	52.2	64.8	877	71.3
Gross Beta	pCi/L	1	54	55	3.41	43.3	27.9	524	50.8
Gross Gamma	pCi/L	0	7	27	82.8	139	65.7	343	188
Water Canyon [b]									
Americium-241	pCi/L	3	53	72	0.0	0.101	0.079	1.18	0.122
Cesium-137	pCi/L	0	27	65	0.0	4.92	2.57	15	5.89
Cobalt-60	pCi/L	0	8	28	0.857	3	1.52	8.3	4.05
Neptunium-237	pCi/L	0	3	28	7.05	12.1	4.54	15.9	17.2
Plutonium-238	pCi/L	2	28	69	0.0	0.111	0.038	0.549	0.125
Plutonium-239, Plutonium-240	pCi/L	2	43	69	0.0	0.323	0.281	3.15	0.407
Potassium-40	pCi/L	0	25	28	1.26	105	197	511	183
Radium-226	pCi/L	0	1	1	–	0.245	–	–	–
Radium-228	pCi/L	0	1	2	–	1.06	–	–	–

Measured Radiochemical		2001 through 2005							
		Detected per ESR	Used In This SWEIS	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Sodium-22	pCi/L	0	0	28	–	–	–	–	–
Strontium-90	pCi/L	10	54	65	0.14	2.32	1.99	16.9	2.85
Tritium	pCi/L	2	15	49	88.4	148	24.9	231	161
Uranium-234	pCi/L	6	56	67	0.049	13.6	9.4	79	16
Uranium-235, Uranium-236	pCi/L	0	42	67	0.009	0.934	0.583	4.86	1.11
Uranium-238	pCi/L	6	60	67	0.019	16.4	13.8	82.1	19.9
Uranium (calculated)	µg/L	0	123	123	0.0	14.5	20	190	18
Uranium (measured)	µg/L	0	46	46	0.025	13	25.9	93.4	20.5
Gross Alpha	pCi/L	8	51	65	0.463	150	105	1,660	179
Gross Beta	pCi/L	8	62	65	1.26	234	173	2,990	278
Gross Gamma	pCi/L	0	8	23	93.1	300	228	496	455

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Canyon sampling stations are at perimeter locations.

[b] Canyon sampling stations are at both onsite and perimeter locations.

Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–23 Radiochemical Statistical Analysis of Soils from 2001 through 2003

Measured Radiochemical		2001 through 2003						
		Detected per ESR	Used In This SWEIS	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Regional Stations								
Americium-241	pCi/g	10	10	0.0	0.004	0.002	0.009	0.005
Cesium-137	pCi/g	10	10	0.06	0.257	0.105	0.65	0.322
Plutonium-238	pCi/g	5	5	0.0	0.002	0.002	0.004	0.004
Plutonium-239, Plutonium-240	pCi/g	10	10	0.001	0.01	0.005	0.029	0.013
Strontium-90	pCi/g	10	10	0.05	0.156	0.041	0.26	0.181
Tritium	pCi/mL	10	10	0.0	0.273	0.237	0.94	0.419
Uranium-234	pCi/g	7	7	0.55	0.729	0.246	1.2	0.911
Uranium-235	pCi/g	7	7	0.033	0.056	0.022	0.077	0.073
Uranium-238	pCi/g	7	7	0.59	0.74	0.263	1.2	0.935
Uranium (calculated)	pCi/g	6	6	1.7	2.2	0.240	2.7	2.39
Gross Alpha	pCi/g	6	6	3.7	4.48	1.1	6.1	5.37
Gross Beta	pCi/g	6	6	3.7	4.55	0.436	5.01	4.9
Gross Gamma	pCi/g	6	6	6	7.33	1	8	8.13
Perimeter Stations								
Americium-241	pCi/g	29	29	0.001	0.012	0.003	0.058	0.013
Cesium-137	pCi/g	30	30	0.09	0.337	0.023	0.84	0.346
Plutonium-238	pCi/g	24	24	0.0	0.003	0.001	0.011	0.004
Plutonium-239, Plutonium-240	pCi/g	30	30	0.008	0.059	0.023	0.53	0.067

Measured Radiochemical		2001 through 2003						
		Detected per ESR	Used In This SWEIS	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Strontium-90	pCi/g	29	29	0.01	0.174	0.008	0.45	0.177
Tritium	pCi/mL	25	25	0.01	0.822	0.551	3	1.04
Uranium-234	pCi/g	20	20	0.6	1.12	0.439	2.25	1.31
Uranium-235	pCi/g	20	20	0.033	0.081	0.041	0.188	0.099
Uranium-238	pCi/g	20	20	0.54	1.12	0.454	2.32	1.32
Uranium (calculated)	pCi/g	20	20	2.1	3.93	1.36	9.3	4.53
Gross Alpha	pCi/g	20	20	1.93	5.41	1.97	7.9	6.27
Gross Beta	pCi/g	20	20	2.38	4.91	1.83	7.7	5.71
Gross Gamma	pCi/g	20	20	9	11.3	3.17	20	12.7
Onsite Stations								
Americium-241	pCi/g	36	36	0.002	0.015	0.008	0.2	0.018
Cesium-137	pCi/g	36	36	0.03	0.345	0.061	0.9	0.365
Plutonium-238	pCi/g	32	32	0.0	0.002	0.0	0.006	0.002
Plutonium-239, Plutonium-240	pCi/g	36	36	0.002	0.056	0.032	0.8	0.067
Strontium-90	pCi/g	34	34	0.0	0.142	0.038	0.38	0.154
Tritium	pCi/mL	36	36	0.1	0.907	0.724	4	1.14
Uranium-234	pCi/g	24	24	0.75	1.08	0.345	1.8	1.22
Uranium-235	pCi/g	24	24	0.044	0.069	0.03	0.152	0.081
Uranium-238	pCi/g	24	24	0.77	1.15	0.364	1.87	1.3
Uranium (calculated)	pCi/g	24	24	2.41	3.51	0.997	6	3.91
Gross Alpha	pCi/g	24	24	3.59	5.54	1.32	8.1	6.07
Gross Beta	pCi/g	24	24	2.9	4.7	1.39	8.1	5.26
Gross Gamma	pCi/g	24	24	10	11.6	1.54	14	12.2

ESR = Environmental Surveillance Reports, UCL = upper confidence limit, pCi/mL = picocuries per milliliter, pCi/g = picocuries per gram.
Sources: LANL 2002, 2004a, 2004b, 2005, 2006b.

Table F–24 presents EPA and EPA-equivalent maximum contaminant levels (MCLs) (Title 40 *Code of Federal Regulations* [CFR], Part 141) for comparison between the groundwater, surface water or stormwater runoff concentrations presented in the above tables. The regulations at 40 CFR Part 141 only apply to drinking water systems.

Table F–24 Benchmark Concentrations for Analyzed Radionuclides for Groundwater, Surface Water, or Stormwater Runoff [a]

Constituent	Benchmark Concentration	
Americium-241	picocuries per liter	15 [b]
Cesium-137	picocuries per liter	93 [c]
Cobalt-60	picocuries per liter	173 [c]
Neptunium-237	picocuries per liter	15 [b]
Plutonium-238	picocuries per liter	15 [b]
Plutonium-239	picocuries per liter	15 [b]
Plutonium-240	picocuries per liter	15 [b]

Constituent	*Benchmark Concentration*	
Potassium-40	picocuries per liter	251 [c]
Radium-226, Radium-228	picocuries per liter	5 [b]
Sodium-22	picocuries per liter	407 [c]
Strontium-90	picocuries per liter	8 [b]
Tritium	picocuries per liter	20000 [b]
Uranium-234	micrograms per liter	30 [b]
Uranium-235	micrograms per liter	30 [b]
Uranium-236	micrograms per liter	30 [b]
Uranium-238	micrograms per liter	30 [b]
Uranium Total	picocuries per liter	10 [d]
Gross Alpha	picocuries per liter	15 [b]
Gross Beta	millirem per year	4 [b]
Gross Gamma	millirem per year	4 [b]

[a] Similar values are available for soils and sediments, but this would require more detailed analysis of agricultural and recreational use at a particular location.
[b] EPA maximum contaminant levels (40 CFR Part 141).
[c] EPA-equivalent maximum contaminant levels. Published value calculated to yield an annual dose equivalent of 4 millirem per year to the total body using Federal Guidance Report 11 dose factors.
[d] Calculated using sum of fractions rule and isotopic distribution for naturally occurring uranium.

The LANL environmental surveillance program also includes chemicals and elements, that are periodically measured at Regional, Perimeter, and Onsite stations. Samples of soil, sediment, surface water and groundwater were all measured for these chemicals and elements which are listed in **Tables F–25 and F–26** (LANL 2002, 2004a, 2004b, 2005, 2006b).

Table F–25 Chemicals Measured in the Los Alamos National Laboratory Environmental Surveillance Program

Chemical	*Chemical*	*Chemical*
Acenaphthene	2-Chloronaphthalene	Isophorone
Acenaphthylene	2-Chlorophenol	Isopropylbenzene
Acetone	Chrysene	4-Isopropyltoluene
4-Amino-2,6-dinitrotoluene	2,4-D	Methylene Chloride
2-Amino-4,6-dinitrotoluene	2,4-DB	2-Methylnaphthalene
Aniline	4,4'-DDD	2-Methylphenol
Anthracene	4,4'-DDE	4-Methylphenol
Aroclor-1016 (PCB)	4,4'-DDT	Naphthalene
Aroclor-1242 (PCB)	Dibenzofuran	3-Nitroaniline
Aroclor-1254 (PCB)	1,2-Dichlorobenzene	4-Nitroaniline
Aroclor-1260 (PCB)	1,3-Dichlorobenzene	Nitrobenzene
Azobenzene	1,4-Dichlorobenzene	N-Nitrosodimethylamine
Benzo(a)anthracene	3,3'-Dichlorobenzidine	N-Nitroso-di-n-propylamine
Benzo(a)pyrene	Dieldrin	1,2,3,4,6,7,8,9-Octachlorodibenzodioxin
Benzo(b)fluoranthene	Diethylphthalate	Pentachlorophenol
Benzo(g,h,i)perylene	Dimethyl Phthalate	Perchlorate
Benzo(k)fluoranthene	Di-n-butylphthalate	Phenanthrene
Benzoic Acid	Di-n-octylphthalate	Phenol
Benzyl Alcohol	2,4-Dinitrotoluene	Pyrene

Chemical	Chemical	Chemical
delta-BHC	1,4-Dioxane	Pyridine
Bis(2-chloroethoxy)methane	Endrin	RDX
Bis(2-ethylhexyl)phthalate	Ethylbenzene	Styrene
Bromodichloromethane	Fluoranthene	2,3,7,8-Tetrachlorodibenzofuran
Bromoform	Fluorene	Tetrachloroethene
2-Butanone	Heptachlor	Toluene
Butylbenzylphthalate	Heptachlor Epoxide	Trichloroethene
Carbazole	1,2,3,4,6,7,8-Heptachlorodibenzodioxin	1,1,1-Trichloroethane
4-Chloroaniline	Hexachlorobenzene	2,4,6-Trichlorophenol
Chlorodibromomethane	2-Hexanone	1,3,5-Trinitrobenzene
Chloroform	HMX	2,4,6-Trinitrotoluene
Chloromethane	Indeno(1,2,3-cd)pyrene	

PCB = polychlorinated biphenyls.

Table F–26 Elements Measured in the Los Alamos National Laboratory Environmental Surveillance Program

Element	Element	Element
Silver	Chromium	Antimony
Aluminum	Copper	Selenium
Arsenic	Iron	Tin
Boron	Mercury	Strontium
Barium	Manganese	Thallium
Beryllium	Molybdenum	Vanadium
Cadmium	Nickel	Zinc
Cobalt	Lead	

Measured environmental concentrations of the chemicals and elements listed in Tables F–25 and F–26 did not exceed EPA or New Mexico Environment Department standards with the following exceptions of perchlorate, hexavalent chromium, polychlorinated biphenyls (PCBs), and 1,4-dioxane. The number of “Detected per ESR” and “Used in This SWEIS” data points for these four chemicals are identical because the ESR source for these chemicals only reported data that were considered detected.

Perchlorate is a chemical of particular interest that has a high propensity to enter the groundwater. Perchlorate is used in rocket solid propellant, fireworks, lubricating oils, paint production, explosives, fabrics, and dye fixers. Perchlorate is formed naturally in the upper atmosphere and may also be created from fertilizers, mineral weathering, or electrochemical reactions. Perchlorate is soluble in water and has been shown to disrupt thyroid function and influence thyroid tumor formation if ingested in sufficient quantities. There is no Federal EPA MCL or MCL goal for perchlorate in drinking water. The EPA, however, has established a No Observed Effect Level (NOEL) of 23 parts per billion or 23 micrograms per liter for perchlorate, based on a daily oral exposure of 0.0007 milligram per kilogram per day for a 154-pound (70-kilogram) adult consuming 0.53 gallons (2 liters) of water per day. The EPA Drinking Water

Equivalent Level is 24.5 Micrograms per liter. The State of New Mexico has established an interim groundwater screening level of 1 part per billion or 1 microgram per liter. Between 2002 and 2005, 903 detectable sample measurements of perchlorate were made in groundwater samples at the environmental monitoring stations. A statistical analysis of these measurements is presented in **Table F–27**. Measured mean values of perchlorate at most LANL locations were below both the EPA NOEL and New Mexico screening limit. Only Mortandad and Pueblo Canyons exceeded the New Mexico limit, and only Mortandad Canyon exceeded the EPA NOEL (USACHPPM 2006, EPA 2006a, LANL 2006b, NAS 2005, NMAC 2006).

Hexavalent chromium, also known as chromium (VI), is one of three forms of the element chromium that occurs naturally, but can also be artificially produced. Hexavalent chromium is also a chemical of particular interest that is soluble in water and therefore has a high propensity to enter groundwater. Hexavalent chromium has been shown to damage or irritate the respiratory system and is identified by the EPA as a known carcinogen if inhaled in sufficient quantities. The EPA MCL for hexavalent chromium in drinking water is 100 micrograms per liter. The State of New Mexico has established a groundwater standard of 50 micrograms per liter for hexavalent chromium. Both the EPA and State of New Mexico hexavalent chromium water concentration limits are based on the measurement of filtered groundwater samples.

Table F–27 Statistical Analysis of Perchlorate in Groundwater (micrograms per liter)

Measured Radiochemical	*2002 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	16	16	0.05	0.431	0.457	0.958	0.654
Guaje Canyon	32	32	0.05	0.623	0.552	1.45	0.814
Los Alamos	92	92	0.05	0.953	0.693	13.8	1.1
Mortandad Canyon	273	273	0.05	32.8	5.74	256	33.4
Pajarito Canyon	81	81	0.05	0.561	0.594	1.45	0.691
Pueblo Canyon	76	76	0.05	1.95	0.571	5.02	2.07
Sandia Canyon	63	63	0.05	0.642	0.471	2.17	0.759
Water Canyon	106	106	0.05	0.724	0.633	1.45	0.845
White Rock Canyon	164	164	0.05	0.751	0.762	12	0.868

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

Measured hexavalent chromium concentrations in groundwater samples in and around LANL were significantly higher for unfiltered water than for filtered water. This has been attributed to drilling equipment and well-casing materials, which are composed of steel compounds that contain hexavalent chromium and to the presence of chromium-bearing minerals in aquifer materials. Between 2001 and 2005, 1,020 detectable sample measurements of hexavalent chromium were made in groundwater at the environmental monitoring stations. A statistical analysis of these filtered sample measurements is presented in **Table F–28**. Measured mean values for hexavalent chromium at all LANL locations from 2001 through 2005 were below both the EPA MCL and the New Mexico standard (EPA 2006b, LANL 2006b, NMAC 2006).

Table F–28 Statistical Analysis of Hexavalent Chromium in Filtered Groundwater Samples (micrograms per liter)

Measured Radiochemical	*2001 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	8	8	1	1.75	0.542	2.4	2.13
Guaje Canyon	0	0	–	–	–	–	–
Los Alamos	63	63	0.503	2.25	0.243	16.7	2.31
Mortandad Canyon	92	92	0.503	7.04	11.9	404	9.48
Pajarito Canyon	46	46	0.503	1.21	0.444	3.7	1.34
Pueblo Canyon	18	18	0.503	1.08	1.07	4.9	1.57
Sandia Canyon	8	8	1	13.1	9.18	21.2	19.4
Water Canyon	89	89	0.52	1.53	0.699	10.5	1.67
White Rock Canyon	82	82	0.503	2.86	0.338	5.01	2.93
San Ildefonso	0	0	–	–	–	–	–
Santa Fe	0	0	–	–	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

In 2005, chromium concentrations between 375 and 404 micrograms per liter were detected in Well R-28 in the regional aquifer below Mortandad Canyon. Additional sampling in 2006 indicated that chromium contamination was found in the regional aquifer in a limited area beneath Sandia and Mortandad Canyons and in perched groundwater beneath Mortandad Canyon. Chromium contamination was not detected in water supply wells. In recognition of these results, the LANL contractor has prepared an *Interim Measures Work Plan for Chromium Contamination in Groundwater* in 2006 (LANL 2006a). The goals of the Work Plan were to:

- Determine the primary sources of chromium contamination and the nature of operations associated with the releases;
- Characterize the present-day spatial distribution of chromium and related constituents;
- Collect data to evaluate the geochemical, physical, and hydrologic processes that govern chromium transport; and
- Collect and evaluate data to help guide subsequent investigations and remedy selection.

These activities were conducted and completed in the summer and fall of 2006 and the results were summarized in an interim measures investigation report to provide a basis for follow-on work (LANL 2006c). This report found that the main source of hexavalent chromium was chromium-treated cooling water from a TA-3 power plant at the head of Sandia Canyon during its operations between 1956 and 1972. Other sources of chromium were identified as past facility discharges into Mortandad Canyon and Los Alamos Canyon. Sampling data from one regional groundwater well in Sandia Canyon and one regional groundwater well in Mortandad Canyon contain clear evidence of LANL-derived chromium contamination. Additional data collection from other regional groundwater monitoring wells is needed to further assess the extent of LANL-derived chromium contamination. Recommendations included additional data collection on chromium and other chemicals for use in risk assessments and the selection of corrective action remedies.

PCBs are a family of 209 chlorinated hydrocarbon compounds that were produced in the U.S. until 1997. PCBs are chemicals of particular interest because they decompose slowly and can exist and cycle between air, water, and soil. PCBs were at one time used in flame retardants, inks, adhesives, dyes, paints, fluorescent lighting fixtures, electrical transformers, electrical capacitors, and other electrical equipment. PCBs have a strong affinity for airborne particles, sediments, and soil, but do not typically migrate to groundwater. PCBs also have the potential to accumulate in fish and animals. PCBs have been shown to cause skin conditions and damage the liver and have been identified by the EPA as a known carcinogen if inhaled or ingested in sufficient quantities. The EPA MCL for PCBs in drinking water is 0.5 micrograms per liter. The State of New Mexico has established a groundwater standard of 1 microgram per liter for PCBs.

Between 2004 and 2005, four detectable sample measurements of PCBs were made in groundwater at these stations. These measurements are presented in **Table F–29**. The PCB contamination was detected only once in each of four sampling stations; no PCBs were detected in any other groundwater samples collected from the four stations. These single occurrences may indicate that the samples in which PCBs were detected are not representative of the groundwater. Despite the detection of PCBs in stormwater runoff within the LANL site boundaries, available data show no discernible impacts on PCB concentrations in the Rio Grande. Three independent types of measures showed that PCB concentrations downstream of LANL to the Cochiti Reservoir were indistinguishable from concentrations upstream of LANL. Mean total PCB concentrations in fish from Abiquiu reservoir were statistically similar to mean total PCB concentrations in fish from the Cochiti Reservoir. The statistical similarity in PCBs upstream and downstream of LANL has also been shown for dissolved water concentrations. Additionally, sampling of Rio Grande surface water by the New Mexico Environment Department and LANL showed whole water concentrations of PCBs were similar upstream and downstream of LANL. These results indicated that there are other sources of PCBs in the Rio Grande. A preliminary analysis indicated that PCB concentrations greater than 0.1 nanogram per liter can be ascribed to background fallout levels of PCBs. This is within the magnitude of some values measured in the Rio Grande water column. Measured mean value of PCBs at LANL locations was below both the EPA MCL and the New Mexico standard (EPA 2006d, LANL 2006b, NMAC 2006).

Table F–29 Statistical Analysis of Polychlorinated Biphenyl in Groundwater (micrograms per liter)

Measured Radiochemical	*2004 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Ancho Canyon	1	1	–	0.44	–	–	–
Los Alamos Canyon	2	2	0.059	0.061	–	0.063	–
White Rock Canyon	1	1	–	0.17	–	–	–

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

1,4-Dioxane, also known as diethylene oxide and glycol ethylene ether is the name of an industrial solvent used in paints, varnishes, lacquers, cleaning and detergent preparations. It is of particular interest because it mixes readily with water and migrates rapidly in soil. It does not degrade and can exist and cycle between air, water, and soil. 1,4-Dioxane has been shown to damage the liver and kidneys and has been identified by the EPA as a probable carcinogen if inhaled or ingested in sufficient quantities. There is no EPA MCL for 1,4-dioxane in drinking water; however, the EPA Region 6 cancer risk level of 1 in 100,000 for 1,4-dioxane is 61 micrograms per liter and is applicable to LANL groundwater measurements in accordance with the Consent Order. In 2005, a total of seven detectable sample measurements of 1,4-dioxane were made in groundwater at Mortandad Canyon stations. A statistical analysis of these measurements was collated and is presented in **Table F–30**. Measured mean values of 1,4-dioxane at these LANL locations were above the EPA 1 in 100,000 cancer risk level (EPA 2006c, HHS 2006, LANL 2006b, NMAC 2006).

Table F–30 Statistical Analysis of 1,4-Dioxane in Groundwater (micrograms per liter)

Measured Radiochemical	*2004 to 2005*						
	Detected per ESR	*Used In This SWEIS*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Mortandad Canyon	7	7	21.6	40.3	16.1	56.4	52.3

ESR = Environmental Surveillance Reports, UCL = upper confidence limit.

F.4 References

ANL (Argonne National Laboratory), 2005a, "Human Health Fact Sheet, Americium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005b, "Human Health Fact Sheet, Plutonium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005c, "Human Health Fact Sheet, Cesium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005d, "Human Health Fact Sheet, Strontium," Environmental Science Division, Argonne, Illinois, August.

ANL (Argonne National Laboratory), 2005e, "Human Health Fact Sheet, Tritium (Hydrogen-3)," Environmental Science Division, Argonne, Illinois, August.

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

EPA (U.S. Environmental Protection Agency), 2006a, "Integrated Risk Information System" *Perchlorate and Perchlorate Salts*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/1007.htm), February 13.

EPA (U.S. Environmental Protection Agency), 2006b, "Integrated Risk Information System," *Chromium (VI) (CASRN 18540-29-9)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0144.htm), November 30.

EPA (U.S. Environmental Protection Agency), 2006c, "Integrated Risk Information System," *1,4-Dioxane (CASRN 123-91-1)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0326.htm), November 30.

EPA (U.S. Environmental Protection Agency), 2006d, "Integrated Risk Information System," *Polychlorinated biphenyls (PCBs) (CASRN 1336-36-3)*, Office of Research and Development, National Center for Environmental Assessment, Washington, DC, (http://www.epa.gov/iris/subst/0294.htm), November 30.

HHS (U.S. Department of Health and Human Services), 2006, *Toxicological Profile for 1,4-Dioxane*, Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine/Toxicology Branch, Atlanta, Georgia, July.

LANL (Los Alamos National Laboratory), 2001, *Derivation and Use of Radionuclide Screening Action Levels*, LA-UR-01-990, Environmental Restoration Project, Los Alamos, New Mexico, March 29.

LANL (Los Alamos National Laboratory), 2002, *Environmental Surveillance at Los Alamos during 2001*, LA-13979-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2004b, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006a, *Interim Measures Work Plan for Chromium Contamination in Groundwater*, LA-UR-06-1961, Environmental Stewardship Division, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006b, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006c, *Interim Measures Investigation Report for Chromium Contamination in Groundwater*, LA-UR-06-8372, Los Alamos, New Mexico, November.

NAS (National Academy of Sciences), 2005, "Report Assesses Health Implications of Perchlorate Exposure," Available at http://www4.nationalacademies.org/news.nsf/isbn/0309095689?OpenDocument, January 10.

NMAC (New Mexico Administrative Code), 2006, "Title 20 Environmental Protection, Chapter 6 Water Quality, Part 2 Ground and Surface Water Protection," Water Quality Control Commission, November 8.

USACHPPM (U.S. Army Center for Health Promotion and Preventive Medicine), 2006, "Perchlorate in Drinking Water," Publication No. 31-003-0502, *Readiness thru Health*, Aberdeen Proving Ground, Maryland, Available at http://chppm-www.apgea.army.mil/dwater, February 13.

APPENDIX G
IMPACTS ANALYSES OF PROJECTS TO MAINTAIN EXISTING LOS ALAMOS NATIONAL LABORATORY OPERATIONS AND CAPABILITIES

APPENDIX G
IMPACTS ANALYSES OF PROJECTS TO MAINTAIN EXISTING LOS ALAMOS NATIONAL LABORATORY OPERATIONS AND CAPABILITIES

The projects discussed in this appendix are elements of the Expanded Operations Alternative as described in Chapter 3 of this *Final Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS). The Expanded Operations Alternative reflects proposals that would expand the overall operations level at Los Alamos National Laboratory (LANL) above those established for the No Action Alternative. Additionally, the Expanded Operations Alternative includes a number of new projects whose purpose is not to expand the operations level, but to update existing facilities or provide new buildings in which to continue existing operations and capabilities. In some cases, the projects to maintain existing operations and capabilities have the potential to impact land use at LANL. However, not all new projects would affect land use, as many would involve actions within or modifications to existing structures or construction of new facilities within previously developed areas of LANL. This appendix presents the project-specific analyses for nine proposed construction or refurbishment projects that would be implemented or for which implementation decisions are needed within the timeframe under consideration in this SWEIS.

- Technical Area 3 (TA-3) Physical Science Research Complex (formerly the Center for Weapons Physics Research) (Section G.1)
- TA-3 Replacement Office Buildings (Section G.2)
- TA-48 Radiological Sciences Institute, including Phase I – The Institute for Nuclear Nonproliferation Science and Technology (Section G.3)
- TA-50 Radioactive Liquid Waste Treatment Facility Upgrade (Section G.4)
- TA-53 Los Alamos Neutron Science Center (LANSCE) Refurbishment (Section G.5)
- TA-55 Radiography Facility (Section G.6)
- TA-55 Plutonium Facility Complex Refurbishment (Section G.7)
- TA-62 (TA-3) Science Complex (Section G.8)
- TA-72 Remote Warehouse and Truck Inspection Station (Section G.9)

Collectively, the nine projects presented in this appendix represent one component of the National Nuclear Security Administration's (NNSA's) ongoing effort to replace much of the older workspace and physical infrastructure at LANL with corresponding modern equivalents, consolidate certain operations, and eliminate underutilized and redundant structures and buildings. To support this effort, NNSA has identified distinct areas to be addressed to ensure infrastructure sustainability. These include initiatives to reduce structure footprints and operating costs, and to improve safety, security, environmental protection, scientific interactions, and productivity. The proposed timeframes associated with construction or refurbishment and operation of the proposed facilities are depicted in **Figure G–1**.

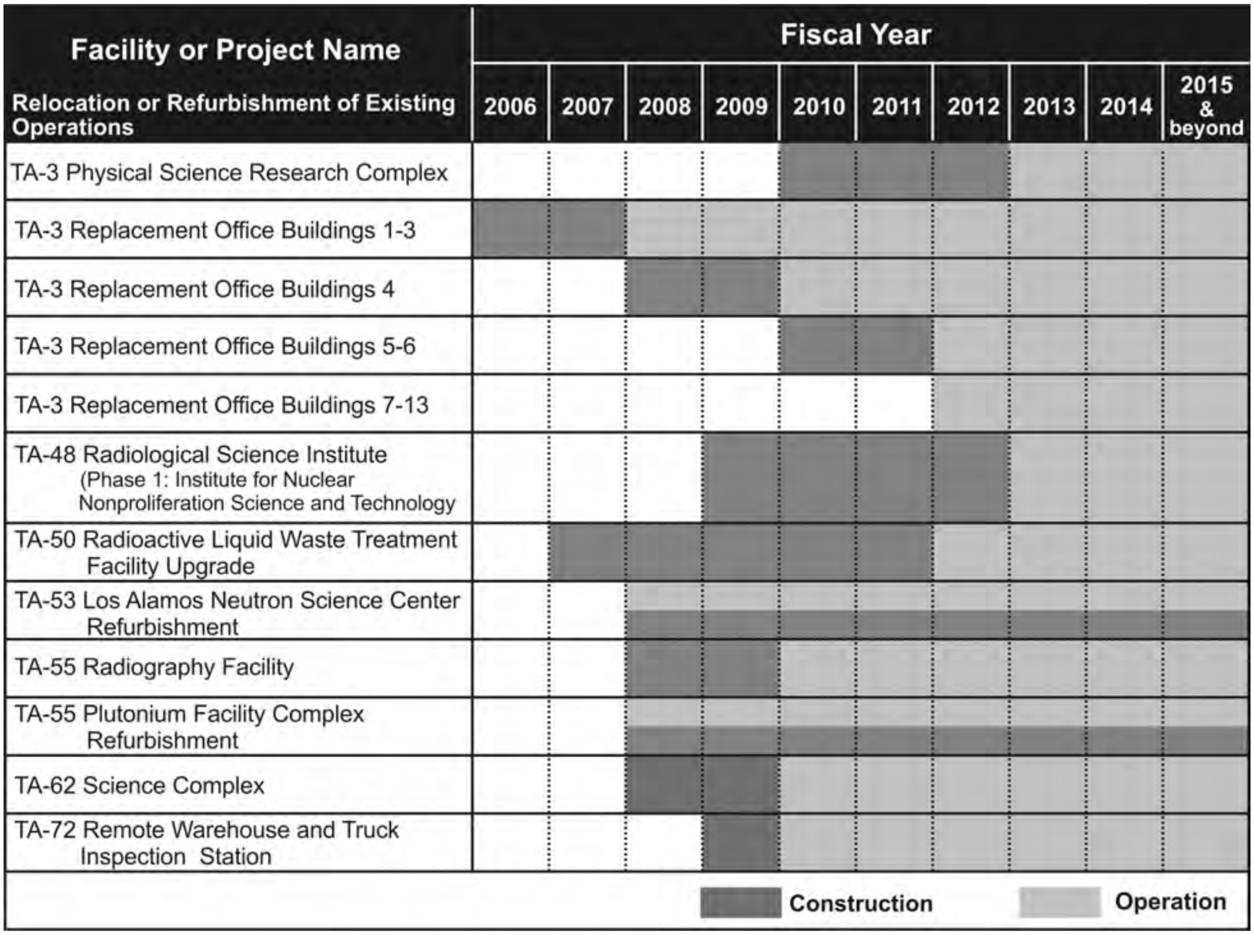


Figure G–1 Proposed Timeframes for Construction and Operation of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities

The projects included in this appendix are categorized into two broad groups: (1) those that would relocate existing operations to a completely new facility, with the former facility(ies) undergoing decontamination, decommissioning, and demolition (DD&D); and (2) those that would renovate or refurbish an existing facility to prolong its capabilities and bring it up to current standards. In keeping with congressional "one for one" space requirements, all proposed new building construction projects discussed in this appendix also include the DD&D of a comparable amount of space in older buildings or transportable structures that are no longer needed or that are unsuitable for future use. Standard construction practices applicable to all construction projects at LANL are described in the text box on the following page. The general process for DD&D of the structures is described in Appendix H.

Detailed project-specific work plans for DD&D of the structures would be developed and approved by NNSA before any actual work began. The plans would include those required for environmental compliance (such as stormwater pollution prevention plans) and monitoring activities (such as using real-time radiation monitors); all necessary legal and regulatory requirements in effect at the time would be undertaken before any DD&D activities were conducted.

Construction Work Elements

Design and Operation Standards: All new structures at LANL would be designed and constructed in compliance with applicable DOE Orders, requirements, and governing standards that have been established to protect public and worker health and the environment. DOE Order 420.1B (DOE 2005) requires that nuclear and nonnuclear facilities be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. DOE Standard 1020-2002 (DOE 2002a) implements DOE Order 420.1B and provides criteria for the design of new structures, systems, and components and for evaluation, modification, or upgrade of existing structures, systems, and components so that DOE facilities safely withstand the effects of natural phenomena hazards, such as earthquakes. The criteria specifically reflect adoption of the seismic design and construction provisions of the International Building Code for DOE Performance Category 1 and 2 facilities. Prior to construction of any new facilities, an estimate of the seismic hazard at the proposed site would be conducted using the most current seismic information. The new facilities would also be designed to meet safety and engineering criteria specified in the *LANL Engineering Standards Manual*, OST220-03-01-ESM (LANL 2004b), and would meet current code requirements for electrical, plumbing, fire protection, and other utilities.

Facilities would be constructed according to Leadership in Energy and Environmental Design (LEED) standards (USGBC 2006). LEED for New Construction and Major Renovations is a green building rating system designed to guide and distinguish high-performance commercial and institutional projects, with a focus on office buildings. The standards used for new LANL buildings would increase energy use efficiency and probably achieve net reductions in energy use. LEED emphasizes state-of-the-art strategies for sustainable site development, water savings, energy efficiency, material selection, and indoor environmental quality. Under LEED standards, older, less-efficient buildings would be removed, and, in general, their former locations would be used for parking and open space.

Construction Safety and Health Plan: The work would be planned, managed, and performed to ensure that standard worker safety goals are met and that work would be performed in accordance with good management practices, regulations promulgated by the Occupational Safety and Health Administration, and LANL resource management plans. To prevent serious injuries, all site workers (including contractors, subcontractors, lessees and permit or easement holders or their contractors and subcontractors) would be required to submit and adhere to an approved construction safety and health plan.

Environmental Management: NNSA's goal for the construction of new facilities is to retain as much of the natural setting, vegetation, and overall environmental integrity of the site as practical. The site surrounding new buildings and parking would be professionally landscaped within the guidelines of the LANL Site and Architectural Design Principles (LANL 2002a) and LANL Sustainable Design Guide (LANL 2002b). Disturbance and removal of vegetation at the construction site would be limited to those areas necessary to accommodate building, roadway, parking, parking structure footprint, and work areas. Total tree removal would be allowed within only 50 feet (15 meters) of building footprints and 5 feet (1.5 meters) of parking and roadways. Trees greater than 10 inches (25.4 centimeters) in diameter measured 4.5 feet (1.35 meters) from the ground surface would not normally be cut and removed from areas with a slope less than 20 degrees at distances greater than 20 feet (6 meters) from building footprints or 10 feet (3 meters) from parking lots and roadways. No tree cutting or other disturbance would occur in areas with greater than 20 percent slope, except as periodically needed for wildland fire management purposes. Wildfire management planning is currently being developed in the *Los Alamos National Laboratory Wildland Fire Management Plan*, LA-UR-05-0286 (LANL 2005d). Management activities, such as tree thinning, could be put into effect at the proposed facilities. Tree thinning procedures would include incorporation of best management practices to prevent soil erosion and use of manual timber cutting on the steep slopes rather than mechanical methods.

National Pollutant Discharge Elimination System: No construction would be conducted within floodplains or wetlands. As appropriate, engineered best management practices for each building, parking structure, or roadway site would be implemented as part of a site stormwater pollution prevention plan executed under a National Pollutant Discharge Elimination System construction permit. Best management practices may include the use of hay bales, straw wattles, and silt fences. Prior to construction, topsoil from the site would be removed and stockpiled for later use in land restoration efforts at either this site or other sites. Soil stockpiles would be seeded and protected with silt fences to prevent erosion and impact on nearby drainages. Following construction, areas surrounding the buildings would be restored to enhance site drainage and stormwater capture for passive irrigation of landscaping. Recontoured areas would then be reseeded with a native grass mix to stabilize the site and planted with landscape vegetation closer to the buildings. Permanent site engineered controls for stormwater runoff may include stormwater retention ponds, curbing, permeable asphalt, or use of timber or stone as riprap to slow waterflow runoff. Vehicle fueling would not occur within drainages or floodplain areas.

Excavation and Dust Suppression: Dozers, backhoes, or graders may be used to remove tree stumps and rocks and to smooth the surface. Clearing or excavation activities during site construction would have the potential to generate dust. Standard dust suppression methods (such as water spraying or soil tackifiers) would be used to minimize dust generation during construction activities.

Cultural resources: If cultural remains were encountered during construction, activities would cease until their significance was determined and appropriate subsequent actions taken.

Ultimate disposition of the facilities constructed by the projects in this appendix would be considered at the end of their operations, usually several decades after construction. Facilities that would support missions involving radioactive and hazardous materials are required to be designed with consideration of the entire lifecycle of the facilities; this includes incorporating features into the design that would facilitate eventual facility DD&D. The impacts from the eventual disposition of the newly constructed facilities would be similar to or less than the impacts from the disposition of the facilities that they replace.

Purpose and Need

LANL's primary mission is to support national security. Nuclear technology and the associated radiological facilities at LANL are vital to this mission. The mission includes programs such as defense nuclear nonproliferation, emergency operations, domestic safeguards, and corresponding training operations and encompasses activities related to nuclear weapons, nuclear nonproliferation and arms control, homeland security, nuclear energy, radioactive waste management, environmental management, nuclear regulation, health and safety, nuclear medicine, and advanced materials science.

LANL has consistently applied state-of-the-art basic and applied scientific research in solving complex problems of national importance. The same attention to the state of infrastructure and facilities has not kept pace over the years. As a result, LANL's infrastructure is deteriorating to the point of jeopardizing its long-term ability to fulfill its stockpile stewardship mission. Many of the current structures in use at LANL are from 20 to 50 years old. A large percentage of the LANL workforce is located in facilities that are in marginal condition and frequently overcrowded. Buildings and structures built and occupied at LANL since the late 1940s are often incorrectly sized to effectively accommodate modern operations. The demands on the services, utilities, and communications were not anticipated when the buildings were designed. Current activities are conducted in scattered, old structures, many of which are obsolete and increasingly expensive to operate. Today, LANL has the oldest facilities and the greatest number of old facilities among the three national security laboratories and the Nevada Test Site. Approximately half of LANL's facilities are in poor or fair condition.

The liability and cost of aging infrastructure is an escalating problem throughout the U.S. Department of Energy (DOE) complex. Because the cost of operations and maintenance for aging LANL facilities is significant and growing, leaving this problem unaddressed would impact LANL's ability to carry out NNSA's stockpile stewardship mission. In the past, preventive facility maintenance has been deferred for higher priorities. The current DOE budgeting process allocates 5 to 8 percent less for infrastructure and repair than the industrial average. Over time, this practice has resulted in a backlog of repairs that threatens to overtake LANL's ability to effectively address these problems while pursuing research activities critical to NNSA's Defense Program mission. The majority of LANL facilities are reaching the end of their useful lives and would require major upgrade investments to meet future mission needs and ensure the health and safety of LANL employees. Even after such investment in upgrading aging facilities, the functionality of these buildings would remain marginal. These buildings and structures were neither built to current structural (including seismic), health, safety, and security standards, nor can they be easily or economically retrofitted to meet these standards or to accommodate present day office electronics, communications equipment, or heating and cooling systems. If these buildings are not replaced, they would eventually need to be shut down for safety reasons, and their missions would be compromised.

Employee safety would be improved by providing modern, well-designed workspaces. Current structures are poorly suited to today's demanding security needs. Many safety controls can be deployed by only new building design and construction. In addition, NNSA's purpose is to: (1) improve the quality of the facilities to carry out current and future anticipated research programs in support of NNSA's missions, (2) decrease and control operational and maintenance costs for LANL facilities, and (3) consolidate peer groups that need to interact frequently and provide a working environment that encourages collaboration, creative innovation, and efficiency.

Three of the projects proposed in this appendix are part of a TA-3 Revitalization Plan, which specifically addresses changes to one of LANL's most populated TAs; these include the Physical Science Research Complex in TA-3, construction and operation of Replacement Office Buildings in TA-3, and the Remote Warehouse and Truck Inspection Station in TA-72. Other projects address consolidation of LANL radiochemistry and nuclear nonproliferation capabilities in a new complex at TA-48, replacement of radioactive liquid waste treatment capabilities at TA-50, refurbishment of the LANSCE at TA-53, relocation of nondestructive examinations into a radiography facility at TA-55, refurbishment of the Plutonium Facility Complex in TA-55, and construction of a new Science Complex in either TA-62 or TA-3. Additional discussion of the purpose and need for the Radioactive Liquid Waste Treatment Facility Upgrade Project, TA-55 Radiography Facility Project, and Remote Warehouse and Truck Inspection Station Project are described below. The remaining projects are encompassed by the general purpose and need discussion above.

Purpose and Need for the Radioactive Liquid Waste Treatment Facility Upgrade Project

NNSA needs to provide reliable means for treating LANL-generated radioactive liquid wastes in compliance with DOE and other applicable regulatory requirements. Capability is needed for the treatment of liquid low-level radioactive waste, acidic transuranic waste, caustic transuranic waste, and small amounts of industrial wastewater that are generated in support of mission-critical and other work performed at LANL. Specifically, the ability to manage radioactive liquid waste is necessary for the continued performance of Stockpile Stewardship Program work in the Plutonium Complex and the Chemistry and Metallurgy Research Building. The current facility is over 40 years old and has liquid effluent discharges and air emissions resulting from liquid waste treatment that must meet current regulatory requirements. NNSA needs to provide for the ability to modify or expand treatment components as necessary to meet future regulatory requirements that may be more stringent than those currently in effect.

Purpose and Need for the Technical Area 55 Radiography Facility Project

Examination of nuclear items and components through radiography is a key process in U.S. nuclear weapons stockpile safety and reliability verification. Use of high-energy radiography capability formerly located at TA-8 required nuclear items and components to be temporarily moved out of TA-55 where the items and components are fabricated and stored. Transportation and examination at TA-8 required significant security resources. Movement of these nuclear items and components has become difficult. In addition, TA-8 facilities require extensive renovations to meet current requirements for a nuclear facility. High-energy radiography capability for nuclear materials is limited, affecting mission milestones and deadlines. NNSA needs to provide a more efficient high-energy radiography capability that eliminates the need for transporting nuclear items and components outside the security perimeter of TA-55.

Purpose and Need for the Remote Warehouse and Truck Station

The current warehouse facility is over 50 years old and has become cramped as LANL and NNSA have increased materials holding time requirements for materials in order to meet quality control inspection and chain-of-custody protocols. Additionally, LANL programs and activities have been expanding, resulting in increases in the amount of material processed at the current TA-3 warehouse facility. The current TA-3 warehouse facility is not properly equipped or constructed to meet current security requirements, including the need to segregate incoming vendor vehicles from government warehouse vehicles. Furthermore, the current location of the TA-3 warehouse facility requires offsite vehicles to travel through the densely populated TA-3 areas.

Overview of Projects

A brief introduction to each project is presented below, with detailed analysis of the environmental impacts associated with each project presented in the following sections. Chapter 4 of this SWEIS provides a detailed description of the affected environment at LANL. Therefore, the affected environment discussion is minimal in this appendix unless unique characteristics of the project or project area require further discussion.

Physical Science Research Complex (Technical Area 3)

Approximately 750 scientists from various divisions and disciplines located across LANL would be consolidated and collocated in this new facility, which would facilitate the science required for nuclear weapons stockpile stewardship and certification. The Physical Science Research Complex would be constructed in a developed area of TA-3 that currently has several existing structures in it; these structures would be demolished to accommodate the new facility.

Replacement Office Buildings (Technical Area 3)

The TA-3 Replacement Office Buildings would consolidate staff currently located in temporary structures or aging permanent buildings throughout TA-3 or from other parts of LANL. The complex would consist of 12 new buildings and related parking infrastructure. The replacement offices would include a Los Alamos Site Office Building. The number of staff housed in the overall Replacement Office Buildings would total approximately 900.

Radiological Sciences Institute, including Phase I – The Institute for Nuclear Nonproliferation Science and Technology (Technical Area 48)

NNSA proposes to build a new consolidated and integrated Radiological Sciences Institute. This project would serve two purposes: (1) modernization of LANL radiochemistry capabilities, and

(2) assumption of capabilities that could potentially be lost from LANL due to changes in other facilities (such as hot cell capabilities from the Chemistry and Metallurgy Research Building). The new institute would be constructed over 20 years, in a phased approach. Construction of the first phase, the Institute for Nuclear Nonproliferation for Science and Technology, is proposed to begin during the timeframe analyzed in this SWEIS. The Institute for Nuclear Nonproliferation Science and Technology would ultimately include a Security Category I and II training facility with a Security Category I vault, several Security Category III and IV laboratories, a field security test laboratory, a secure radiochemistry facility, and associated office support facilities. Further, Security Category III and IV material and capabilities from TA-18 that would remain at LANL would be relocated to the Institute for Nuclear Nonproliferation Science and Technology.

Radioactive Liquid Waste Treatment Facility Upgrade (Technical Area 50)

NNSA proposes to construct a new treatment facility adjacent to the existing Radioactive Liquid Waste Treatment Facility to ensure that LANL can maintain the capability to treat radioactive liquid waste safely, reliably, and effectively for the next 50 years with normal maintenance. The main building of the existing Radioactive Liquid Waste Treatment Facility would be retained; the three annexes that do not meet current seismic or wind-loading standards would undergo DD&D. The new structure would house equipment for treating liquid low-level radioactive waste and liquid transuranic waste and would provide flexibility to accommodate new technology that may be required in the upcoming years to meet more stringent discharge standards.

Los Alamos Neutron Science Center Refurbishment (Technical Area 53)

Since the LANSCE linear accelerator first accelerated protons in 1972, the facility mission has evolved considerably. However, investment in the physical infrastructure and technology has not been adequate to ensure long-term sustainable operation at high reliability. The LANSCE Refurbishment Project proposes to sustain reliable facility operations well into the next decade. The LANSCE Refurbishment Project would address the following priorities: (1) replacing facility equipment where necessary to address code compliance or end-of life issues that could severely impact facility operations; (2) enhancing cost-effectiveness by system refurbishments or improvements that stabilize decreasing facility reliability and maintainability; (3) stabilizing the overall beam availability and reliability in a manner that is sustainable over the longer term; and (4) accomplishing the above with minimal disruption to scheduled user programs.

Radiography Facility (Technical Area 55)

This project would enhance the safety and ease the logistics of LANL's stockpile management procedures. Nondestructive examinations using dye penetrant testing, ultrasonic testing, and x-ray radiography of nuclear items and weapons components are necessary elements of LANL's mission for stockpile management. Many steps of this process occur in TA-55, but final radiography was performed in TA-8. This required that the nuclear components and items be shipped between TA-55 and TA-8, a distance of 4.5 miles (7.2 kilometers), for this single step of the examination process. A rolling roadblock was required when the materials were transported, and a temporary material accountability area needed to be set up in TA-8 while the nondestructive examination procedures took place. These steps required significant security resources, making the process expensive, logistically difficult, and inefficient. NNSA proposes to construct a new high-energy nondestructive examination facility at TA-55 to eliminate the need for transporting these nuclear items to different locations at LANL during the examination process.

Plutonium Facility Complex Refurbishment (Technical Area 55)

The TA-55 Plutonium Facility Complex was constructed in the mid-1970s and has been in operation for approximately 30 years. Although systems in this complex function as designed, many are near the end of their design lives and have become increasingly difficult and expensive to maintain. NNSA has determined that an investment is needed in the near term to upgrade electrical, mechanical, safety, and other selected facility-related systems that are approaching the end of life. The proposed project comprises a number of subprojects considered for execution within the timeframe analyzed in this SWEIS.

Technical Area 62 (Technical Area 3) Science Complex

The Science Complex would consist of two buildings and one supporting parking structure that would be constructed in TA-3 or north of TA-3 in TA-62. This new complex would provide approximately 400,200 square feet (37,180 square meters) of office and light laboratory space in support of basic and applied scientific research and technology. One of the buildings would provide facilities for many of the bioscience activities currently conducted in the former Health Research Laboratory, now known as the Bioscience Facilities, located adjacent to the Los Alamos townsite.

Technical Area 72 Remote Warehouse and Truck Inspection Station

The current warehouse located at TA-3 provides centralized shipping, receiving, distribution, packaging, and transportation compliance and mail services for all LANL organizations. The facility is over 50 years old and has become cramped as LANL and NNSA have increased materials holding time requirements for purposes of quality control inspection and chain-of-custody protocols. The facility does not meet current security requirements. NNSA proposes construction of a consolidated warehouse facility and truck inspection complex in TA-72 to replace the current warehouse facility and LANL's temporary truck inspection station.

G.1 Physical Science Research Complex Construction and Operation Impact Assessment

This section provides an impact assessment for the construction and operation of a Physical Science Research Complex in TA-3 at LANL. Section G.1.1 provides background information on the construction project and a physical description of the Physical Science Research Complex. Section G.1.2 provides a description of the proposed project to construct and operate a Physical Science Research Complex in TA-3. Section G.1.3 provides an analysis of environmental consequences of the proposed project and the No Action Alternative.

G.1.1 Introduction

Over the past 3 years, a detailed analysis of the cost of operating and maintaining LANL facilities and a prioritization system to fund facilities and infrastructure upgrades have been developed. NNSA has been evaluating and implementing methods to reduce facility costs and has identified distinct areas that must be addressed to ensure future infrastructure sustainability. These areas include facility consolidation and cost reduction initiatives to reduce facility footprints and operating costs, as well as the improvement of safety, security, environmental protection, scientific interactions, and productivity. A TA-3 Revitalization Plan has been developed to address the upgrade of LANL's most populated area. The proposed construction and operation of the Physical Science Research Complex in TA-3 is one such consolidation and strategic planning effort being considered at LANL.

Theoretical and computational weapons physics research requires the use of delicate equipment and highly sensitive computers in carefully regulated laboratory environments. However, many such activities at LANL are currently conducted in scattered, 20- to 50-year-old facilities, many of which are obsolete and increasingly expensive to operate. The lack of adequate building infrastructure has resulted in experiments being conducted in spaces never intended to serve as laboratories. The space that has been made available to conduct this research is spread across TA-3, TA-35, and TA-53, rather than being consolidated in a single facility resulting in inefficiencies among the staff. Recent and ongoing construction actions have been undertaken to correct these deficiencies and address the modernization of several such facilities in TA-3, including the Nonproliferation and International Security Center, the Nicholas C. Metropolis Center for Simulation and Modeling, and the National Security Science Building. The Physical Science Research Complex would complete the theoretical and computational research core in TA-3. The project would consolidate and relocate critical operations necessary for continued support of the stockpile stewardship mission. The proposed Physical Science Research Complex would be located in TA-3, just west of the Nonproliferation and International Security Center.

G.1.2 Options Considered

The two options identified for the Physical Science Research Complex are the No Action Option and the proposed project option.

G.1.2.1 No Action Option

Under the No Action Option, LANL stockpile stewardship mission staff would continue to operate at current levels at existing geographically dispersed facilities at TA-3, TA-35, and TA-53. Corrective maintenance and actions would continue to be performed as facility infrastructure failures occur. Staff consolidation in a state-of-the-art research center would not occur, nor would the proposed DD&D of vacated older buildings and structures.

G.1.2.2 Proposed Project

The proposed project is the construction and operation of a new Physical Science Research Complex in a currently developed area of TA-3 (see **Figure G–2**). The Physical Science Research Complex would provide a new, modern facility and would consolidate staff currently located throughout TA-3, in TA-35, and in TA-53 in temporary structures or aging permanent buildings in failing and poor condition. Approximately 750 upper-level management, technical, and administrative staff whose work directly supports the Stockpile Stewardship Program would be consolidated in this facility. Currently, these individuals are located in outdated buildings or transportables (office trailers) in TA-3, TA-35, and TA-53 (LANL 2006a). The Physical Science

Research Complex would consist of up to four buildings, providing approximately 350,000 square feet (32,500 square meters) of space to house offices, light laboratories, computer rooms, analytical facilities, and support and common areas. Each building would be four stories tall; three of the four buildings would be designated as classified buildings and require security controls and fencing (LANL 2006a). In total, the facility would have a combined footprint of approximately 128,000 square feet (11,900 square meters). Approximately 30 percent of the total floor space would be composed of light-to-medium experimental laboratories, consisting primarily of laser laboratories (LANL 2006a). The Physical Science Research Complex would be sited south of the National Security Science Building where the Administration Building parking lot, guard station, Integrated Management Building and associated transportables, and part of the Administration Building A wing are located today.

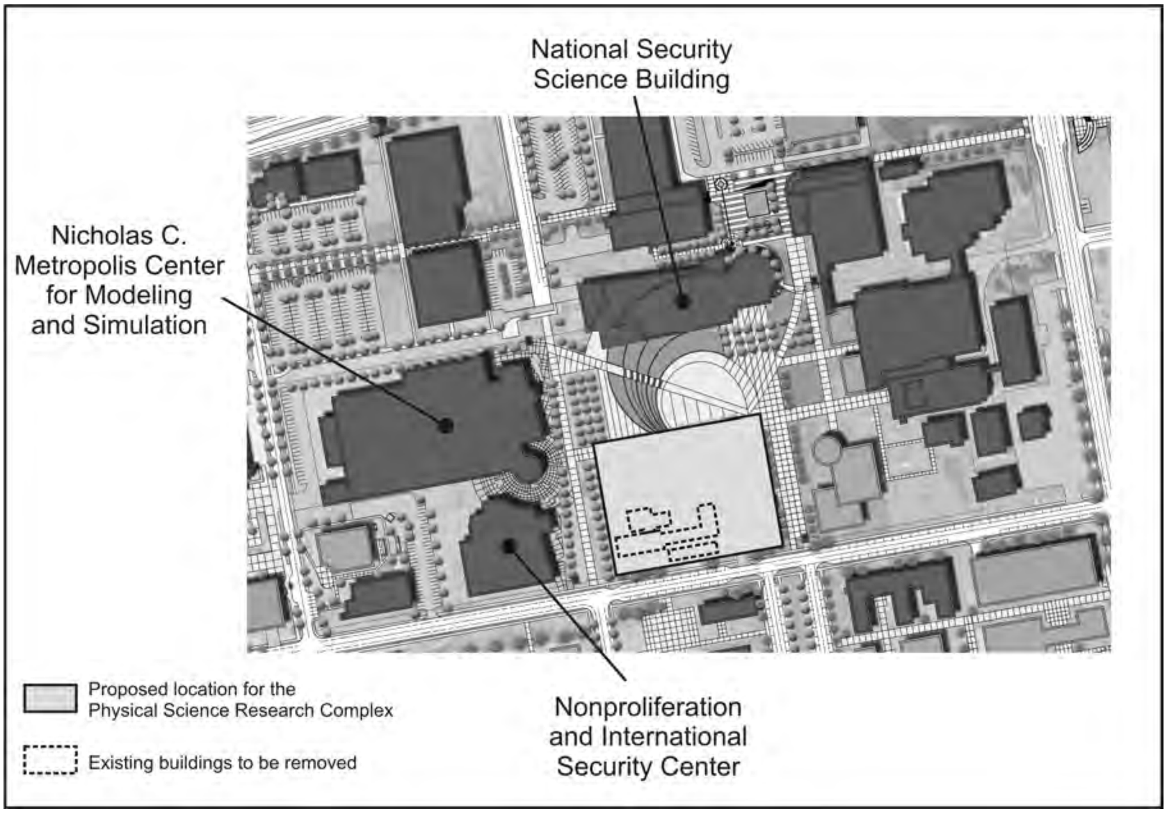


Figure G–2 Proposed Location for the Physical Science Research Complex

The light laboratories would have an efficient heating, ventilating, and air conditioning system with an ability to control temperature within 2 to 3 degrees; specialized flooring to limit vibration; extensive electrical grounding; and pressurized air, helium, and nitrogen gas available for use. No wet chemistry is expected to be conducted in the Physical Science Research Complex. The complex would include a clean room and vault space for classified weapons designers and would require a substantial amount of electricity (LANL 2006a). Common areas would include three auditoriums of different sizes, various-sized conference rooms, a 20,000-square-foot (1,900-square-meter) computer room with access floor, a computer equipment room, a vault-type room for offices, a computer machine room, a kitchen, and equipment storage rooms (LANL 2006a).

As shown in Figure G–2, construction and operation of the Physical Science Research Complex would occur at a location in TA-3 that includes approximately 74,000 square feet (6,900 square meters) of existing structures. These structures (TA-03-0028, -0142, -0510, -1559, -1566, and 1663) would undergo DD&D to accommodate construction of the proposed new facility. Once constructed, the Physical Science Research Complex would also house staff and capabilities from approximately 22 other LANL structures. In total, about 30 buildings and structures located across TA-3, TA-35, and TA-53 comprising about 867,000 square feet (80,550 square meters) would be removed under the proposed project. Physical Science Research Complex construction is scheduled to begin in 2010 and take approximately 2 years to complete. The associated DD&D of buildings within the proposed footprint of the Physical Science Research Complex would occur at the beginning of this timeframe, with subsequent DD&D of other buildings in TA-3, TA-35, and TA-53 occurring after their respective staff have relocated to the Physical Science Research Complex. At this time, project-specific work plans have not been prepared that would define the actual methods, timing, or workforce to be used for DD&D of these structures. Typical processes and methods for DD&D as discussed in Appendix H would be used for this proposed project.

G.1.3 Affected Environment and Environmental Consequences

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources* – The proposed site is in an already-developed area of TA-3 and the proposed land use is consistent with land use plans. Only the visual environment is included in the impacts discussion.

- *Water Resources* – The proposed site is located in an already-developed area of TA-3, and operations would not result in new discharges.

- *Ecological Resource*s – The proposed project is located in an already-developed area of TA-3; in general, wildlife is expected only around the periphery of TA-3.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is confined to an already-developed area of TA-3, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – The proposed project would not implement new activities associated with radiological materials; only industrial accidents may occur.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: visual environment, geology and soils, air quality and noise, human health, cultural resources, site infrastructure, waste management, and transportation.

G.1.3.1 No Action Option

Under the No Action Option, NNSA would not construct the Physical Science Research Complex at TA-3 and LANL stockpile stewardship mission staff would continue to occupy existing structures spread among three TAs at the site. Benefits that would result from consolidating personnel in a modern facility would not occur. Outdated structures and temporary buildings that presently accommodate personnel would continue to contribute adversely to the visual character of TA-3 and other areas. Benefits in the areas of resource efficiency and conservation that would be realized by vacating currently occupied energy-inefficient structures would not take place. Expenses for repairs and replacement of aging heating, ventilation, and air conditioning systems and other building components would increase. As building systems and other components fail and cannot be replaced or repaired, affected buildings would be partially or completely closed and the staff relocated. No disturbance of existing TA-3 land or building sites would occur. The proposed vacating and DD&D of outdated facilities and temporary buildings would not occur, and no construction or DD&D waste requiring disposal would be generated.

G.1.3.2 Proposed Project

Land Resources—Visual Environment

Construction Impacts—Impacts on visual resources resulting from construction of the Physical Science Research Complex would be temporary in nature and could include increased levels of dust from heavy equipment.

Operations Impacts—The existing buildings are part of the "dense mixed development" within TA-3 that constitutes an adverse visual impact because it contains unusually discordant structures (NNSA 2001). The proposed Physical Science Research Complex would be visually compatible with nearby office and computing structures and would enhance the overall architectural character of the Core Development Area.

DD&D Impacts—Impacts on visual resources resulting from DD&D of vacated buildings under the proposed project would be temporary in nature and could include increased levels of dust from heavy equipment. Once these activities are completed, the general appearance of TA-3, TA-35, and TA-53 should benefit from the removal of outdated and vacated structures.

Geology and Soils

The site for the Physical Science Research Complex lies within a part of the Pajarito Fault system characterized by subsidiary or distributed fault ruptures; two small, closely spaced faults are located below TA-3. The annual probability of surface rupture in areas beyond the principal or main trace of the Pajarito Fault, such as at the Physical Science Research Complex site, is less than 1 in 10,000 (LANL 2004c). To account for seismic risk, the Physical Science Research Complex would be designed and constructed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Approximately 499,000 cubic yards (381,000 cubic meters) of soil would be disturbed during building excavation within areas already disturbed by previous facility construction; there would be no impact on undisturbed LANL soils. Construction of the new buildings would require removal of soils as well as new excavation of shallow bedrock in some areas. As a result, construction and DD&D activities would generate excess soil and excavated bedrock that may be suitable for use as backfill. This uncontaminated backfill material would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater or other water discharges or wind.

DD&D Impacts—DD&D activities associated with existing facilities would have a negligible additional impact on geologic and soil resources at LANL, as the affected facility areas are developed and adjacent soils are already disturbed. Additional ground disturbance would be necessary to establish laydown yards and waste management areas in the vicinity of the facilities to be razed. Available paved surfaces, such as parking lots in the vicinity of the facilities to be demolished, would be used to the extent possible.

The major indirect impact on geologic and soil resources at the DD&D locations would be associated with the need to excavate any contaminated tuff and soil from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade, but such resources would be available from onsite borrow areas (see Section 5.2) and in the vicinity of LANL. LANL staff would survey potentially affected areas to determine the extent and nature of any contamination and required remediation in accordance with established procedures. All excavated contaminated media would be characterized and managed according to waste type and all applicable LANL procedures and regulatory requirements.

Air Quality and Noise

Construction Impacts—Construction of new facilities at TA-3 would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of the TA-3 Physical Science Research Complex's largest new facilities and compared to the most stringent standards. Construction modeling considered particulate emissions from activity in the construction area and emissions from various earthmoving and material-handling equipment. The maximum ground-level pollutant concentrations off site and along the perimeter road to which the public has regular access would be below the ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide. Estimated concentrations for particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}) would be greatest for the site work phase. Estimated maximum PM_{10} concentrations are an annual average of 3.5 micrograms per cubic meter and a 24-hour average of 72.1 micrograms per cubic meter. The maximum annual and short-term concentrations for construction would occur at the site boundary or roadway north-to-northeast of TA-3. Soil disturbance during construction could result in small radiological air emissions, but would be controlled by best management practices, thereby resulting in no impacts on workers or the public.

Construction of the new Physical Science Research Complex at TA-3 would result in a temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employee vehicles and materials and debris shipments. Noise sources associated with construction at TA-3 are not expected to include loud impulsive sources such as blasting.

Operations Impacts—Criteria and toxic air pollutants could be generated from the operation and testing of an emergency generator, if an additional one is necessary. Also, the use of various chemicals in laboratories and other activities would result in criteria and toxic air pollutant emissions. Emissions from the diesel generator would occur during periodic testing and would result in little change in air pollutant concentrations, and expected air quality impacts on the public would be minor.

Little or no change in toxic pollutant emissions or air pollutant concentrations at LANL is expected under this option. Toxic pollutants released from laboratories would vary by year with the activities performed and are expected to be similar to the current combined emissions from the existing buildings and capabilities that would be consolidated at TA-3. The emissions would continue to be small and below Screening-Level Emission Values (see Appendix B). Therefore, the air quality impacts on the public would be minor. Additionally, operations would have no significant radiological air emissions.

Noise impacts of operating the new Physical Science Research Complex at TA-3 are expected to be similar to those of existing operations at TA-3. Although there would be small changes in traffic and equipment noise (for example, new heating and cooling systems) near the area, there would be little change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new facilities.

DD&D Impacts—DD&D of buildings being replaced by the Physical Science Research Complex would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were not modeled for the DD&D of buildings at TA-3, but would be less than those from construction of the new facilities. DD&D of buildings at other TAs would be similar to DD&D activities taking place at various areas at LANL. Concentrations off site and along the roads to which the public has regular access would be below ambient air quality standards. Soil disturbance during demolition could result in small radiological air emissions, but would be controlled by best management practices, thereby resulting in no impacts on workers or the public.

DD&D of excessed buildings and structures in TA-3, TA-35, and TA-53 would result in some temporary increase in noise levels near the area from construction equipment and DD&D activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of DD&D activities, except for a small increase in traffic noise levels from DD&D employee vehicles and materials and debris shipments.

Human Health

Construction Impacts—Potentially serious exposures to various hazards or injuries would be possible during the construction and DD&D phases of the proposed project. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities) (DOE 2004, BLS 2003). The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 1.99 million person-hours to construct the new facilities, no fatal accidents are expected to occur. Nonfatal injuries are estimated to be between 23 (DOE 2004) and 84 (BLS 2003).

To prevent serious exposures and injuries, all site construction contractors would be required to submit and adhere to a Construction Safety and Health Plan and undergo site-specific hazard training. No potential offsite human health effects of construction hazards are expected.

Operations Impacts—Physical Science Research Complex operation is expected to have a beneficial effect on the LANL staff working environment, as working conditions would be improved by use of proper lighting, heating, ventilation, and air conditioning, and ergonomic equipment and furniture. Office, administrative, and light laboratory activities would constitute most of the Physical Science Research Complex operations, and applicable safety and health training and worksite criteria would be required for these workers.

DD&D Impacts—A potential source of impacts on noninvolved workers and members of the public would be associated with the release of radiological contaminants during the DD&D process. Any emissions of contaminated particulates would be reduced by the use of plastic draping and enclosures, coupled with high-efficiency particulate air (HEPA) filters. Construction and demolition workers would be actively involved in potentially hazardous activities such as heavy-equipment operations; soil excavations; and handling, assembly, or DD&D of various building materials. Potentially serious exposures to various hazards or injuries are possible during the DD&D phase of the proposed project. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities). The potential for industrial accidents is based on both DOE and the Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 286,000 person-hours to demolish the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 3 (DOE 2004) to 12 (BLS 2003).

To prevent serious exposures and injuries, all site construction contractors would be required to submit and adhere to a Construction Safety and Health Plan and undergo site-specific hazard training. Appropriate personal protection measures, such as personal protection device use (gloves, hardhats, steel-toed boots, eyeshields, and earplugs or ear covers) would be a routine part of construction activities. The proposed project is not expected to have an effect on the health of any demolition workers under normal operations conditions.

DD&D of certain buildings and structures in TA-3 would involve removal of some asbestos-contaminated material, which would be conducted according to existing asbestos management programs at LANL which are in compliance with strict asbestos abatement guidelines. Workers would be protected by personal protective equipment and other engineered and administrative controls. As a result of the controls that would be established, no asbestos would be released that could be inhaled by members of the public.

Cultural Resources

DD&D Impacts—The proposed site of the Physical Science Research Complex is in an already-developed area of TA-3. However, TA-03-0028 is a potentially significant historic building that would be removed. Prior to its demolition it would be assessed for inclusion in the National Register of Historic Places. The current Administration Building (TA-03-0043) has been formally declared as eligible for the National Register of Historic Places and a Memorandum of Agreement has been signed regarding required documentation prior to its removal.

Socioeconomics and Infrastructure

Construction Impacts—Utility infrastructure resources would be required for Physical Science Research Complex construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 2.6 million gallons (10 million liters) of liquid fuels and 14.4 million gallons (54 million liters) of water for the entire project.

The existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure. Utility lines are located adjacent to the proposed building sites and would require minimal trenching to connect them to the new structures. Minor repairs to existing underground sewer or water lines may be necessary (NNSA 2001).

Operations Impacts— Physical Science Research Complex operations would result in estimated annual electrical and water requirements of 45,000 megawatt-hours and 9.6 million gallons (36 million liters), respectively (LANL 2006a). This power and water use would be similar to or less than the facilities that are being replaced. Although LANL does not meter water or electrical use at most buildings, nor does it track waste generated at individual buildings, the Physical Science Research Complex is expected to operate with more energy-efficient utility systems than the current structures. Water consumption is also expected to decrease with the DD&D of existing resource-inefficient structures currently in operation. As such, Physical Science Research Complex operation is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the Physical Science Research Complex are projected to require 129,000 gallons (488,000 liters) of liquid fuels and 4.1 million gallons (16 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be very minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities be shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed.

Waste Management

Construction Impacts—Physical Science Research Complex construction would result in approximately 1,600 cubic yards (1,200 cubic meters) of waste, consisting primarily of debris such as gypsum board, pallets, and wire generated in the course of normal construction. Waste types and quantities generated by removal of the structures would be within the capacity of the existing waste management system and would not result in a substantial impact on existing waste management disposal operations.

No known potential release sites are present within the proposed footprint of the Physical Science Research Complex site (LANL 2006a). Should any potential release site be disclosed during subsurface construction work, LANL's environmental restoration project staff would review the site, stipulate procedures for working within that site area, and perform remediation as needed consistent with DOE and the Compliance Order on Consent (Consent Order) (NMED 2005) requirements.

Operations Impacts—Solid waste generated during Physical Science Research Complex operations would be disposed of at the Los Alamos County Landfill or other appropriate solid waste landfill. The amount of waste generated during Physical Science Research Complex operations would not increase substantially from current volumes generated at the existing structures. Sanitary waste would be removed from the facility via sanitary wastewater lines to the Sanitary Wastewater Systems Plant.

DD&D Impacts—DD&D of associated buildings would produce approximately 195,000 cubic yards (149,000 cubic meters) of waste, including low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, sanitary waste, and nonhazardous solid waste. DD&D would also generate about 314,000 pounds (142,000 kilograms) of chemical waste and 311 cubic yards (238 cubic meters) of asbestos waste. This waste would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment off site to a permitted asbestos disposal facility along with other asbestos waste generated at LANL. The anticipated amount of waste would not be beyond the disposal capacity of existing on and offsite disposal facilities. **Table G–1** summarizes waste types and volumes expected to be generated during DD&D activities. Although excessed LANL transportables are usually donated to the public, it has been assumed for purposes of analysis that they would also be dispositioned as demolition debris. About 8.9 percent of waste produced during DD&D activities is bulk low-level radioactive wastes. For purposes of analysis, NNSA has evaluated both the on and offsite disposal of low-level radioactive waste to ensure that the environmental consequences of either waste management option were considered. Potential available offsite disposal sites include the Nevada Test Site near Mercury, Nevada, and a commercial facility.

Table G–1 Estimated Waste Volumes from Physical Science Research Complex Decontamination, Decommissioning, and Demolition Activities (cubic yards)

Low-Level Radioactive Waste	*Mixed Low-Level Radioactive Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
17,400	< 1	177,000	3	311

[a] Includes demolition and sanitary waste.
Note: To convert cubic yards to cubic meters, multiply by 0.76455.

For disposal of generated low-level radioactive waste, two capability scenarios were evaluated. Low-level radioactive waste could be disposed of on site or shipped off site, with the selected disposal path determined based on TA-54 disposal capacity and disposal priorities.

Scenario 1. Under this scenario, NNSA would pursue offsite disposal of the low-level radioactive waste resulting from DD&D of the buildings and structures, including concrete, soil, steel, and personal protective equipment. Among other possible offsite disposal locations, both the Nevada Test Site, a DOE waste disposal facility, and a commercial facility have the capacity to accept these quantities of waste.

Scenario 2. Under this scenario, low-level radioactive waste would be disposed of on site in TA-54. The current disposal site footprint has limited waste capacity, although expansion into Zone 4 is planned. Onsite disposal capacity is expected to be adequate for the amount of low-level radioactive waste that would be generated by the DD&D activities.

All other wastes generated by the DD&D activities would be handled, managed, packaged, and disposed of in the same manner as the same wastes generated by other activities at LANL. Most mixed low-level radioactive waste generated at LANL is sent off site to other DOE or commercial facilities for treatment and disposal. The estimated volume of mixed low-level radioactive waste generated is small, and offsite disposal capacity is adequate.

Small amounts of hazardous waste would also be generated during DD&D activities. These wastes would be handled, packaged, and disposed of according to LANL's hazardous waste management program and are within its capacity.

Demolition debris and sanitary waste would be managed at the Los Alamos County Landfill or transported to an offsite landfill. For the purposes of analysis, it was assumed that these wastes would be disposed of at an offsite location. DD&D would generate nonradiological asbestos waste. This waste would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment off site to a permitted asbestos disposal facility along with other asbestos waste generated at LANL. Offsite disposal capacity would be adequate.

Transportation

Construction Impacts—Construction personnel would park on site and at remote designated parking areas. Truck traffic volumes carrying waste material to local or regional landfill sites would increase during these periods.

Operations Impacts—Once construction is completed, operation of the Physical Science Research Complex would account for the relocation of approximately 250 personnel from TAs other than TA-3. Using a ratio of 0.45 vehicles per employee, approximately 113 more vehicles may be added to TA-3 roadways and parking areas as a result of Physical Science Research Complex personnel relocation (DOE 1998).

DD&D Impacts—The generated DD&D wastes would need to be transported to storage or disposal sites using over-the-road truck transportation. These sites could be at LANL TA-54 or an offsite location. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported along the routes and highways. There is also increased risk from traffic accidents (without release of radioactive material) and radiological accidents (in which radioactive material is released).

The effects of incident-free transportation of construction and DD&D wastes on the worker population and general public are presented in **Table G–2**. Effects are presented in terms of the collective dose in person-rem resulting in excess latent cancer fatalities (LCFs) in Table G–1. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project and estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risk for development of excess LCFs is highest for workers under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–2, disposal of low-level radioactive waste at Nevada Test Site, which is located farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low for all disposal options.

Table G–2 Incident-Free Transportation Impacts – Physical Science Research Complex

Disposal Option	*Low-Level Radioactive Waste Disposal Location*	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.037	2.2×10^{-5}	0.01	6.0×10^{-6}
Offsite disposition	Nevada Test Site	4.65	0.0028	1.35	0.00081
	Commercial facility	4.51	0.0027	1.32	0.00079

LCF = latent cancer fatality, TA = technical area.

Table G–3 presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents from both the collisions themselves and from excess LCFs from exposure to releases of radioactivity. The analyses assumed that all nonradiological wastes would be transported to offsite disposal facilities.

The results in Tables G–2 and G–3 indicate that no traffic fatalities and no excess LCFs are expected from the transportation of generated waste derived from the DD&D of excessed buildings and structures at TA-3, TA-35, and TA-53.

Table G–3 Transportation Accident Impacts – Physical Science Research Complex

Low-Level Radioactive Waste Disposal Location [a]	*Number of Shipments* [b]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	10,897	4.16	Not analyzed [c]	0.0013
Nevada Test Site	10,897	6.76	1.2×10^{-8}	0.0036
Commercial facility	10,897	6.50	9.6×10^{-9}	0.0033

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported off site.
[b] Approximately 10 percent of shipments are radioactive wastes. Others include 90 percent industrial and sanitary waste and about 0.1 percent asbestos and hazardous wastes.
[c] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.
Note: To convert kilometers to miles, multiply by 0.6214.

G.2 Replacement Office Buildings Impact Assessment

This section provides an assessment of environmental impacts for the proposed Replacement Office Buildings at TA-3. Section G.2.1 provides background information on the proposed project to build a Replacement Office Building Complex and two parking structures and to DD&D two structures. Section G.2.2 provides a brief description of the proposed options for the replacement offices. Section G.2.3 presents the environmental consequences of the No Action Option and the proposed project (construction and operation of the proposed Replacement Office Buildings at TA–3).

G.2.1 Introduction

NNSA is working to reduce the number of substandard structures across LANL and to relocate staff and activities into more efficient and safe structures. Staff currently occupies trailers and other temporary structures that have exceeded their intended lifespan. NNSA has a congressional mandate to remove facilities at the same rate as new construction. NNSA is in the process of reducing non-office and inefficient office space, focusing on increased use and replacement of inefficient structures.

Over the past 3 years, a detailed analysis of the cost of operating and maintaining LANL facilities and a prioritization system to fund structural and infrastructure upgrades were developed. NNSA evaluated and implemented methods to reduce facility costs and identified distinct areas to be addressed to ensure infrastructure sustainability. These areas include structure consolidation and cost reduction initiatives to reduce structure footprints and operating costs as well as improve safety, security, environmental protection, scientific interactions, and productivity. A TA-3 Revitalization Plan, developed to address the upgrade of LANL's most populated areas and the construction of Replacement Office Buildings in TA-3, is one such consolidation and strategic planning effort being considered at LANL.

G.2.2 Options Considered

The two options identified for the Replacement Office Buildings are the No Action Option and proposed project option.

G.2.2.1 No Action Option

Under the No Action Option, no action would be taken. The site would not be changed and no Replacement Office Buildings or parking structures would be constructed. No DD&D activities would occur. Employees intended for the proposed office buildings would remain at their current locations throughout TA-3, and no consolidation would occur.

G.2.2.2 Proposed Project

The proposed project would be located partially on undeveloped land south of West Jemez Road and partially in the area of the existing Wellness Center and would consist of 12 new buildings (1 would be available to house NNSA's Los Alamos Site Office) and two new parking structures, one north of Mercury Road and one to the south of West Jemez Road. The Wellness Center and a warehouse would be demolished to accommodate this project. The current Los Alamos Site Office Building would also be demolished. Impacts of the Los Alamos Site Office Building DD&D were analyzed in the *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico* (DOE 1999c). Three office buildings that were proposed before the larger project was envisioned were categorically excluded from further National Environmental Policy Act (NEPA) evaluation under DOE's NEPA implementing regulations. However, these three buildings are integral to this office complex and are included in the impacts analysis. The complex would provide new, modern structures and would consolidate staff located primarily throughout TA-3 in temporary structures or aging permanent buildings in failing and poor condition. LANL staff located in other TAs may also be housed in the new Replacement Office Buildings. The surface parking area near Mercury Road would become a parking structure in the distant future. **Figure G–3** shows the currently proposed layout of the Replacement Office Building complex.

The buildings would be sited partially on undeveloped land south of West Jemez Road and partially in the area of the existing Wellness Center. The Replacement Office Buildings would include construction of a 45,000-square-foot (4,200-square-meter) Los Alamos Site Office Building, which would house approximately 150 staff. Construction of the Los Alamos Site Office Building has begun. The remaining office buildings would consist of two-story structures, each with a footprint of 8,000 to 9,000 square feet (740 to 840 square meters). These new buildings would provide approximately 15,000 to 17,500 gross square feet (1,400 to 1,600 square meters) of office space and house approximately 50 to 70 staff each. The number of administrative staff housed in the overall Replacement Office Buildings would total approximately 900. This staff would migrate from other offices in various locations throughout LANL and would not constitute new hires.

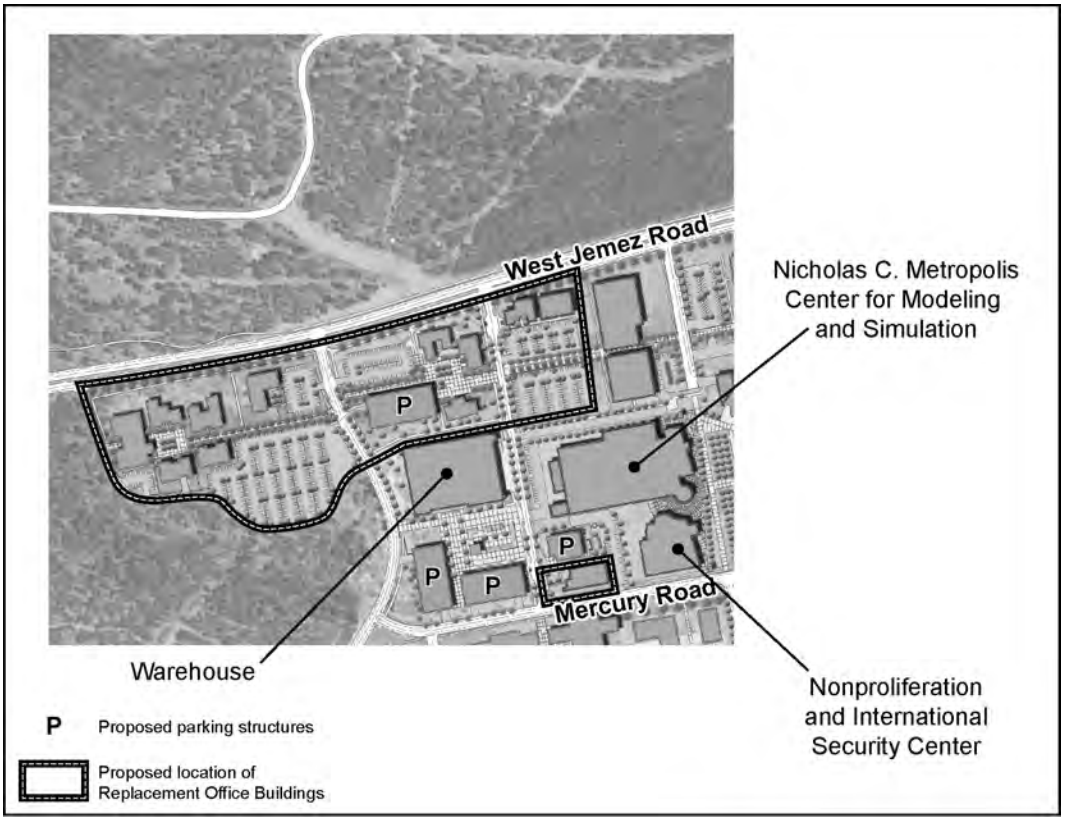


Figure G–3 Replacement Office Building Complex Proposed Layout

G.2.3 Affected Environment and Environmental Consequences

For the Replacement Office Buildings, the affected environment descriptions include only those resource areas that would be impacted. The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to the TA-3 affected environment is available and aids understanding potential impacts of constructing and operating the Replacement Office Buildings, it is included.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is mainly confined to already-developed areas of TA-3, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – The proposed project would not implement new activities associated with radiological materials; only industrial accidents may occur.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, and transportation.

G.2.3.1 No Action Option

Under the No Action Option, LANL administrative staff would continue to operate at existing scattered LANL locations. The Replacement Office Buildings would not be constructed at TA-3, nor would the Wellness Center or the Warehouse undergo DD&D. Poor quality office space and the effectiveness of current staff to recruit and retain qualified employees would remain a problem. Current DOE seismic standards or applicable building codes would not be met, and use of the buildings would be phased out over time as commercial lease space or space within LANL became available or trailers could be brought on site. Outdated structures and temporary buildings that presently accommodate personnel would continue to contribute adversely to the visual character of the TA-3 area. No disturbance of existing TA-3 land or building sites would occur. There would be no construction or building removal debris to require disposal. Utility usage would remain the same as existing usage in the near future. Continued expenses for repairs and replacement of aging heating, ventilation, and air conditioning systems and other building components would increase. As building systems and other components fail and cannot be replaced or repaired, affected buildings would be partially or completely closed and the staff relocated. Benefits that would result from consolidating personnel in a modern facility that fosters better communication and collaboration between scientists and administrative personnel would not occur. Likewise, benefits would not result in the areas of resource efficiency and conservation by vacating currently occupied energy-inefficient structures.

G.2.3.2 Proposed Project

The Replacement Office Buildings Project also includes DD&D of the existing Wellness Center and warehouse located in the northwest section of TA-3. The following discussion summarizes potential impacts during construction, operations, and DD&D, as appropriate.

Land Resources—Land Use

Construction Impacts—Construction of the Replacement Office Building Complex, including parking lots and construction laydown areas, would require 13 acres (5.3 hectares) of previously undisturbed land within TA-3 that is presently designated as Reserve.

Operations Impacts—Additional acreage would be required within previously disturbed portions of the TA that are designated as Physical and Technical Support. Future land use plans have designated the proposed site area in the undeveloped portion of TA-3 as Physical and Technical Support. Thus, placement of the Replacement Office Buildings and a parking lot within the western part of TA-3 would be consistent with these plans.

Land Resources—Visual Resources

Construction Impacts—Impacts on visual resources resulting from construction of the Replacement Office Building Complex would result in short-term impacts on the visual environment, including increased dust generation due to construction activities.

Operations Impacts—Once complete, the project would result in a change in both near and distant views of TA-3. The project site is partially located within a forested area along West Jemez Road, which would be replaced with buildings and a parking lot. Although landscaping along West Jemez Road could help mitigate views, the new buildings and parking lot would be readily visible from the road and nearby areas. Views from Pajarito Road would also change; however, this would impact primarily employees, as the road is restricted from public use. Also, because the size of developed portions of TA-3 would increase and the area of woodland decrease, distant views of the TA would change as a result of construction of the Replacement Office Building Complex. However, the overall effect would be minimal due to the present highly developed nature of that part of LANL.

Geology and Soils

The Replacement Office Buildings site lies within a part of the Pajarito Fault system characterized by subsidiary or distributed fault ruptures; two small, closely spaced faults are located in TA-3. The annual probability of surface rupture in areas beyond the principal or main trace of the Pajarito Fault, such as at the Replacement Office Buildings site, is less than 1 in 10,000 (LANL 2004c). This probability is less than the required performance goal for the facility and in accordance with DOE standards. Additionally, the Replacement Office Buildings would be designed and constructed in accordance with current DOE seismic standards and applicable building codes.

The proposed area for the facility includes both disturbed and undisturbed soils. The undisturbed soils maintain the present vegetative cover. They are arid soils consisting largely of sandy loam material alluvially deposited from tuff units on higher slopes to the west and eroded from underlying geologic units. In general, the soils are poorly developed, with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species being able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Construction of the Replacement Office Buildings would include both areas already disturbed by previous facility construction and areas not previously disturbed. The impact on LANL undisturbed (native) soils would be proportional to the total area of new construction. Approximately 369,000 cubic yards (282,000 cubic meters) of soil and rock would be excavated for building construction. As a result, construction activities would generate excess soil and excavated bedrock that may be suitable for use as backfill. Uncontaminated backfill material would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater or other water discharges or wind.

Operations impacts—Office building operations would not result in additional impacts on geologic and soil resources at LANL.

DD&D Impacts—DD&D activities associated with existing facilities would have a negligible additional impact on geologic and native soil resources at LANL, as the affected facility areas are already developed and adjacent soils are already disturbed. Additional ground disturbance would be necessary to establish laydown yards and waste management areas in the vicinity of the facilities to be razed. Available paved surfaces, such as parking lots in the vicinity of the facilities to be demolished, would be used to the extent possible.

The major indirect impact on geologic and soil resources at the DD&D locations would be associated with the need to excavate any contaminated tuff and soil from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade, but such resources are available from onsite borrow areas (see Chapter 5, Section 5.2) and in the vicinity of LANL. LANL staff would survey potentially affected contaminated areas to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures. All excavated material would be characterized before removing it for disposal.

Water Resources

The proposed site is predominantly flat, with a slight slope toward the adjacent steep-sided canyon to the southwest. During storm events, unchanneled stormwater runoff from the mesa drains into the canyon.

Construction Impacts—Little or no effect on surface water resources is anticipated during construction of the Replacement Office Buildings. The proposed project would not result in disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment.

Under the current U.S. Environmental Protection Agency (EPA) Construction General Permit Program, permits are required for all LANL construction activities or other projects that disturb 1 or more acres (0.4 or more hectares) of land. Conditions of the permit require the development and implementation of a stormwater pollution prevention plan. Silt fences, hay bales, or other appropriate best management practices would be employed to minimize stormwater transport of fine particulates (disturbed during construction) into surface water in the vicinity of TA-3.

Operations Impacts—There would be an increase in stormwater runoff associated with the new office building because of the increase in impervious areas of buildings and parking lots. The replacement of buildings should not change the stormwater runoff from these TAs significantly.

Air Quality and Noise

Construction Impacts—Construction of new facilities at TA-3 would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of TA-3's largest new facilities and compared to the most stringent standards. The maximum ground-level concentrations off site and along the perimeter road to which the public has regular access would be below the ambient air quality standards, except for possible short-term concentrations of nitrogen oxides and carbon monoxide. Estimated concentrations for PM_{10} would be greatest for the site work phase. Estimated maximum PM_{10} concentrations are an annual average of 3.8 micrograms per cubic meter and a 24-hour average of 78.5 micrograms per cubic meter. The maximum annual and short-term concentrations for construction would occur at the site boundary or roadway north-to-northeast of TA-3. Modeling considered particulate emissions from activity in the construction area and emissions from various earthmoving and material-handling equipment.

Construction of new office facilities at TA-3 would result in some temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments. Noise sources associated with construction at TA-3 are not expected to include loud impulsive sources such as blasting.

Operations Impacts—Operation of the Replacement Office Buildings at TA-3 would not result in an increase of criteria pollutant emissions above the existing level because the total number of employee trips to LANL would remain the same.

Noise impacts of operating the new office complex at TA-3 are expected to be similar to those from overall existing operations at TA-3. Although there would be a small change in traffic and equipment noise (for example, new heating and cooling systems) near the area, there would be little change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new structures.

DD&D Impacts—DD&D of buildings being replaced by new facilities would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Maximum ground-level concentrations offsite and along the perimeter road to which the public has regular access would be below the ambient air quality standards, except for short-term concentrations of nitrogen oxides, carbon monoxide, and PM_{10}.

Demolition of the Wellness Center and warehouse would result in some temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of demolition activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments.

Ecological Resources

Construction Impacts—Construction of the Replacement Office Building Complex would involve clearing and grading 13 acres (5.3 hectares) of ponderosa pine and mixed conifer forest within TA-3. This would result in loss of less-mobile wildlife, such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they moved. If the area were at its carrying capacity, displaced animals would not be likely to survive. Indirect impacts of construction, such as noise or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. These impacts could be mitigated by clearly marking the construction zone to prevent equipment and workers from disturbing adjacent habitat and by properly maintaining equipment. Construction of the new buildings and parking lot would not impact wetlands, as none are located in or near the construction zone.

The northern portion of TA-3 falls within the Los Alamos Canyon Mexican spotted owl (*Strix occidentalis lucida*) Area of Environmental Interest. Potential impacts to the Mexican spotted owl were evaluated in a biological assessment prepared by DOE. This assessment noted that although 11.2 acres (4.5 hectares) of buffer habitat would be disturbed, spotted owls have been not been detected in Los Alamos Canyon in recent years. The report concluded that if all reasonable and prudent alternatives are taken, actions associated with the construction of the Replacement Office Building Complex may affect, but are not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include ensuring that all lighting complies with the New Mexico Night Sky Protection Act, appropriate erosion and runoff controls be employed, unnecessary disturbance to vegetation be avoided, and all exposed soils be revegetated as soon as feasible (LANL 2006b). The U.S. Fish and Wildlife Service (USFWS) has concurred with this assessment (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle (*Haliaeetus leucocephalus*) and southwestern willow flycatcher (*Empidonax traillii extimus*) do not include any part of TA-3. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with the Replacement Office Building Complex project, the biological assessment concluded that provided appropriate reasonable and prudent alternatives are implemented to protect adjacent foraging habitat, the project may affect, but is not likely to adversely affect, the bald eagle. In addition to the reasonable and prudent alternatives noted above for the Mexican spotted owl, those for the bald eagle could include not disturbing winter roosting trees, monitoring the presence or absence of eagles during project activities, and keeping noise and disturbance to a minimum. Since the nearest southwestern willow flycatcher Area of Environmental Interest is more than 4.6 miles (7.4 kilometers) from the project site, the biological assessment concluded that the proposed project would have no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations Impacts—Operation of the Replacement Office Building Complex would have minimal impact on terrestrial resources within or adjacent to TA-3. Because the wildlife residing in the area has already adapted to levels of noise and human activity associated with current operation, it is unlikely that it would be adversely affected by similar types of activity involved with operation of the new buildings. Areas not permanently disturbed (for example, construction laydown areas) would be landscaped; however, this would provide little habitat to native wildlife.

Human Health

Construction Impacts—During construction of the Replacement Office Buildings, some construction-related accidents would potentially occur. The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities (DOE 2004, BLS 2003). Based on an estimated 1.35 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 15 (DOE 2004) to 57 (BLS 2003).

DD&D Impacts—Health and safety impacts of demolition activities would be similar to those expected during construction activities. Based on an estimated 7,600 person-hours for DD&D of the existing facilities (including the current Los Alamos Site Office Building), no fatal accidents would occur, and nonfatal injuries are not expected (DOE 2004, BLS 2003).

Cultural Resources

A total of eight archaeological sites have been located within TA-3. Sites include lithic scatters, trails and stairs, and a wagon road. Two archaeological sites are eligible for listing on the National Register of Historic Places, four are of unknown eligibility, and two are not eligible. There are no National Register of Historic Places-eligible archaeological resources located in the vicinity of the proposed Replacement Office Building Complex; however, one site of undetermined status, a historical trail, is located to the south of the parking lot. Although three National Register of Historic Places-eligible buildings are located in TA-3, none are situated near the proposed new complex. One traditional cultural property is present within TA-3.

Construction Impacts—There are no cultural resource sites eligible for the National Register of Historic Places within the vicinity of the Replacement Office Buildings. However, the historic trail located to the south of the parking lot must be managed as a National Register of Historic Places-eligible site until formally determined otherwise. Due to its proximity to the proposed project, there could be potential adverse effects of construction. As noted above, one traditional cultural property is located within TA-3. However, it would not be affected by construction or operation of the Replacement Office Building Complex.

Operations Impacts—Operation of the Replacement Office Buildings and associated parking lots would not impact any cultural resources.

Socioeconomics and Infrastructure

Construction Impacts—Utility infrastructure resources would be required for Replacement Office Buildings construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection.

For Replacement Office Buildings construction, total liquid fuel consumption is estimated to be 1.8 million gallons (6.8 million liters). Total water consumption is estimated to be 9.6 million gallons (36 million liters). The existing LANL infrastructure would be capable of supporting the requirements for new facility construction without exceeding site capacities, resulting in negligible impact on site utility infrastructure.

Operations Impacts—In general, utility infrastructure requirements for operation of the new office structures would be limited to building connections, and no upgrades to existing utilities would be required. Usage in the proposed structures would be equivalent to or less than that of the replaced structures because contemporary building design includes water and energy conservation features. As such, Replacement Office Buildings operation is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the Replacement Office Buildings are projected to require 356,000 gallons (1.35 million liters) of liquid fuels and 11.3 million gallons (43 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be very minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities be shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed.

Waste Management

Construction Impacts—Replacement Office Building Complex construction would generate approximately 1,700 cubic yards (1,300 cubic meters) of construction waste, primarily construction debris and associated solid waste. Construction debris is not hazardous and may be disposed of in a solid waste landfill. A substantial portion of construction debris at LANL is routinely recycled; in 2003, approximately 89 percent of the uncontaminated construction and demolition waste was recycled, and those rates are expected to continue (LANL 2004d).

Operations Impacts—Operations at the new Replacement Office Building Complex would generate sanitary wastes. However, because the offices are a replacement for existing office space, no increase in waste is expected.

DD&D Impacts—Demolition activities would generate approximately 6,900 cubic yards (5,300 cubic meters) of demolition debris and sanitary waste. The demolition debris would be transferred to appropriate offsite recycling or disposal facilities. As with construction debris, as much as 89 percent of the demolition debris could potentially be recycled. Although no radiological waste is anticipated as a result of the demolition activities of the Wellness Center and warehouse, 31 cubic yards (24 cubic meters) of low-level radioactive waste was estimated in case contaminated materials were encountered during the demolition activities. This waste would be disposed of at TA-54. Because the estimated volume is small, no impacts on disposal capacity are expected.

Transportation

Construction Impacts—Construction personnel would park onsite and at remote designated parking areas. Truck traffic volume carrying construction materials to LANL and waste to local and regional landfill sites would increase. This increase in traffic would not have any significant impact on the adjacent road systems, including West Jemez Road. As stated earlier, a substantial portion of construction debris at LANL is routinely recycled.

DD&D Impacts—Demolition activities would generate a small amount of low-level radioactive wastes that would be disposed of onsite or shipped offsite. The demolition debris would be transported to offsite recycling or disposal facilities. As with construction debris, a majority of demotion debris could potentially be recycled.

G.3 Radiological Sciences Institute, Including Phase I – The Institute for Nuclear Nonproliferation Science and Technology Impact Assessment

This section provides an assessment of environmental impacts for the proposed Radiological Sciences Institute at LANL's TA-48. Section G.3.1 provides background information on the proposed project to replace deteriorated structures scattered over six TAs with the Radiological Sciences Institute. Section G.3.2 provides a description of the proposed options for the Radiological Sciences Institute. Section G.3.3 presents environmental consequences of the No Action Option and the proposed project (construction and operation of the proposed Radiological Sciences Institute at TA-48 and DD&D of the replaced facilities).

G.3.1 Introduction

The proposed project site is located in TA- 48, approximately 1 mile (1.6 kilometers) southeast of TA-3 along Pajarito Road and also includes a small portion of the western edge of TA-55. The Radiological Sciences Institute would provide state-of-the-art facilities for wet chemistry, metallurgy, safeguards (domestic and international), material protection control and accountability, machining and manufacturing, training schools, and underground storage of special nuclear material (LANL 2006a). This project would also involve DD&D of 52 deteriorating structures (80 percent of LANL's radiological facilities) (LANL 2006a). The project would consolidate radiological laboratories and working spaces to a significantly smaller footprint of modern, flexible facilities in up to 13 buildings located at TA-48.

The missions proposed for relocation to the Radiological Sciences Institute include (but are not limited to) support for weapons manufacturing, material property evaluations for stockpile stewardship, support for domestic and international safeguards, training for International Atomic Energy Agency inspectors, training and support for national emergency response to threats involving radioactive sources, biological research, detection and sensor technologies, various chemistry and chemical engineering missions, radioisotope production and distribution, and basic energy science. New and developing projects that require radiological facilities include missions such as homeland security, advanced fuel cycle initiatives, separation processes for commercial-reactor spent fuel, production capability for nuclear fuels for space missions, powder metallurgy for space and medical applications, nonproliferation, threat reduction, nuclear material control and accountability, alternative energy systems, advanced fusion, and nuclear-weapons-related research.

Much of the radiological infrastructure at LANL is 40 to 60 years old, and the ability to continue critical national missions is threatened. Current facilities are rapidly approaching obsolescence, with operation and maintenance costs associated with increased safety, security, regulatory, and operating requirements becoming prohibitive. Radiological competence and mission commitments need to be met at LANL (LANL 2006a). The existing radiological facilities were built in accordance with building codes and safety and security requirements that are now outdated (LANL 2006a). NNSA needs to replace aging structures with modern buildings designed to meet usage needs.

Table G–4 shows the types of buildings currently in use by different programs that would be replaced by the Radiological Sciences Institute Project, including their building numbers, approximate age, facility condition, and existing floor space. **Table G–5** lists the names and functions of the 30 permanent structures that would be replaced by the Radiological Sciences Institute.

Table G–4 Summary of Los Alamos National Laboratory Radiological Buildings Proposed for Decontamination, Decommissioning, and Demolition Radiological Sciences Institute Project

Program	*Structure*	*Building Numbers* [a]	*Area (gross square feet)*	*Predominant Condition*	*Predominant Building Age (years)*
Chemistry	10 permanent buildings	46-24, 46-31, 46-158, 46-200, 46-250, 48-1, 48-8, 48-17, 48-26, 59-1	167,409	Poor to failing	40-59
	8 transportable	48-27, 48-29, 48-33, 48-34, 48-46, 48-47, 48-208, 48-214			
	2 trailers	48-149, 48-154			
Materials Science and Technology	5 permanent buildings	3-29, 3-35, 3-169, 3-66, 3-451	258,922	Poor to failing	40-59
	2 trailers	3-1524, 3-1525			
Nuclear Nonproliferation	13 permanent buildings	18-1, 18-28, 18-30, 18-129, 18-141, 18-147, 18-227, 18-297, 3-66, 35-2, 35-27, 35-115, 35-347	180,099	Poor to failing	40-59
	1 transportable	35-253			
	8 trailers	18-288, 18-300, 18-301, 35-239, 35-261, 35-262, 35-263, 35-382			
	3 other	18-256, 18-257, 18-258			
Radiological Machining and Inspection	1 permanent building	3-102	29,365	Adequate	40-59
Totals	52 structures		635,795		

[a] 100 percent of most building functions would be moved to the Radiological Sciences Institute. Buildings whose functions would be only partially replaced by the Radiological Sciences Institute and the corresponding percentages are: 3-29, 7 percent (the hot cells); 35-2, 33 percent; 46-24, 50 percent; 46-31, 25 percent; 46-158, 15 percent; 46-200, 50 percent; 59-1, 25 percent.

Notes: Facilities associated with the Institute for Nuclear Nonproliferation Science and Technology Phase I DD&D include the International Atomic Energy Agency schoolhouse portion of 3-66; Buildings 35-2 (33 percent), 35-27, 35-115, 35-247; and all TA-18 buildings. DD&D of these facilities is not part of the Institute for Nuclear Nonproliferation Science and Technology and would be handled separately.

To convert square feet to square meters, multiply by 0.092903.

Source: LANL 2006a.

Table G–5 Name, Function, and Number of Employees of Permanent Buildings Proposed for Decontamination, Decommissioning, and Demolition by the Radiological Sciences Institute Project

Technical Area Building [a]	*Name*	*Current Use*	*Employees* [b]
46-24 (50%)	Laboratory and Office Building	Optics laboratories	24
46-31 (25%)	Test Building No. 2	Optics laboratories	3
46-158 (15%)	Laser-Induced Chemistry Laboratory	Optics laboratories	1
46-200 (50%)	Chemistry and Laser Laboratory	Chemistry laboratory	2
46-250	Analytical Chemistry	Chemistry laboratory	7
48-1	Radiochemistry Building	Chemical laboratory (nuclear)	149
48-8	Isotope Separator Building	Machine shops	2
48-17	Assembly Checkout Building	Assembly facilities	3
48-26	Office Building	Office	2
59-1 (25%)	Occupational Health Laboratory	Radiation effects laboratory	46
3-29 (7%)	Chemistry and Metallurgy Research Laboratory (Hot Cells)	Nuclear laboratory	24
3-169 [c]	Warehouse (Sigma)	General storage	125
3-66 [c]	Sigma Building	Laboratories (nuclear)	125
3-451	Micro Machining Facility	Physics laboratory	8
3-1524	Laboratory and Office Building	Laboratories (nuclear)	2
35-2 [c]	Laboratory and Office Building (Nuclear Safeguards Research)	Laboratories (nuclear)	93
35-27 [c]	Nuclear Safeguard Laboratory	Laboratories (nuclear)	72
35-115	Solvent Storage Shed	Hazardous and flammable storage	0
35-347	Garage	General storage	0
18-1 [d]	Staging Area	Fabrication facility	1
18-28	Warehouse	Programmatic general storage	1
18-30	Main Building	Office	222
18-129	Reactor Sub-Assay Building	Nuclear physics laboratory	10
18-141	Ultra-Sonic Cleaning Building	Nuclear physics laboratory	0
18-147	Office Building	Office	6
18-227	Accelerator Device Laboratory	Accelerator building	0
18-256	Butler Building	Applied physics laboratory	0
18-297	Storage Building	General storage	0
3-102 [c]	Technical Shops Addition (Radiological Machine Shop)	Nuclear contaminated storage	0
Total			1,074 [e]

[a] Unless noted by a percentage shown in parentheses, 100 percent of the floor space and building function would be moved to the Radiological Sciences Institute.
[b] One hundred percent of employees currently located at each building are listed, except for those buildings where only a portion of the function is to be transferred to the Radiological Sciences Institute. In those instances, the number of employees that would move to the Radiological Sciences Institute was assumed to be proportional to the percentage of floor space in the building that the Radiological Sciences Institute would replace.
[c] Identified as a radiological facility in the *SWEIS Yearbook – 2003* (LANL 2004d).
[d] All TA-18 functions from the Pajarito Site, except the Solution High-Energy Burst Assembly (SHEBA), would be moved to the Radiological Sciences Institute.
[e] Total includes permanent buildings listed in this table and 146 employees located in transportables and trailers not included in the table.
Source: LANL 2006a.

G.3.2 Options Considered

The two options identified for the Radiological Sciences Institute are the No Action Option and the proposed project option.

G.3.2.1 No Action Option

Under the No Action Option, the current use of existing radiological facilities throughout LANL would continue. At least two facilities are currently planned for DD&D under other actions: the TA-18 and Chemistry and Metallurgy Research Buildings. The facilities have exceeded their design life and are rapidly becoming obsolete and seriously deteriorating; corrective maintenance actions would continue as failures occur. Maintenance cost would continue to escalate to support the aging facilities until they must be shut down. Upgrade costs to meet currently applicable building codes and safety and security requirements are prohibitive and would provide only a limited lifespan to existing facilities. LANL would systematically lose radiological competence, and mission commitments would not be met. Failures of the existing facilities and equipment would delay programmatic work, possibly damage equipment, and possibly pose a risk to personnel safety, campaigns, critical experiments, and related activities. Because nearly 70 percent of all LANL radiological facilities are 40 to 60 years old, they would experience more and more severe failures over time, until corrective maintenance is no longer possible and the facilities would have to be shut down if unreliability adversely impacts safety or the environment.

G.3.2.2 Proposed Project

Under the proposed project, the Radiological Sciences Institute would be constructed and 52 obsolete structures scattered over six TAs would undergo DD&D. This analysis assumes the Radiological Sciences Institute would consist of up to 13 facilities. Phase I of the Radiological Sciences Institute Project would include 5 buildings associated with the Institute for Nuclear Nonproliferation Science and Technology, for which construction would begin in 2009, with an estimated occupancy in fiscal year 2012. New construction for the Institute for Nuclear Nonproliferation Science and Technology would include a Security Category I and II laboratory with a Security Category I vault, several Security Category III and IV laboratories, a field test laboratory, a secure radiochemistry facility, and associated office support facilities, further described below.

- *Security Category I and II Facility* – a small Nuclear Hazard Category 2 laboratory located within a security Isolation Zone and within the Perimeter Intrusion Detection and Assessment System (PIDAS) adjacent to TA-55 but physically isolated from the programmatic activities and personnel inside TA-55. The facility would provide the ability to utilize and store Security Category I and II quantities of materials (including rollup of various numbers of Security Category III and IV quantities).

- *Security Category III and IV Laboratories* – an independent radiological facility incorporating both open and secured laboratories, used for research and development, testing, and evaluation of technology directly applied to nuclear nonproliferation programs.

- *Secure Radiochemistry Facility* – a secure, low-background-dissolving and radiochemistry capability for the receipt and processing of classified samples to meet the requirements of current and future national security programs. The building would be a vault-type room.

- *Field Test Laboratory* – an outdoor vehicle portal and long-standoff nuclear material monitoring and detection field laboratory to be used to develop and demonstrate advanced nuclear detection technology suitable for deployment in border-protection situations and in other environments requiring long-distance monitoring.

- *Office Support Facility* – an office complex sized to accommodate the staff in the Institute for Nuclear Nonproliferation Science and Technology, to include both open and secured office space, and mechanical, electrical, and software design, fabrication, and assembly facilities for building prototype instruments and supporting research and development needs.

The Radiological Sciences Institute would consolidate radiological activities in an optimally designed, efficient, safe, and secure set of buildings. Facilities would be included for wet chemistry, metallurgy, safeguards (domestic and international), material protection control and accountability, machining and manufacturing, and nonproliferation training schools. The complex would also include a Security Category I underground vault for storage of special nuclear material, eliminating (through underground tunnels) routine material transport on public roads. Also, the complex would be designed to accommodate multiple concurrent radiological activities and Security Categories (III and IV) and temporary Security Category II International Atomic Energy Agency training schools. A Nuclear Hazard Category 3 operations building for specific co-located actinide chemistry operations and safeguards would also be included. In addition to the programs and functions listed above, others that would be moved to the Radiological Sciences Institute and have measurable quantities of emissions or waste include those of the Sigma Complex (Buildings TA-3-66, -35, and -169), the Pajarito Site (TA-18 buildings, except the Solution High-Energy Burst Assembly (SHEBA Project), the Radiological Machine Shop at TA-3 (TA-3-102), the Chemistry and Metallurgy Research hot cells (located at TA-3-29), and the Radiochemistry Facility currently located in TA-48.

This project would also involve DD&D of 52 obsolete structures (80 percent of LANL's radiological facilities), accounting for approximately 636,000 gross square feet (59,100 square meters) of building space located in six TAs (TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59) (LANL 2006a). There are about 1,074 employees located in buildings that would be replaced by the Radiological Sciences Institute (see Table G–5). Of that total, 293 are in existing buildings at TA-48 slated for replacement (193 in permanent structures and 100 in transportables or trailers). Phase I of the Radiological Sciences Institute (the Institute for Nuclear Nonproliferation Science and Technology) would occupy approximately 145,000 net square feet (13,500 square meters), a reduction of about 50,000 net square feet (4,600 square meters) relative to the facilities to be replaced, and would house approximately 450 to 500 technical and support staff (LANL 2006a).

G.3.3 Affected Environment and Environmental Consequences

For Radiological Sciences Institute construction and operation, the affected environment is primarily TA-48, although the region of influence for each resource evaluated may extend beyond TA-48 and LANL. For DD&D of buildings replaced by the Radiological Sciences Institute, the affected environment is primarily TA-3, TA-35, TA-46, TA-48, and TA-59. DD&D of buildings in TA-18 is not part of the impacts evaluation for the Radiological Sciences Institute, but rather is included as part of the TA-18 Closure, Including Remaining Operations Relocation, and Structure DD&D Impacts Assessment (see Appendix H). Also, the DD&D impacts for the Chemistry and Metallurgy Research Building hot cells (Wing 9 of Building 3-29) are not part of the Radiological Sciences Institute evaluation, but are included as part of the proposed project analyzed in the *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory* (DOE 2003). The impacts of TA-18 operations and the hot cells that would be moved to the Radiological Sciences Institute are included in the affected environment baseline for comparison with the impacts of the new Radiological Sciences Institute.

The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to TA-48 (or the TAs impacted by DD&D activities) is available and aids understanding the Radiological Sciences Institute affected environment, it is included here. An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is mainly confined to already-developed areas, with no disproportionate human health impacts to low-income or minority populations expected.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, transportation, and facility accidents.

G.3.3.1 No Action Option

Under the No Action Option, LANL radiochemistry capabilities would not be modernized and would not take on capabilities that could potentially be lost from LANL due to changes in other facilities (the Chemistry and Metallurgy Research and Pajarito Site). No disturbance of existing land or building sites would occur. There would be no construction or building removal debris to require disposal. Utility use would remain essentially the same as the present use. Continued expenses for repairs and replacement of aging heating, ventilation, and air conditioning systems and other building components would increase. As building systems and other components fail and cannot be replaced or repaired, affected buildings would be partially or completely closed and the staff relocated. Personnel would remain scattered throughout LANL, and collaboration between scientists and administrative personnel would be hindered. Under the No Action Option, the inefficiencies of using outmoded and deteriorating buildings would continue.

No changes in emissions or air pollutant concentrations are expected under the No Action Option. Under this option, radiological air emissions would continue to be generated from operations at the Sigma Complex (TA-3-66), Machine Shops (TA-3-102), Radiochemistry (TA-48), and hot cells (Wing 9) at the Chemistry and Metallurgy Research Building. No increases in emissions or additional radionuclides are expected under the No Action Option.

Human Health

The consequences of continued operations at facilities that release radiological air emissions, and would be consolidated in the proposed Radiological Sciences Institute (Sigma Complex [TA-3-66], Machine Shops [TA-3-102], and Radiochemistry [TA-48]), on public and worker health under the No Action Option are presented below. A discussion of the terminology used in the human health evaluation and basic radiological health effects and the methodologies used to evaluate consequences can be found in Appendix C of this SWEIS.

Public Health—The collective dose to the public from all airborne radioactive emissions from these three facilities was estimated to a 50-mile (80-kilometer) radius from each facility. The total population dose from all three facilities, shown in **Table G–6**, is estimated to be 0.18 person-rem per year, which is a small part of the total population dose (30 person-rem) from all Key Facilities at LANL. This population dose would result in no additional fatalities in the 50-mile (80 kilometer) radius population of close to 300,000.

Table G–6 Annual Radiological Impacts on the Public from Operations under the Radiological Sciences Institute Project No Action Option

	Population Dose within 50 Miles (80 kilometers)	*Facility-Specific MEI Dose*	*MEI Location (feet)*
Sigma (TA-3-66)	0.16 person-rem	0.026 millirem	N 3,560 LANL boundary
Machine Shops (TA-3-102)	0.013 person-rem	0.0023 millirem	N 3,380 LANL boundary
Radiochemistry (TA-48)	0.0065 person-rem	0.0019 millirem	NNE 2,920 Royal Crest Trailer Park
Total dose	0.18 person-rem	Not applicable	
Cancer fatality risk	0.00011	1.6×10^{-8} (Sigma)	
Regulatory dose limit [a]	Not applicable	10 millirem	
Background radiation dose [b]	120,000 person-rem	400 millirem	

MEI = maximally exposed individual, TA = technical area.

[a] Title 40 of the *Code of Federal Regulations*, Part 61, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.

[b] The annual individual dose from background radiation at LANL ranges from a low of about 300 millirem to a high of about 500 millirem (see this SWEIS, Appendix C). The population living within 50 miles (80 kilometers) of TA-48 was estimated to be 299,508 in 2000.

Note: To convert feet to meters, multiply by 0.3048.

Sources: Chapter 5 and Appendix C of this SWEIS.

A maximally exposed individual (MEI) is a hypothetical member of the public residing at the LANL site boundary who would receive the maximum dose from facility emissions. Each facility has a different location for its MEI, based on many factors, including the climate, distance, type and amount of radiological air emissions, and physical form of the radionuclides. The location and estimated dose for each of the three facilities that have radiological air emissions are listed in Table G–6; these doses do not include exposures from other sources at LANL. The highest of the three MEI doses is from emissions at the Sigma Complex. This MEI would receive an estimated annual dose of 0.026 millirem from operations as compared to the LANL site-wide MEI, who would receive 7.8 millirem per year from emissions from all LANL facilities. To put these doses into perspective, comparisons with doses from natural background radiation and the regulatory limit of 10 millirem established in Title 40 *Code of Federal Regulations* [CFR] Part 61 are included in the table.

In general, collective total effective dose equivalent by Key Facility or TA is difficult to determine because these data are assigned to the individual worker, not to a specific TA or building. In addition, members of many groups and organizations receive doses at several locations. Under the No Action Option, the average worker doses expected at the Sigma Complex, Machine Shops, and Radiochemistry would be similar to those in the 6-year period from 1999 through 2004.

Hazardous Chemical Impacts—No chemical-related health impacts would be associated with this option. As stated in Chapter 5, Section 5.6, of this SWEIS, the quantities of chemicals that could be released to the atmosphere during routine normal operations are minor and would be below screening levels used to determine the need for additional analysis. Under normal operating conditions, workers would be protected from hazardous chemicals by adherence to Occupational Safety and Health Administration and EPA occupational standards that limit concentrations of potentially hazardous chemicals in the workplace.

Waste Management

The impacts of managing waste from continued operations at the Radiochemistry Facility, Sigma Complex, Pajarito Site (TA-18), and Machine Shops (Building 03-102 only) would be the same as those currently experienced at these facilities because the same types and quantities of waste would be generated and subsequently managed.

Some gains in waste management efficiencies are expected over the next few years, and these gains would be realized under both the No Action Option and the proposed project (that is, whether or not the Radiological Sciences Institute is constructed and operated). Significant reductions in the volume of radioactive liquid discharges are expected over the next few years as improvements are made to the beryllium laundry operations, electroplate bath condensate system, and perchloric acid exhaust duct washdown process. Based on historical data and planned improvements, the projected discharge volume of radioactive liquids is 845,000 gallons (3.2 million liters) per year (LANL 2006a).

Chemical waste generation rates are expected to be 31,000 pounds (14,000 kilograms) per year. Low-level radioactive waste generation rates are estimated to be 157 cubic yards (120 cubic meters) per year. Mixed low-level radioactive waste and transuranic waste generation rates are expected to be very low, approximately 1.3 cubic yards (1 cubic meter) per year for each category. No mixed transuranic waste is expected to be generated (LANL 2006a).

Facility Accidents

Potential accidents under the No Action Option estimated to have the highest impacts would involve radiological operations and materials associated with Chemistry and Metallurgy Research Wing 9 hot cell operations. Five accident scenarios were selected to represent the bounding impacts of accidents. Information used to estimate the impacts of these accidents is shown in **Table G–7**. The material at risk in a hot cell is estimated to be 10.6 ounces (300 grams) of plutonium-238 equivalent and an additional 28.7 pounds (13 kilograms) of plutonium-238 equivalent in iridium cans inside two layers of textured graphite (general purpose heat source modules).

Table G–7 Bounding Radiological Accident Scenarios under the Radiological Sciences Institute Project No Action Option

Accident	*Source Term* [a] *(curies)*	*Release Energy (watts)*	*Annual Frequency*
Hot cell fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238	2.04×10^{6}	1.0×10^{-4}
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	22.572 plutonium-238 1.386 plutonium-239	2.04×10^{6}	2.4×10^{-4}
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238 0.315 plutonium-239	0	2.4×10^{-3}
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.001283 plutonium-238	0	0.1
Hot cell plutonium-238 spill with no confinement	0.4104 plutonium-238	0	0.01

a. A release height of 4.9 feet (1.5 meters) is assumed for all accidents. Specific activity is 0.063 curies per gram for plutonium-239 and 17.1 curies per gram for plutonium-238.

Assuming that an accident occurred, estimated consequences for a noninvolved worker located 330 feet (100 meters) from the accident, the onsite worker population, the MEI located at West Jemez Road, and the offsite population are shown in **Tables G–8** through **G–10**. Estimated risks that take accident frequency into account to these same receptors are shown in Table G–10.

The hypothetical accidents with the highest radiological impacts would be the seismic-induced building collapse with no fire and the seismic-induced building collapse with a fire involving plutonium-238 in general purpose heat source modules. If either of these accidents were to occur, the consequences are estimated to be 2.9 or 8.6 increased LCFs for the offsite population, 0.047 or 0.052 increased risk of an LCF for the MEI, and 0.21 or 0.18 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident, respectively. After taking into account the frequency (or probability) of each accident, the seismic-induced building collapse with no fire is estimated to have the highest risks. For this accident, the annual risks are estimated to be 0.0069 LCFs for the offsite population, 0.00011 increased risk of LCFs for the MEI, and 0.00049 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident.

Table G–8 Radiological Accident Offsite Population Consequences under the Radiological Sciences Institute Project No Action Option

Accident	MEI		Population to 50 Miles (80 kilometers)	
	Dose (rem)	LCF [a]	Dose (person-rem)	LCF [b, c]
Hot cell fire involving plutonium-238 in general purpose heat source modules	9.18	0.0055	3,060	1.84
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	43	0.052	14,400	8.64
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	39	0.047	4,770	2.86
Spill of plutonium-238 residue from (0.5-gallon (2-liter) bottles outside of hot cell	0.012	7.4×10^{-6}	1.12	0.00067
Hot cell plutonium-238 spill with no confinement	3.96	0.0024	359	0.22

MEI = maximally exposed individual, LCF = latent cancer fatality.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.
[b] Increased number of LCFs for the offsite population, assuming the accident occurs.
[c] Offsite population size is approximately 300,000 persons.

Table G–9 Radiological Incident Onsite Worker Consequences under the Radiological Sciences Institute Project No Action Option

Accident	Noninvolved Worker at 330 Feet (100 meters)	
	Dose (rem)	LCF [a]
Hot cell fire involving plutonium-238 in general purpose heat source modules	32.5	0.039
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	152	0.18
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	171	0.21
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.045	2.7×10^{-5}
Hot cell plutonium-238 spill with no confinement	14.3	0.0086

LCF = latent cancer fatality.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.

The impacts of the other postulated accidents are shown in Tables G–8 through G–10. Comparing the seismic accident that includes a fire with one that does not include a fire, the former has higher offsite population and MEI impacts, while the latter has higher individual worker and worker population impacts. This is because the buoyant effects of a fire loft the radioactive plume over the onsite workers, while the greater releases associated with this scenario would impact the general population farther downwind. In contrast, the absence of a fire and its buoyant effects has a greater impact on close-in individuals like the noninvolved worker at 330 feet (100 meters) and the large worker population at the Chemistry and Metallurgy Research Building.

Table G–10 Radiological Accident Offsite Population and Worker Risks under the Radiological Sciences Institute Project No Action Option

Accident	*Onsite Worker (LCFs)*	*Offsite Population (LCFs)*	
	Noninvolved Worker (at 330 feet [100 meters]) [a]	***MEI*** [a]	***Population to 50 Miles (80 kilometers)*** [a, b]
Hot cell fire involving plutonium-238 in general purpose heat source modules	3.9×10^{-6}	5.5×10^{-7}	0.00018
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules [c]	4.4×10^{-5}	1.2×10^{-5}	0.0021
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules [c]	0.00049	1.1×10^{-4}	0.0069
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	2.7×10^{-6}	7.4×10^{-7}	6.7×10^{-5}
Hot cell plutonium-238 spill with no confinement	8.6×10^{-5}	2.4×10^{-5}	0.0022

LCF = latent cancer fatality, MEI = maximally exposed individual.

[a] Increased risk of an LCF to an individual per year.

[b] Offsite population size is approximately 300,000 persons.

[c] An updated probabilistic seismic hazard analysis has been completed for LANL (LANL 2007), which results in higher peak horizontal ground acceleration values for the same annual probability of exceedance. In the seismic accident analyses for the Chemistry and Metallurgy Research Building, the radioactive source term was conservatively based on the assumption that all structures, systems, and components failed, therefore, the updated probabilistic seismic hazard analysis is not expected to change the accident consequences or risks.

G.3.3.2 Proposed Project

Land Resources—Land Use

Construction Impacts—Construction of the Radiological Sciences Institute, including parking lots and construction laydown areas, would require 33.6 acres (13.6 hectares) of land. Of the land area required for the Radiological Sciences Institute, approximately 12.6 acres (5.1 hectares) are undeveloped (LANL 2006a).

Operations Impacts—Upon project completion, 32 acres (13 hectares) would be occupied by permanent facilities. While the land use designation of much of the site would remain Reserve, some Reserve areas and the currently designated Experimental Science area would be redesignated in the future as Nuclear Materials Research and Development (LANL 2003b).

The Radiological Sciences Institute would be constructed in TA-48 and a small portion of TA-55 located within the Pajarito Corridor West Development Area. Construction of the Radiological Sciences Institute within TA-48 would take place in areas designated within that plan as available for Primary Development and Proposed Parking, as well as within the currently developed portion of the site which is identified as Potential Infill. Although the Radiological Sciences Institute would result in the use of previously undeveloped land and involve a change in land use designation in TA-48, its construction would be compatible with future land use plans. The small portion of the western edge of TA-55 that would be affected by the Radiological Sciences Institute is classified as Nuclear Materials and Research. Under this option, land use within this area would not change from its current land use designation of Nuclear Materials Research and Development.

DD&D Impacts—DD&D of buildings proposed for replacement is not expected to result in a change in land use at the respective TAs. These structures are within built-up areas that would continue to be used for other purposes. Once removed, the land upon which these buildings stood would be available for future development.

Land Resources—Visual Resources

The buildings that would be replaced by the Radiological Sciences Institute are all in currently developed areas consisting of industrial and office buildings, transportables, and trailers. The buildings are primarily located in TAs along Pajarito Road, except buildings in TA-3. As with TA-48, the views are industrial in nature and are viewed primarily by site personnel.

Construction Impacts—Construction of the Radiological Sciences Institute would result in a change in both near and distant views of TA-48 and the western edge of TA-55. Short-term impacts would include the construction activity itself as well as increased dust generation. Although landscaping is planned along Pajarito Road following construction, new buildings and parking lots would be more visible from the road than current facilities due to their increased number and size. Additionally, a number of buildings, as well as parking lots, would be located closer to the road than are the current Advanced Radiochemistry Diagnostics Building and associated facilities. These changes in the visual environment would mainly impact LANL employees. Additionally, new development of TA-48 would be visible at the entrance to the controlled access along Pajarito Road and to viewers in the southeast quadrant of TA-3.

Distant views from the higher elevations to the west of TA-48 (as well as the western edge of TA-55) would also change as a result of construction of the Radiological Sciences Institute, as the size of the developed area would increase as well as the number of buildings and parking lots. However, the overall effect on the view would be minimal due to the present nature of development on the mesa.

DD&D Impacts—Although removal of buildings that the Radiological Sciences Institute would replace would positively affect visual resources, the level of improvement would be small. Near views of LANL facilities along the mesa are seen mostly by LANL employees. From higher elevations to the west, the Pajarito Mesa presents the appearance of a mosaic of industrial buildings within a ponderosa pine forest. Removal of a limited number of buildings would not appreciably change the view.

Geology and Soils

The 9-mile-long (14-kilometer-long) Rendija Canyon Fault is located approximately 0.5 miles (0.8 kilometers) east of the Radiochemistry Laboratory at TA-48. Geologic mapping shows that there is no faulting in the near surface directly beneath TA-48. The closest fault is located about 300 feet (90 meters) southwest of the Radiochemistry Laboratory (LANL 2004c). This small fault trace exhibits only about 2 feet (0.6 meters) of offset. Most of these small faults have been inferred to represent ruptures subsidiary to the major faults, and, as such, their potential rupture hazard is very small (Gardner et al. 1999). Additionally, all buildings in the Radiological Sciences Institute would be designed in accordance with current DOE seismic standards and applicable building codes.

The proposed area for the facility includes undisturbed soils that maintain the present vegetative cover. They are arid soils consisting largely of sandy loam material alluvially deposited from tuff units on higher slopes to the west and eroded from underlying geologic units. In general, the soils are poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species being able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Approximately 802,000 cubic yards (613,000 cubic meters) of soil would be disturbed during building excavation. These estimates are based on building footprints and do not include the impact of short-term construction support activities such as the use of equipment laydown yards. The impact of such support areas would be minimized by locating these facilities in developed areas such as parking lots.

Adherence to standard best management practices for soil erosion and sediment control, including watering, during construction would serve to minimize soil erosion. After construction, disturbed areas would lie within the footprint of the new buildings and roadway, with temporarily disturbed areas stabilized and revegetated, so they would not be subject to long-term soil erosion.

For construction of the Security Category I underground vault for special nuclear material storage and the associated tunnel, excavation depths of up to 45 feet (14 meters) into the mesa may be necessary. Excavation of welded tuff could necessitate blasting to speed construction. A site survey and foundation study would be conducted as necessary to confirm site geologic characteristics for facility engineering purposes. In addition, prior to commencing ground disturbance, NNSA would survey potentially affected contaminated areas to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures.

Aggregate (sand, gravel, crushed stone) and other geologic resources would be required to support Radiological Sciences Institute construction activities at TA-48, but such resources are readily available from onsite borrow areas and otherwise abundant in the vicinity of Los Alamos County.

Operations Impacts—Radiological Sciences Institute operations would not result in additional impacts on geologic and soil resources at LANL. Any new facilities and uses within TA-48 would be evaluated, designed, and constructed in accordance with DOE Order 420.1B and sited to minimize risk from geologic hazards, including earthquakes.

DD&D Impacts—DD&D activities associated with existing radiological facilities would have a negligible additional impact on geologic and soil resources at LANL, as the affected facility areas are already developed and adjacent soils are already disturbed. Additional ground disturbance would be necessary to establish laydown yards and waste management areas in the vicinity of the facilities to be razed. Available paved surfaces, such as parking lots in the vicinity of the facilities to be demolished, would be used to the extent possible.

The major indirect impact on geologic and soil resources at DD&D locations would be associated with the need to excavate any contaminated tuff and soil from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade, but such resources are readily available from onsite borrow areas and otherwise abundant in the vicinity of Los Alamos County. LANL staff would survey potentially affected contaminated areas to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures and the Consent Order. All excavated material would be characterized before removing it for disposal.

Water Resources

All radioactive liquid effluents are directed to the Radioactive Liquid Waste Treatment Facility in TA-50 and sanitary liquid effluents to the Sanitary Wastewater Systems Plant in TA-46. Any potential contamination sources, such as aboveground storage tanks, are controlled through a Spill Prevention Control and Countermeasures Plan.

For TAs that would be impacted by DD&D activities, there are currently two National Pollutant Discharge Elimination System (NPDES) outfalls (which discharged 3.81 million gallons [14.4 million liters] in 2005) associated with the Sigma Complex at TA-3 (LANL 2006f). There is also one NPDES outfall (which discharged 0.92 million gallons [3.48 million liters] in 2005) associated with the Chemistry and Metallurgy Research Building at TA-3, but it is not associated with the Wing 9 hot cells.

Construction Impacts—Little or no effect on surface water resources is anticipated during construction of the Radiological Sciences Institute. The proposed project would not result in disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. Silt fences, hay bales, or other appropriate best management practices would be employed and specified in a stormwater pollution prevention plan to ensure that fine particulates created during construction would not be transported by stormwater into surface water features in the vicinity of TA-48.

Operations Impacts—The proposed project should produce minimal effects on surface water resources during operations. There are three NPDES outfalls associated with facilities moving to the Radiological Sciences Institute. The Sigma Complex currently has two NPDES outfalls (03A-022 and 03A-024) (LANL 2006a), and the Chemistry and Metallurgy Research Building has one NPDES outfall (03A-021) (LANL 2006a), but it is not associated with the Chemistry and Metallurgy Research Building hot cell operations that would be moved into the Radiological Sciences Institute.

There would be more stormwater runoff from the new facility because of the increase in impervious areas of buildings and parking lots. This may be offset by the decreased stormwater runoff from the demolished facilities.

Aboveground storage tanks may be added to the Radiological Sciences Institute, but the number would not exceed the current number of aboveground storage tanks associated with the operations slated to be moved to the Radiological Sciences Institute. Radioactive and sanitary liquid effluents from the Radiological Sciences Institute would continue to be discharged to the Radioactive Liquid Waste Treatment Facility and Sanitary Wastewater Systems Plant, respectively.

The proposed project should produce minimal effects on groundwater resources during operations. Potable and industrial water use during operation of the Radiological Sciences Institute would not vary significantly from current volumes used for operations at the various radiological facilities that would be incorporated at the Radiological Sciences Institute. The cooling tower at Building 48-1 and the Sigma Building 3-66 would be incorporated into a new cooling tower system for the Radiological Sciences Institute. The cooling tower cycle increase program would reduce the amount of water used by this new system. Groundwater quality should not be affected by the operation of the Radiological Sciences Institute, as no new potential contamination sources would be added.

DD&D Impacts—Although several of the NPDES outfalls at the facilities to be demolished have already been blocked off and no longer discharge industrial effluent to the environment, the possibility of accidental discharges through these drains would be eliminated when the buildings at TA-3-66, TA-18, and TA-35 are demolished (LANL 2006a). Elimination of the 14 buildings at TA-18 that would be replaced by the Radiological Sciences Institute also would eliminate a potential source of contamination in the Pajarito Canyon 100-year floodplain. As noted above, increased impervious areas at the Radiological Sciences Institute that would create more stormwater runoff may be offset by the decreased stormwater runoff from demolished buildings and parking lots.

Air Quality and Noise

Nonradiological air pollutant emission sources at TA-48 include three natural-gas-fired boilers and emissions from various toxic chemicals. Emissions from boilers for 2003 are reported in **Table G–11**. **Table G–12** shows emissions of other pollutants from the Machine Shop at TA-3 and activities at TA-18 that could be transferred to TA-48.

Table G–11 Nonradiological Air Pollutant Emissions at Technical Area 48 – 2003 (tons per year)

Pollutant	*Boiler BS-1*	*Boiler BS-2*	*Boiler BS-6*
Criteria Pollutants			
Carbon monoxide	0.455	0.455	0.609
Nitrogen oxides	0.542	0.542	0.725
Particulate matter	0.041	0.041	0.055
PM_{10}	0.041	0.041	0.055
$PM_{2.5}$	0.041	0.041	0.055
Sulfur oxides	0.003	0.003	0.004
Volatile organic compounds	0.030	0.030	0.040

PM_{10} and $PM_{2.5}$ = particulate matter with aerodynamic diameters of 10 and 2.5 micrometers, respectively, or less.
Source: LANL 2006e.

Table G–12 Nonradiological Air Pollutant Emissions at Technical Area 3 Machine Shops and Technical Area 18 – 2005 (tons per year)

Pollutant	*Machine Shop (TA-3)*	*TA-18 Pajarito Site*
Ethanol	0.012	0.0035
Kerosene	0.0012	0
Zinc chloride fume	0	0.00013

TA = technical area.
Source: LANL 2006f.

Radiological air emissions for 1999 – 2005 are presented in Chapter 4, Section 4.4.3.1. Doses associated with radiological emissions at LANL are discussed in the section on human health. Emissions from three facilities that are projected to be consolidated in the proposed Radiological Sciences Institute are, or have been, monitored for radiological air emissions. Both the Machine Shops at TA-3 and Radiochemistry Complex at TA-48 have monitored point sources. Monitoring at the Sigma Complex (TA-3) was discontinued in 2000; it was determined that because of sufficiently low emissions, stack monitoring was no longer necessary for compliance. There are radiological air emissions from TA-18, but because the source of those emissions, SHEBA, would not be moved to the Radiological Sciences Institute, those data are not included here.

Estimated emission rates for toxic air pollutants emitted at TA-48 were compared to screening-level emission values for the *Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a). A screening-level emission value was developed for each chemical. A screening level emission value is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year) period, would not exceed a health-based guideline value. This screening-level emission value was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at a TA over the course of 1 year were available to become airborne. At TA-48, chemicals have been emitted at levels below the screening levels identified.

Construction Impacts—Construction of new facilities at TA-48 would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of the TA-48 Radiological Sciences Institute's largest new facilities. Maximum ground-level concentrations off site and along the perimeter road to which the public has regular access would be below ambient air quality standards, and the air quality impacts on the public would be minimal. Estimated concentrations for PM_{10} would be greatest for the site work phase. Estimated maximum PM_{10} concentrations are an annual average of 2.3 micrograms per cubic meter and a 24-hour average of 31.9 micrograms per cubic meter. The maximum annual and short-term concentrations for construction would occur at the site boundary north of TA-48. Construction modeling considered particulate emissions from activity in the construction area and emissions from various earthmoving and material-handling equipment.

Although no radiological releases to the environment are expected in association with construction activities at TA-48, the potential exists for contaminated soils and possibly other media to be disturbed during excavation and other site activities. A large potential release site encircles all of TA-48-1 and TA-48-45 (LANL 2006a). To determine the extent and nature of any contamination, an assessment of the affected areas would be performed prior to commencing ground disturbance. As needed, any contamination found would be remediated before continuing, and appropriate personal protection equipment would be required for working in this area.

In addition, there are other potential release sites within TA-48 (LANL 2006a). These sites and others at LANL are being investigated and assessed consistent with DOE requirements and the Consent Order. If it is determined that the potential release sites pose an unacceptable risk to the public or to LANL workers, the sites would be cleaned up before proceeding.

Construction of the new Radiological Sciences Institute at TA-48 would result in some temporary increase in noise levels near the area from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of construction equipment operation. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipments. Noise sources associated with construction at TA-48 may include loud impulsive sources such as blasting.

Operations Impacts—Under the proposed project, criteria and toxic air pollutants would be generated from the operation and testing of an emergency generator, use of various chemicals in laboratories, and other activities. Emissions from the diesel generator would occur during periodic testing resulting in little change in air pollutant concentrations. Air quality impacts on the public would be minor.

Little or no change in toxic pollutant emissions or air pollutant concentrations at LANL is expected under this option. For facilities that would be combined at TA-48, toxic pollutants released from laboratories would be similar to those from current uses as shown under the No Action Option and would vary by year with the activities performed. Emissions would continue to be below screening-level emission values, and air quality impacts on the public would be minor.

Projected annual radiological air emissions from the Radiological Sciences Institute were estimated to be the combined total of the projected emissions from the individual facilities whose functions would be moved to the Radiological Sciences Institute. The projected emissions are shown in **Table G–13**. The individual facility air emissions combined together in the Radiological Sciences Institute at TA-48 are described in detail in this SWEIS, Appendix C (Human Health). Impacts of radiological air emissions released during normal operations are discussed under Human Health.

Noise impacts of operation of the new Radiological Sciences Institute at TA-48 are expected to be similar to those from existing operations at TA-48. Although there would be a slight increase in traffic and equipment noise near the area (for example, new heating and cooling systems), there would be minimal change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new facilities.

Table G–13 Radiological Air Emissions from the Radiological Sciences Institute

Radionuclide	*Emission Rate (curies per year)*
Arsenic-72	1.21×10^{-4}
Arsenic-73	2.55×10^{-3}
Arsenic-74	1.33×10^{-3}
Beryllium-7	1.65×10^{-5}
Bromine-77	9.35×10^{-4}
Germanium-68	8.97×10^{-3}
Krypton-85	1.00×10^{2}
Rubidium-86	3.08×10^{-7}
Selenium-75	3.85×10^{-4}
Xenon-131m	4.50×10^{1}
Xenon-133	1.50×10^{3}
Other activation products [a]	5.58×10^{-6}
Plutonium-239	1.21×10^{-5}
Uranium-234	6.60×10^{-5}
Uranium-235	4.84×10^{-7}
Uranium-238	1.95×10^{-3}
Mixed fission products [b]	1.54×10^{-4}

[a] Other activation products are a mixed group of activation products represented by strontium-90 and yttrium-90 in equilibrium.

[b] Mixed fission products are rep resented by strontium-90 and yttrium-90 in equilibrium.

Source: Appendix C of this SWEIS.

DD&D Impacts—DD&D of buildings at TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59 would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Maximum ground-level concentrations at the site boundary would be below the ambient air quality standards, except for possible short-term concentrations of carbon monoxide. Concentrations off site and along the perimeter road to which the public has regular access would be below ambient air quality standards, and it is expected that air quality impacts on the public would be minor.

DD&D of buildings at TA-3, TA-35, and TA-48 would result in some release of radionuclides. The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during demolition of these facilities. The release of radionuclides would be minimized by proper decontamination of buildings prior to demolition and the use of appropriate containment devices. Radiological air emissions would be comparable to or less than those emitted during normal operations. Impacts of these radiological air emissions released during DD&D of the buildings under the proposed project are discussed under Human Health.

DD&D of buildings at TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59 would result in some temporary increase in noise levels near the area from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of demolition activity. There would be no change in noise impacts on the public outside of LANL as a result of these activities, except for a small increase in traffic noise levels from employee vehicles and debris shipments.

Ecological Resources

Effects of the Cerro Grande Fire within TA-48 varied from a burn severity of medium to low or unburned. Those portions of the TA in the vicinity of the Radiochemistry Building (Building 48-1) were categorized as being burned at the low or unburned severity level (DOE 2000). The buildings that would be replaced by the Radiological Sciences Institute are all located in currently developed industrial and office areas. While buildings situated in TA-3, TA-35, TA-46, TA-48, and TA-59 are located within the ponderosa pine forest vegetation zone and those in TA-18 are in the pinyon (*Pinus edulis* Engelm.)- juniper (*Juniperus monosperma* [Engelm.] Sarg.) woodland vegetation zone, wildlife use of the areas in the immediate vicinity of the buildings would be limited. Due to the presence of people, activity, and security fencing, no large animals are usually found within developed areas.

Four wetlands occur in TA-48, three of which are located within Mortandad Canyon between TA-48 and TA-60. These wetlands, which total about 1.1 acres (0.4 hectares), are characterized by coyote willow (*Salix exigua* Nutt.), Baltic rush (*Juncus balticus* Willd.), cattail (*Typha* spp.), and wooly sedge (*Carex lanuginose* Michx.). The fourth wetland is located between TA-48 and TA-55; cattail is the dominant plant. This wetland is less than 0.1 acre (0.04 hectares) in size (ACE 2005).

Surface water flow within that portion of Mortandad Canyon on the northern boundary of TA-48 is ephemeral. Thus, there are no fish or other permanent aquatic resources present within TA-48. Further, there are no permanent water bodies in any of the TAs within which buildings are to be removed.

Although there are no threatened or endangered species in the TA-48 area (LANL 2006a), portions of the TA are located within both the core habitat and buffer zone of the Mexican spotted owl for the Sandia-Mortandad Canyon Area of Environmental Interest. However, the buffer and core areas encompass only the eastern portion of the TA. They do not include developed areas (or areas adjacent to developed areas) on the mesa. Additionally, a small portion of the southeast corner of TA-48 and the western edge of TA-55 fall within the buffer zone of the Pajarito Canyon Mexican spotted owl Area of Environmental Interest. Areas of Environmental Interest are established under the *LANL Threatened and Endangered Species Habitat Management Plan* to protect important breeding or wintering habitat for certain sensitive species. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any part of TA-48 (LANL 1998).

Of those TAs where buildings are to be demolished in connection with the new Radiological Sciences Institute (TA-3, TA-18, TA-35, TA-46, and TA-59), only TA-3 and TA-35 fall within the core areas of the Los Alamos Canyon and Sandia-Mortandad Canyon Areas of Environmental Interest, respectively, of the Mexican spotted owl. However, only those buildings to be removed at TA-35 are within developed core habitat. None of these TAs falls within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 1998).

Construction Impacts—Although construction of some of the new facilities associated with the Radiological Sciences Institute would involve previously disturbed land, about 12.6 acres (5.1 hectares) of ponderosa pine forest at TA-48 and within the small area of TA-55 would be cleared (LANL 2006a). This would result in decreased less-mobile wildlife such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they move. If the area were at its carrying capacity, displaced animals would not likely survive. Indirect impacts of construction, such as noise or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. The work area would be clearly marked to prevent construction equipment and workers from disturbing adjacent natural habitat.

Construction of the Radiological Sciences Institute would not directly impact wetlands located in Mortandad Canyon or the small wetland situated between TA-48 and TA-55. Best management practices would reduce the potential for indirect impacts to wetlands at TA-48.

While there are no threatened or endangered species in the TA-48 area, portions of the TA are located within both the core and buffer zones of the Sandia-Mortandad Canyon and Pajarito Canyon Mexican spotted owl Areas of Environmental Interest. However, only a small portion of the Radiological Sciences Institute may be built within buffer habitat; most new structures would not be in core or buffer zones. Thus, the biological assessment prepared by DOE concluded that with the application of reasonable and prudent alternatives such as reseeding and erosion protection, the project may affect, but is not likely to adversely affect, the Mexican spotted owl (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any part of TA-48 or TA 55. Recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with construction of the Radiological Sciences Institute, the DOE biological assessment concluded that with appropriate reasonable and prudent alternatives (see Section G.2.3.2) the project may affect, but is not likely to adversely affect, the bald eagle. Since the nearest southwestern willow flycatcher Area of Environmental Interest is over 3 miles (4.8 kilometers) from the project site it was determined that there would be no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations Impacts—Operation of the Radiological Sciences Institute would have minimal impact on terrestrial resources within or adjacent to TA-48. Because the wildlife residing in the area has already adjusted to current levels of noise and human activity associated with current operation, it would not likely be adversely affected by similar types of activity involved with operation of the new facility. Areas not permanently disturbed by the new facility (for example, construction laydown areas) would be landscaped. While these areas would provide some habitat for wildlife, species composition and density would differ from preconstruction conditions.

DD&D Impacts—Removal of existing structures that the Radiological Sciences Institute is to replace would generate increased noise and levels of human disturbance. However, impacts would be temporary and would have minimal effect on wildlife, as these structures exist within disturbed areas and wildlife in adjacent areas is accustomed to human activity. Upon demolition of the buildings, the land would be revegetated and could be available for other uses. Because revegetation would primarily be for purposes of soil stabilization, there would be little benefit for wildlife. Also, if the land were redeveloped, there would be little change in its value as wildlife habitat; however, if development did not take place and native species were used in the revegetation effort, wildlife could benefit. Specific effects would depend on the nearness of existing development and natural habitat.

Since wetlands do not exist in the immediate area of any of the buildings to be removed in association with the new Radiological Sciences Institute, there would be no direct impacts on this resource. The use of best management practices would prevent erosion and subsequent sedimentation of any wetlands located in the canyons.

As noted above, of the buildings to be demolished in connection with the Radiological Sciences Institute, only those located in TA-35 occur within developed core habitat for the Mexican spotted owl. The removal of these buildings could produce noise greater than 6 decibels A-weighted (dB[A]) above background levels in undeveloped core habitat to the north in Mortandad Canyon. However, provided that reasonable and prudent alternatives are followed, the biological assessment concluded that demolition may affect, but is not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include muted back-up indicators on heavy equipment and reseeding and erosion protection. Also, activities involving heavy equipment would not be permitted to take place between March 1 and May 15, or until the completion of surveys for spotted owls. If owls were determined to be present, work restrictions would be extended until August 31. Potential impacts from DD&D activities to the bald eagle and southwestern willow flycatcher would not be expected (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to impacts to the Mexican spotted owl, bald eagle and southeastern willow flycatcher from building demolition (see Chapter 6, Section 6.5.2).

Human Health

Construction Impacts—No radiological risks would be incurred by members of the public from construction activities. Construction workers would be at a small risk for construction-related accidents and radiological exposures. They could receive doses above natural background radiation levels from exposure to radiation from other past or present activities at the site. Any contamination that might be present in the soil would have been determined during site characterization and cleaned up accordingly. Workers would be protected through appropriate training, monitoring, and management controls. Their exposure would be limited to ensure that doses were kept as low as reasonably achievable (ALARA).

The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 3.12 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be 35 (DOE 2004) to 132 (BLS 2003).

Operations Impacts—Radiological Sciences Institute operations would not exceed the combined current operational limits. **Table G–14** shows that the annual collective dose to the population living within a 50-mile (80-kilometer) radius of the new Radiological Sciences Institute at TA-48 would be 0.26 person-rem, far less than the total population dose (30 person-rem) from all Key Facilities at LANL. This population dose would result in no additional fatalities in the population.

Table G–14 Annual Radiological Impacts on the Public from Radiological Sciences Institute Operations [a]

	Population Dose within 50 Miles (80 kilometers)	*MEI Dose*	*MEI Location (feet)*
Dose	0.26 person-rem	0.077 millirem	NNE 2,920 Royal Crest Trailer Park
Cancer fatality risk [b]	0.00016	4.6×10^{-8}	–
Regulatory dose limit [c]	Not applicable	10 millirem	–
Background radiation dose [d]	120,000 person-rem	400 millirem	–

MEI = maximally exposed individual.
[a] The stack parameters were conservative estimates used for the purpose of calculating a dose. A stack height of 10 meters, diameter of 1 meter, and exit velocity of 1 meter per second were used.
[b] Based on a risk estimate of 0.0006 LCFs per person-rem (see Appendix C of this SWEIS).
[c] 40 CFR Part 61 establishes an annual dose limit of 10 millirem via the air pathway to any member of the public from DOE operations. There is no standard for a population dose.
[d] The annual individual dose from background radiation at LANL ranges from a low of about 300 millirem to a high of about 500 millirem (see Appendix C of this SWEIS). The population living within 50 miles (80 kilometers) of TA-48 was estimated to be 299,508 in 2000.
Note: To convert feet to meters, multiply by 0.3048.

An MEI is a hypothetical member of the public residing at the LANL site boundary who would receive the maximum dose. The MEI, located at the Royal Crest Trailer Park, would receive an estimated annual dose of 0.077 millirem from Radiological Sciences Institute operations, as shown in Table G–14. This dose corresponds to an increased annual risk of developing a fatal cancer of 4.6×10^{-8}, or about 1 chance in 22 million for each year of operation.

Depending on the new facility layouts and consolidation of activities, the worker doses may vary from those at the existing facilities. Worker doses would be similar to those under the No Action Option or potentially less due to the improved facility design.

Neither additional chemicals nor an increase in chemical inventories is expected over those associated with current operating levels at the proposed new facility. Therefore, there would be no chemical-related health impacts on workers or the public expected under this option. The quantities of most chemicals that could be released to the atmosphere during routine normal operations are minor and would be below screening levels used to determine the need for additional analysis.

DD&D Impacts—Nonradiological DD&D health impacts could include construction-type injuries and possible fatalities. Based on an estimated 1 million person-hours for DD&D of the existing facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be 12 (DOE 2004) to 45 (BLS 2003).

Demolition of the buildings might also involve removal of some asbestos-contaminated material. Removal of this material would be conducted according to existing asbestos management programs at LANL in compliance with strict asbestos abatement guidelines. Workers would be protected by personal protective equipment and other engineered and administrative controls, and no asbestos would be released that could be inhaled by members of the public.

Potential radiological DD&D health impacts were evaluated for members of the public and workers. The main radiological impacts would result from DD&D of the Sigma Complex (TA-3-66), Machine Shop (Building TA-3-102), and Radiochemistry site (TA-48). Quantitative information has not been presented, as project-specific work plans have not been prepared nor have the buildings in question been completely characterized with regard to types and locations of contamination. The Chemistry and Metallurgy Research Building Wing 9 was not included in the DD&D analysis, as it has previously been considered in a prior NEPA compliance document (DOE 2003). In addition, DD&D impacts of other partial buildings were not included. In addition to those listed above, several other buildings were reviewed with regard to health impacts because they were monitored for radiological air emissions in the past, currently house radiological sources, or have potential for radiological air emissions based on past functions. The review indicated that there would be no health impacts of their DD&D on members of the public or workers.

During early DD&D stages, when interior equipment is being removed from the buildings in question, doses to the public would be comparable to or less than those estimated for normal operation (see Table G–6). The building structures would be intact, with operating filtering systems for the stacks, while the decontamination and decommissioning were taking place. No additional nuclides would be introduced during these stages. Worker doses during decontamination and equipment removal may be higher than during normal operations but would be managed to remain under the DOE Administrative Control Level of 2,000 millirem per year and ALARA (DOE 1999b).

The primary source of potential consequences to workers and members of the public would be associated with the release of radiological air emissions during the demolition stage. Any radiological air emissions would be reduced by plastic draping and an enclosure, coupled with HEPA filters. Potential releases of radioactive particulates from disposition activities are expected to be lower than releases from past normal operations.

Cultural Resources

Surveys have identified two archaeological resource sites within TA-48, both of which are eligible for the National Register of Historic Places. The prehistoric site is a one- to three-room structure, whereas the historic site is a rock and wood enclosure. Additionally, the Radiochemistry Building and a number of other buildings have been determined to be potentially significant historic buildings. However, none of the buildings or structures have been formally evaluated for National Register of Historic Places eligibility status, and are, therefore, considered eligible and managed as such until a formal assessment determination has been made. There are no cultural resource sites in the small area of TA-55 that could be affected by the proposed Radiological Sciences Complex.

Four of the five TAs where structures would be removed as a part of the proposed project contain cultural resource sites. These are briefly summarized in **Table G–15**.

Table G–15 Affected Cultural Resource Sites – Radiological Sciences Institute

Technical Area	*Number of Cultural Resource Sites*	*Types of Resources Present*	*National Register of Historic Places Eligibility* [a]
3	8	Lithic scatter; trail and stairs; wagon road	3/2
18	3	Cavates; historic structure; rock shelter	3/0
35	0		
46	19	Pueblo roomblocks; lithic and ceramic scatters, one- to three-room structures, wagon road, cavates	9/2
59	1	Wagon road	0/0

[a] Number of sites that are eligible (the first number) or undetermined eligibility (the second number).

Traditional cultural properties are properties that are eligible for the National Register of Historic Places because of their association with cultural practices or beliefs of a living community that are (1) rooted in that community's history, and (2) important in maintaining its cultural identity. Consultations to identify traditional cultural properties were conducted with 19 American Indian tribes and 2 Hispanic communities in connection with the preparation of the *1999 SWEIS* (DOE 1999a). As noted in Section 4.7.3 of this SWEIS, traditional cultural properties are present throughout LANL and adjacent lands; however, to protect such sites specific features or locations are not identified (Knight and Masse 2001). Traditional cultural properties are not expected in developed areas of any TA involved in the Radiological Sciences Institute Project.

Construction Impacts—New construction in the area of the prehistoric or historic sites would require that the site boundaries be marked and fenced. Fencing would prevent accidental intrusion and disturbance to the site(s). If either of the two National Register of Historic Places-eligible prehistoric or historic sites could not be avoided by the proposed construction activities and protected by fencing, then a data recovery plan would need to be prepared and site excavation conducted prior to construction.

Radiological Sciences Institute construction and operation impacts on traditional cultural properties are unlikely, as most development would take place within previously disturbed portions of TA-48. Also, because the site would remain developed, potential views of TA-48 from any traditional cultural properties located in the vicinity would remain largely unchanged.

DD&D Impacts—Before demolition could begin on parts of the Radiochemistry Building or structures within TA-3, TA-18, TA-35, TA-46, and TA-59, a cultural resources assessment would be performed, as well as any subsequent compliance requiring documentation. NNSA, in conjunction with the State Historic Preservation Office, would implement documentation measures such as preparing a detailed report containing the history and description of the affected properties. These measures would be incorporated into a formal memorandum of agreement between NNSA and the New Mexico Historic Preservation Division to resolve adverse effects on eligible properties. The Advisory Council on Historic Preservation would be notified of the memorandum of agreement and would have an opportunity to comment. DD&D of buildings to be replaced by the new Radiological Sciences Institute would not impact traditional cultural properties, as all are located within developed portions of LANL.

Socioeconomics and Infrastructure

Construction Impacts—Utility infrastructure resources would be required for construction of the new Radiological Sciences Institute. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be a limited resource. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would be trucked to the point of use, rather than provided by a temporary service connection.

For construction of all 13 buildings, total liquid fuel consumption is estimated to be 4.2 million gallons (16 million liters). Total water consumption is estimated to be 22.4 million gallons (85 million liters). The existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure.

Operations Impacts—No net increase in utility infrastructure demands for operation of the new Radiological Sciences Institute is expected, as its operational demands with more resource-efficient utility systems would be equal to or less than those of the facilities that the new Radiological Sciences Institute would replace. As such, operation of the Radiological Sciences Institute is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the Radiological Sciences Institute are projected to require 101,000 gallons (384,000 liters) of liquid fuels and 3.1 million gallons (12 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, annual impacts of these activities on LANL's utility infrastructure would be minimal. Standard practice dictates that utility systems serving individual facilities be shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities.

Waste Management

The Radiochemistry Facility at TA-48 currently generates sanitary wastes, liquid radioactive wastes, and solid radioactive (low-level and transuranic) and chemical wastes, including mixed wastes. Sanitary wastes are delivered by a dedicated pipeline to the sanitary wastewater systems plant at TA-46. Radioactive liquid wastes are transported via dedicated piping to the Radioactive Liquid Waste Treatment Facility at TA-50. Low-level radioactive wastes are disposed of at

TA-54; all other radioactive, chemical, and mixed wastes are sent off site for treatment or disposal. Historical chemical and radioactive waste generation information is provided in **Table G–16** for TA-48. Table G–16 also includes historical waste generation information for the Sigma Complex, the Machine Shops, and those activities at the Pajarito Site that may be transferred to TA-48.

Table G–16 Waste Generation for the Radiochemistry Facility, Pajarito Site, Sigma Complex, and Machine Shops at Technical Area 3 (1998 to 2003)

		Radiochemistry Facility TA-48	*Pajarito Site TA-18* [a]	*Sigma Complex TA-3*	*Machine Shops TA-3* [b]
Transuranic waste (cubic yards)	Range	0 to 2	0 to 0	0 to 0	0 to 0
	Average	less than 1	0	0	0
Low-level radioactive waste (cubic yards)	Range	23 to 102	0 to 41	less than 1 to 264	20 to 535
	Average	58	13	94	127
Mixed low-level radioactive waste (cubic yards)	Range	less than 1 to 8	0 to 10	0 to 7	0 to less than 1
	Average	3	1	1	less than 1
Chemical waste (pounds)	Range	3,340 to 410,350	0 to 3,760	1,940 to 71,420	340 to 58,370
	Average	80,020	650	26,120	10,800

TA = technical area.

[a] TA-18 waste data include data for SHEBA which would not be moved to the Radiological Sciences Institute. Therefore, data presented for TA-18 are conservative (high) estimates of waste quantities.

[b] The Machine Shops data were compiled jointly for two buildings, the Nonhazardous Materials Machine Shop (Building 03-39) and the Radiological Hazardous Materials Machine Shop (Building 03-102). Only activities from Building 03-102 would be transferred to the Radiological Sciences Institute. Therefore, the values shown are conservative estimates of waste management impacts on the affected environment.

Note: To convert cubic yards to cubic meters, multiply by 0.76455; pounds to kilograms, by 0.4536.

Sources: LANL 2003b, 2004d, 2005c, 2006f.

Construction Impacts—Radiological Sciences Institute construction would generate approximately 2,800 cubic yards (2,100 cubic meters) of waste, primarily construction debris and associated solid waste. Construction debris is not hazardous and may be disposed of in a solid waste landfill. Recent LANL tracking and projection efforts have identified construction and demolition debris as a separate category of nonroutine sanitary (solid) waste. A substantial portion of construction debris at LANL is routinely recycled; in 2003, approximately 89 percent of the uncontaminated construction and demolition debris was recycled, and those rates are expected to continue (LANL 2004d).

Operations Impacts—Radiological Sciences Institute operations are expected to generate sanitary wastes, liquid radioactive wastes, and solid radioactive (low-level and transuranic) and chemical wastes, including mixed wastes. Because the Radiological Sciences Institute would be a new facility, design features would minimize wastes through enhanced processing, avoidance of cross-contamination, and nonhazardous product substitutions. Sanitary wastes would be delivered by dedicated pipeline to the Sanitary Wastewater Systems Plant at TA-46. Radioactive liquid wastes would be transported via dedicated piping to the Radioactive Liquid Waste Treatment Facility at TA-50. Other radioactive and chemical wastes would be managed at the waste management facilities or to a centralized waste storage facility within the Radiological Sciences Institute, where wastes may be stored for less than 90 days. Low-level radioactive wastes would be disposed of at TA-54 or at an offsite facility; all other radioactive and chemical wastes would be sent off site for treatment or disposal.

Because the Radiological Sciences Institute would consolidate operations already under way at the Radiochemistry Facility, Sigma Complex, Pajarito Site (TA-18), and Machine Shops (Building 03-102 only), the same general level of waste generation is expected to continue. Estimates of future waste generation rates were calculated based on historical rates and planned process improvements.

Projected discharge volumes of radioactive liquids are 845,000 gallons (3.2 million liters) per year (LANL 2006a). Chemical waste generation rates are expected to be 31,000 pounds (14,000 kilograms) per year. Low-level radioactive waste generation rates are estimated to be 157 cubic yards (120 cubic meters) per year. Mixed low-level and transuranic waste, including mixed transuranic waste; generation rates are expected to be very low, approximately 1.3 cubic yards (1 cubic meter) per year for each category (LANL 2006a).

DD&D Impacts—DD&D activities are expected to generate significant quantities of debris, including some radioactively contaminated debris. With the exception of low-level radioactive waste, most DD&D waste would be transferred to appropriate offsite treatment, recycling, or disposal facilities. **Table G–17** lists potential DD&D waste volumes from facilities that would be replaced by the Radiological Sciences Institute. Uncontaminated demolition debris may be recycled at on or offsite facilities. Chemical and radioactive wastes generated through decontamination processes would be managed at the waste management facilities. The large quantity of low-level radioactive waste may be disposed of on site or sent to an offsite facility. Solid wastes would be transferred to a permitted municipal landfill.

Table G–17 Decontamination, Decommissioning, and Demolition Waste Volumes for Buildings to be Replaced by the Radiological Sciences Institute

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste [a]	95,700
Mixed low-level radioactive waste	1,020
Remote-handled low-level radioactive waste	479
Contact-handled transuranic waste	1,130
Remote-handled transuranic waste	11
Demolition debris [b]	76,800
Hazardous waste with asbestos	605
Solid hazardous waste with organics	9
Solid hazardous waste with metals	373

DD&D = decontamination, decommissioning, and demolition.
[a] Consists of 71,800 cubic yards (54,900 cubic meters) of bulk waste, 23,500 cubic yards (18,000 cubic meters) of packaged waste, and 479 cubic yards (366 cubic meters) of remote-handled waste.
[b] Demolition waste includes solid and sanitary wastes.
Note: To convert cubic yards to cubic meters, multiply by 0.76455.

Transportation

Pajarito Road would provide access to the Radiological Sciences Institute.

Construction Impacts—Traffic on Pajarito Road could be disrupted due to temporary increases during construction.

Operations Impacts—Under the proposed project, interstate waste transportation would decrease over the long term. However, local traffic would increase.

DD&D Impacts—The large amounts of waste generated by Radiological Sciences Institute DD&D activities would have to be transported to storage or disposal sites using over-the-road truck transportation. These sites could be LANL TA-54 or an offsite location. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported along the routes and highways. Traffic accidents could result both in injuries or deaths from collisions and in an additional radiological dose to the public from radioactivity that may be released during the accident.

The effects of incident-free transportation of construction and DD&D wastes on the worker population and general public are presented in **Table G–18**. Effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project, estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed.

Table G–18 Incident-Free Transportation Impacts – Radiological Sciences Institute

Disposal Option	Low-Level Radioactive Waste Disposal Location [a]	Crew		Public	
		Collective Dose (person-rem)	Risk (LCF)	Collective Dose (person-rem)	Risk (LCF)
Onsite disposal	LANL TA-54	3.56	0.0021	1.06	0.00064
Offsite disposition	Nevada Test Site	31.34	0.0188	8.90	0.0053
	Commercial Facility	30.0	0.018	8.62	0.0052

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes would be disposed of at the Waste Isolation Pilot Plant (WIPP).

The risk of development of excess LCFs is highest for the workers under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–18, disposal of low-level radioactive waste at the Nevada Test Site, which is located farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low for all disposal options. **Table G–19** presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents from both the collisions themselves and from excess LCFs from exposure to releases of radioactivity. The analyses assumed that all transuranic and nonradioactive wastes would be transported to offsite disposal facilities.

Because all estimated LCFs and traffic fatalities, as shown in Tables G–18 and G–19, are much less than 1.0, the analysis indicates that no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from traffic collisions and accidental release.

Table G–19 Transportation Accident Impacts – Radiological Sciences Institute

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	10,469	2.20	4.2×10^{-9}	0.027
Nevada Test Site	10,469	17.03	5.1×10^{-6}	0.174
Commercial facility	10,469	15.54	4.9×10^{-6}	0.158

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported offsite.
[b] Transuranic wastes would be disposed of at WIPP.
[c] Approximately 58.7 percent of shipments are radioactive wastes. Others include 41 percent industrial and sanitary waste and about 0.6 percent asbestos and hazardous wastes.
Note: To convert kilometers to miles, multiply by 0.6214.

Facility Accidents

Operations Impacts—Potential accidents that might occur at the proposed Radiological Sciences Institute that are estimated to have the highest impacts would involve radiological operations and materials that were transferred from Chemistry and Metallurgy Research Wing 9 hot cell operations. Six accident scenarios were selected to represent the bounding impacts of accidents at the Radiological Sciences Institute. Information used to estimate the impacts of these accidents is shown in **Table G–20**. The material at risk in a hot cell is estimated to be 10.6 ounces (300 grams) of plutonium-238 equivalent and an additional 2.2 pounds (1 kilogram) of plutonium-239. The new Radiological Sciences Institute vault is assumed to contain this same entire inventory.

Table G–20 Bounding Radiological Accident Scenarios – Radiological Sciences Institute

Accident	*Source Term* [a] *(plutonium-238 curies)*	*Release Energy (watts)*	*Annual Frequency*
Hot cell fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238	2.04×10^{6}	0.0001
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	22.572 plutonium-238 1.386 plutonium-239	2.04×10^{6}	2.4×10^{-5}
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	5.13 plutonium-238 0.315 plutonium-239	0	0.00024
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.001283 plutonium-238	0	0.1
Hot cell plutonium-238 spill with no confinement	0.4104	0	0.01
Main vault fire	10.26 plutonium-238 0.126 plutonium-239	2.04×10^{6}	$<1 \times 10^{-6}$

[a.] A release height of 4.9 feet (1.5 meters) is assumed for all accidents. Specific activity is 0.063 curies per gram for plutonium-239 and 17.1 curies per gram for plutonium-238.

Assuming that an accident occurred, estimated consequences for a noninvolved worker located 330 feet (100 meters) from the accident, the MEI located at the trailer park, and the offsite population are shown in **Tables G–21** and **G–22**. Estimated risks that take accident frequency into account to these same receptors are shown in **Table G–23**.

Table G–21 Radiological Accident Offsite Consequences – Radiological Sciences Institute

Accident	*MEI*		*Population to 50 Miles (80 kilometers)* [b, c]	
	Dose (rem)	*LCF* [a]	*Dose (person-rem)*	*LCF*
Hot cell fire involving plutonium-238 in general purpose heat source modules	6.31	0.0038	2,770	1.7
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	29.6	0.036	13,000	7.8
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	19.4	0.012	4,650	2.8
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.0066	4.0×10^{-6}	1.1	0.00065
Hot cell plutonium-238 spill with no confinement	2.12	0.0013	350	0.21
Main vault fire	12.8	0.0077	5,620	3.4

MEI = maximally exposed individual, LCF = latent cancer fatality.
[a] Increased risk of an LCF to an individual per year.
[b] Increased number of LCFs for the offsite population per year.
[c] Offsite population size is approximately 300,000 persons located within a 50-mile (80-kilometer) radius.

Table G–22 Radiological Accident Onsite Worker Consequences – Radiological Sciences Institute

Accident	*Noninvolved Worker at 330 Feet (100 meters)*	
	Dose (rem)	*LCF* [a]
Hot cell fire involving plutonium-238 in general purpose heat source modules	32.5	0.039
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules	152	0.18
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules	171	0.21
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	0.045	2.7×10^{-5}
Hot cell plutonium-238 spill with no confinement	14.3	0.0086
Main vault fire	65.9	0.079

LCF = latent cancer fatality.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.

The accident scenarios with the potential for the highest radiological impacts to the MEI are the seismic-induced building collapse with no fire and the seismic-induced building collapse with a fire involving plutonium-238 in general purpose heat source modules. If either of these accidents were to occur, the consequences are estimated to be 2.8 or 7.8 increased LCFs for the offsite population, 0.012 or 0.036 increased risk of LCFs for the MEI, and 0.21 or 0.18 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident, respectively. After taking into account the frequency (or probability) of each accident, the hot cell plutonium-238 spill with no confinement is estimated to have the highest risks. For this accident, the annual risks are estimated to be 0.0021 LCFs (1 chance in 480) for the offsite population, 1.3×10^{-5} increased risk (1 chance in 77,000) of LCFs for the MEI, and 8.6×10^{-5} increased risk (1 chance in 12,000) of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident.

Table G–23 Radiological Accident Offsite Population and Worker Risks – Radiological Sciences Institute

Accident	Onsite Worker (LCFs)	Offsite Population (LCFs)	
	Noninvolved Worker at 330 Feet (100 meters) [a]	*MEI* [a]	*Population to 50 Miles (80 kilometers)* [b, c]
Hot cell fire involving plutonium-238 in general purpose heat source modules	3.9×10^{-6}	3.8×10^{-7}	0.00017
Seismic-induced building collapse and fire involving plutonium-238 in general purpose heat source modules [d]	4.4×10^{-6}	8.5×10^{-7}	0.00019
Seismic-induced building collapse with no fire involving plutonium-238 in general purpose heat source modules [d]	4.9×10^{-5}	2.8×10^{-6}	0.00067
Spill of plutonium-238 residue from 0.5-gallon (2-liter) bottles outside of hot cell	2.7×10^{-6}	4.0×10^{-7}	6.5×10^{-5}
Hot cell plutonium-238 spill with no confinement	8.6×10^{-5}	1.3×10^{-5}	0.0021
Main vault fire	$< 7.9 \times 10^{-8}$	$< 7.7 \times 10^{-9}$	$< 3.4 \times 10^{-6}$

LCF = latent cancer fatality, MEI = maximally exposed individual.
[a] Increased risk of an LCF to an individual per year.
[b] Increased number of LCFs for the offsite population per year.
[c] Offsite population size is approximately 300,000 persons located within a 50-mile (80-kilometer) radius.
[c] An updated probabilistic seismic hazard analysis has been completed for LANL (LANL 2007), which results in higher peak horizontal ground acceleration values for the same annual probability of exceedance. In the seismic accident analyses for the Radiological Sciences Institute, the radioactive source term was conservatively based on the assumption that all structures, systems, and components failed, therefore, the updated probabilistic seismic hazard analysis is not expected to change the accident consequences or risks.

Seismic accidents considered for the proposed Radiological Sciences Institute are estimated to have a probability of release of 0.1 (the same as at the Chemistry and Metallurgy Research Building); the Radiological Sciences Institute would be designed to withstand the evaluation-basis earthquake. In comparing a seismic accident scenario that includes a fire with one that does not include a fire, both located within the Radiological Sciences Institute, the former has higher potential for causing offsite population and MEI impacts, while the latter has higher individual worker impacts. This is because the buoyant effects of a fire loft the radioactive plume over the onsite workers, while the greater releases associated with this scenario would impact the general population farther downwind. In contrast, the absence of a fire and its buoyant effects has a greater impact on close-in individuals like the noninvolved worker at 330 feet (100 meters) and the nearby worker population.

G.4 Radioactive Liquid Waste Treatment Facility Upgrade Impact Assessment

This section provides an assessment of environmental impacts for the proposed Radioactive Liquid Waste Treatment Facility Upgrade. Section G.4.1 provides background information on the proposed project. Section G.4.2 provides a description of the proposed options for the Radioactive Liquid Waste Treatment Facility Upgrade. Section G.4.3 presents environmental consequences of the No Action Option and project options for the Radioactive Liquid Waste Treatment Facility Upgrade. The main volume of this SWEIS contains information about the general environmental setting of LANL and environmental impacts associated with continued operations of the site.

G.4.1 Introduction

The Radioactive Liquid Waste Treatment Facility treats radioactive liquid wastes generated at other LANL facilities and houses analytical laboratories supporting waste treatment operations. The principal capabilities and activities conducted at the Radioactive Liquid Waste Treatment Facility include: (1) waste characterization and packaging, including identification and quantification of constituents of concern in waste streams and packaging and labeling waste according to U.S. Department of Transportation regulations; (2) waste transportation including inspection and cross-checking for acceptance; (3) liquid and solid chemical materials and radioactive waste storage; (4) waste pretreatment; (5) radiological liquid waste treatment using a number of treatment processes, including ultrafiltration and reverse osmosis; and (6) secondary waste treatment.

The original Radioactive Liquid Waste Treatment Facility (Building 50-1) as shown in **Figure G–4** was constructed in 1963. Between 1963 and 1986, three annexes were attached to the north, south, and east sides of the original building. With the addition of these annexes, the current facility has a total floor area of approximately 42,300 square feet (3,900 square meters). The North Annex has a footprint of about 5,000 square feet (450 square meters); the East Annex has a footprint of about 7,000 square feet (630 square meters); and the South Annex has a footprint of about 7,500 (700 square meters).

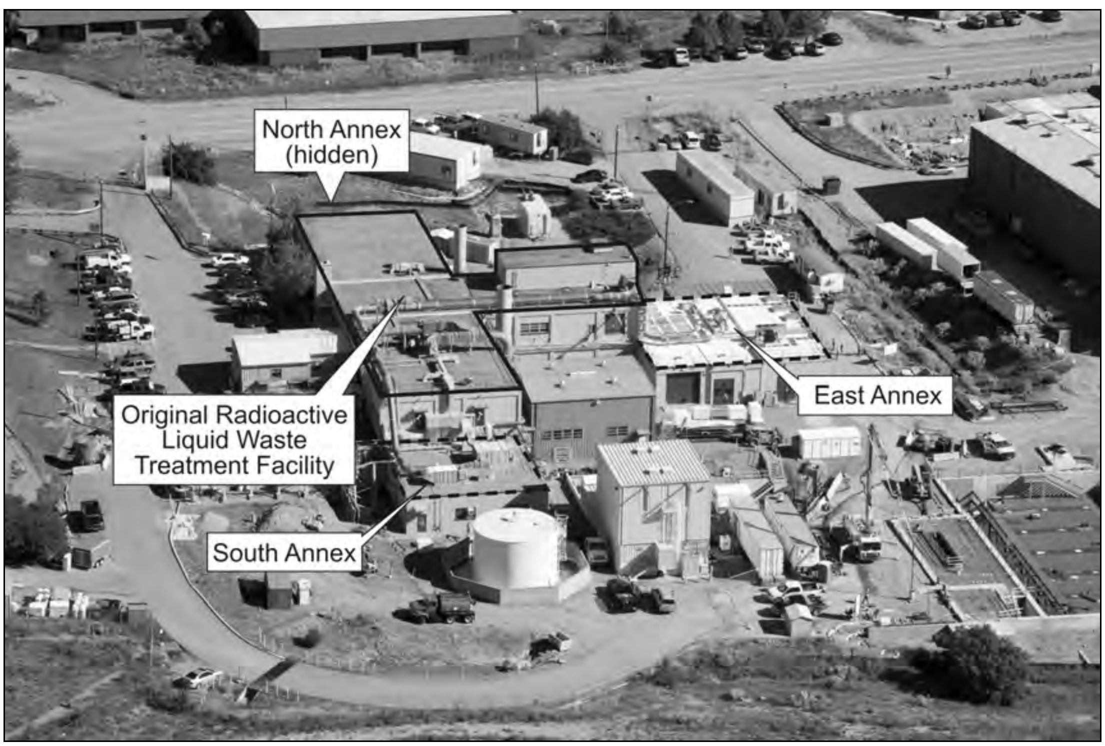


Figure G–4 Existing Radioactive Liquid Waste Treatment Facility

The Radioactive Liquid Waste Treatment Facility is the only facility available at LANL to treat a broad range of transuranic liquid wastes and low-level radioactive liquid waste. However, the ability of this facility to operate reliably is becoming increasingly uncertain. The original building is over 40 years old and has exceeded its design life. Similarly, the clarifiers, rotary vacuum filter, and heating, ventilation, and air conditioning systems, installed in 1963, are also over 40 years old. The infrastructure and treatment equipment require increasing maintenance attention to keep them operational, and replacement parts are increasingly difficult to acquire; replacement components for some older systems are no longer commercially produced. Corrosion of pipes and tanks has resulted in leaks. Radioactive Liquid Waste Treatment Facility materials and components are failing with increased frequency, and key systems could potentially fail within the next 5 to 10 years.

The current Radioactive Liquid Waste Treatment Facility treats all liquid radioactive waste generated at LANL except for that generated at TA-53 and occasionally that from TA-21. A system of pipes collects radioactive wastewater from various facilities, such as the Plutonium Facility at TA-55 and the Chemistry and Metallurgy Research Facility at TA-3, and transfers the wastewater to influent tanks at the Radioactive Liquid Waste Treatment Facility. In a few cases, trucks bring radioactive wastewater from other facilities to the Radioactive Liquid Waste Treatment Facility.

The influent waste stream contains two types of radioactive components: (1) tritiated water, and (2) radioactive solids that are either dissolved or suspended in the liquid. The existing and the proposed Radioactive Liquid Waste Treatment Facility treatment processes are designed to treat the dissolved or suspended solids, but are not able to extract tritiated water. Tritiated wastewater is discharged via a permitted outfall if it meets discharge criteria or is trucked to TA-53's evaporation ponds if it exceeds discharge criteria. Tritiated wastewater has not been trucked to the TA-53 evaporation ponds since 2003.

Although the treatment processes cannot remove tritiated water, they do extract suspended and dissolved radioactive solids from the liquid waste and concentrate the solids by removing additional liquid. The treated liquid is either returned to the low-level radioactive waste influent tank or released to a permitted outfall in Mortandad Canyon. Solid radioactive waste is placed in 55-gallon (208-liter) drums. Drums of solids that meet the waste acceptance criterion regarding liquid content are trucked to TA-54 for storage or disposal. Concentrated liquids resulting from the evaporator portion of the treatment process are sent by truck to a permitted commercial treatment facility in Tennessee for drying, a trip of about 1,400 miles (2,700 kilometers). Typically, about six shipments are made each year. The treatment facility returns the dried solids to TA-54. Drums of solidified transuranic waste from liquid treatment are stored at TA-54 pending preparation for shipment to WIPP near Carlsbad, New Mexico; low-level radioactive waste is disposed of in TA-54.

Future preparation of transuranic waste for shipment is expected to occur in a new TRU (Transuranic) Waste Facility in TA-54 (Appendix H, Section H.3.2.2.2). Some of the functions needed for preparation of transuranic waste from the Radioactive Liquid Waste Treatment Facility may be optionally duplicated in a separate structure co-located with the Radioactive Liquid Waste Treatment Facility. The environmental analysis conducted for the TRU Waste Facility bounds this possibility.

Because many treatment processes work best with water that contains certain ranges of minerals and chemicals and with certain quantities of water, design of the new facility would consider historical usage and future mission requirements. The lower-bound waste volumes assume the generators of radioactive wastewater implement various waste minimization and pollution prevention projects. Calculations of the upper-bound waste volumes assume these waste minimization and pollution prevention projects do not occur and changes in LANL's mission (in particular an increase in pit production up to 80 pits per year) would result in generation of more radioactive wastewater. **Table G–24** shows the quantities of wastewater that the new facilities would be designed to process annually. Upper-bound quantities would be about twice as large.

Table G–24 Design Basis Influent Volumes – Radioactive Liquid Waste Treatment Facility Upgrade

Influent	*Lower Bound (gallons per year)*
Low-level radioactive waste	2,507,000
Acidic transuranic waste	3,700
Caustic transuranic waste	2,600

Note: To convert gallons to liters, multiply by 3.7854.

G.4.2 Options Considered

For the Radioactive Liquid Waste Treatment Facility Upgrade, one No Action Option (see Section G.4.2.1) and three action options (see Sections G.4.2.2, G.4.2.3, and G.4.2.4) are proposed to address facility needs. Additionally, two auxiliary actions to reduce or eliminate the discharge are also proposed (see Section G.4.2.5). The auxiliary actions (evaporation tanks or mechanical evaporation) may be incorporated as part of the No Action Option or any of the three action options. Section G.4.2.6 presents options considered, but dismissed.

G.4.2.1 No Action Option

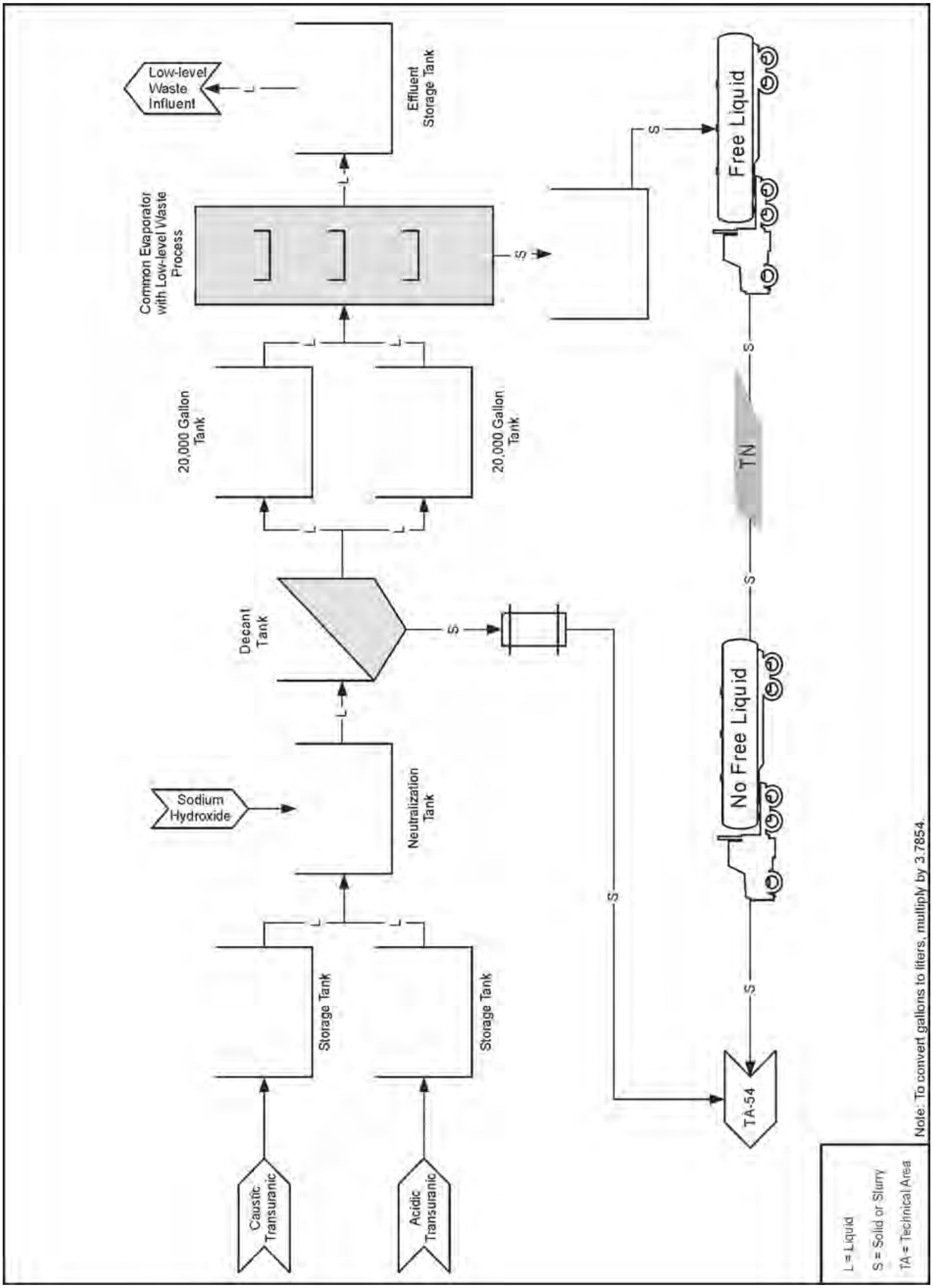
Under the No Action Option, the Radioactive Liquid Waste Treatment Facility would continue to process transuranic and low-level radioactive wastewater in the existing building. No new construction would occur. The annexes to the original Radioactive Liquid Waste Treatment Facility, which do not meet seismic and wind-loading standards, would not be removed. No existing contaminated materials would be removed. Existing processes would continue to treat liquid transuranic waste and liquid low-level radioactive wastes separately. Treatment processes would result in generation of transuranic sludge, low-level radioactive waste sludge, solid low-level radioactive waste, secondary liquid low-level radioactive wastes (evaporator bottoms), and treated effluent. The transuranic sludge would be solidified (cemented), then transported to TA-54 for storage, characterization, and shipment to WIPP for disposal. The low-level radioactive waste sludge would be dewatered, packaged, and shipped to TA-54 for disposal. Solid low-level radioactive wastes would be packaged and shipped to TA-54 for disposal. Secondary liquid low-level radioactive wastes would be transported by truck to an offsite treatment plant where it would be dried, and the resultant solids would be returned to LANL for disposal at TA-54 as solid low-level radioactive wastes, if it meets waste acceptance criteria. Optionally, effluent from the existing facility could be evaporated as discussed in Section G.4.2.5. The existing treatment processes for transuranic waste are shown in **Figure G–5**.

Under the No Action Option, LANL staff would continue to perform routine repairs, safety improvements, and replacement-in-kind of equipment on an as-needed basis. LANL would continue to meet current discharge standards, but may not be able to meet future discharge standards if they become more stringent and the auxiliary actions are not implemented. The existing Radioactive Liquid Waste Treatment Facility would continue to process radioactive liquid wastes until key systems irreparably fail or until the facility can no longer meet discharge standards. System failure or failure to meet discharge standards is estimated to occur sometime within the next 10 years. Therefore, this No Action Option does not meet NNSA's purpose and need to maintain treatment capability at LANL for 50 years.

G.4.2.2 Option 1: Single Liquid Waste Treatment Building Option – Proposed Project

Under the proposed project, NNSA would construct new low-level radioactive waste and transuranic liquid waste treatment facilities to achieve greater reliability, redundancy, and flexibility. A new waste treatment building would have a footprint of about 10,800 square feet (1,000 square meters). The building would consist of a partially below-grade basement, a main floor, and a mezzanine for a total area of 20,700 square feet (1,923 square meters), and would be accompanied by a new central utilities building. NNSA would also modify low-level radioactive and transuranic waste processes to become more effective and better able to incorporate future technology. Portions of the existing Radioactive Liquid Waste Treatment Facility, as described below, would be demolished. The existing facility would not be renovated but would continue to be used for offices and chemical analyses. New equipment would be purchased; some existing equipment may be used to supplement the new equipment and to provide redundancy. Additionally, either one of the auxiliary actions (evaporation tanks or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

The proposed location of the single new low-level radioactive waste and transuranic facility is west of the existing Radioactive Liquid Waste Treatment Facility in an existing parking area (see **Figure G–6**). The building would be sited near the point where transuranic waste lines enter TA-50 to minimize the distance this wastewater must flow to reach the treatment facility. NNSA would conduct DD&D of the East Annex. The existing transuranic storage tank vault (TA-50-66) and the transformer on the north side of the existing Radioactive Liquid Waste Treatment Facility would also be demolished. Some wastewater collection pipes and utilities in the immediate vicinity of the Radioactive Liquid Waste Treatment Facility may be rerouted. Some remediation of contaminated soils would be required.



Note: To convert gallons to liters, multiply by 3.7854.

Figure G–5 Existing Treatment Processes for Transuranic Waste

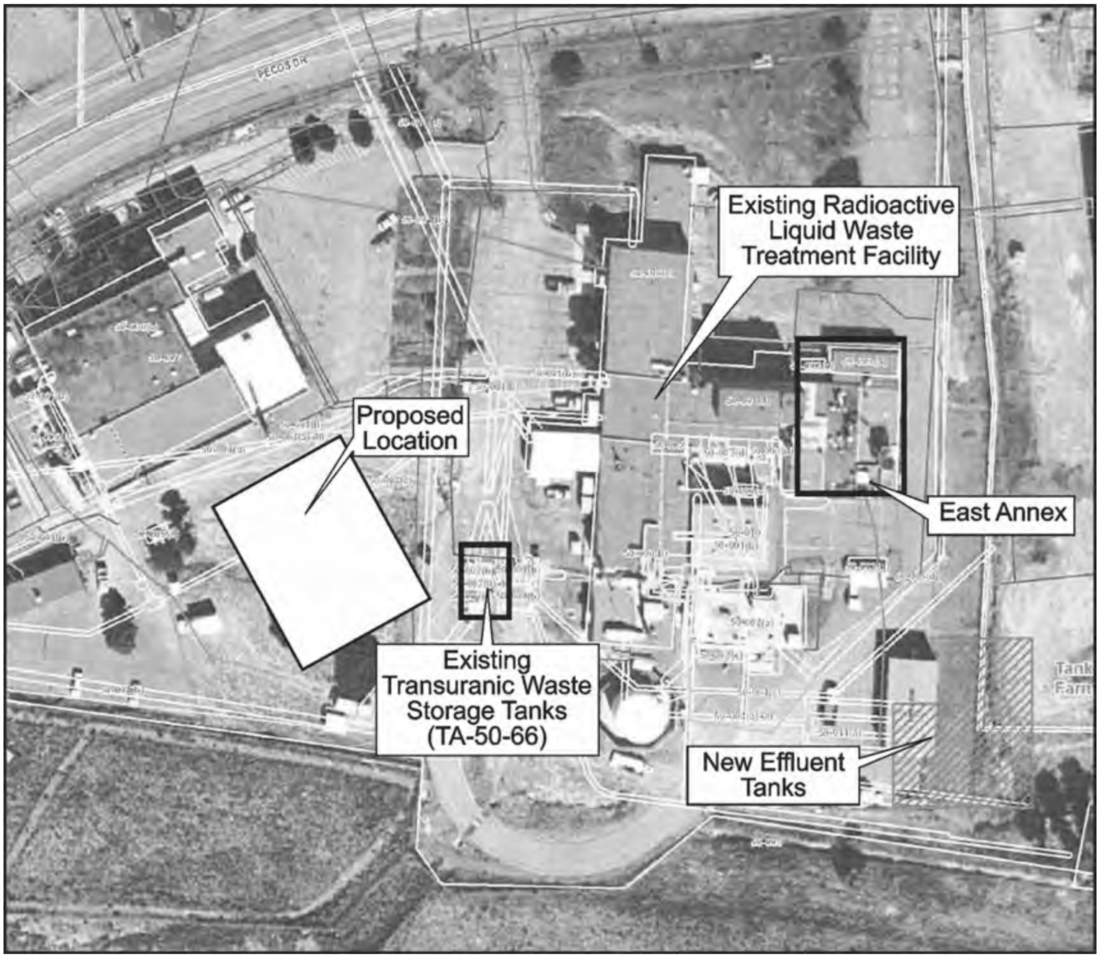


Figure G–6 Proposed Project Location

The proposed low-level radioactive waste treatment process consists of removing suspended and dissolved solids from the liquid waste stream, concentrating the solid waste stream by removing additional liquid, packaging the resulting solid radioactive waste, and ultimately releasing the remaining liquids to a permitted outfall or to evaporative processes. **Figure G–7** shows the proposed low-level radioactive waste treatment process. This process would receive waste via pipeline from the low-level radioactive waste influent tanks and distillate from the transuranic waste treatment process. Some industrial wastewater that cannot be treated by other LANL wastewater treatment systems may also be treated (LANL 2005e). In a typical year, the system could receive approximately 2.5 million gallons (9.5 million liters) of liquid low-level radioactive waste, although the upper bound influent volume may be up to 5 million gallons (20 million liters). The proposed transuranic waste treatment process is shown in **Figure G–8**. The transuranic influent tanks can store approximately 25,000 gallons (96,000 liters) per year of transuranic acid wastewater and 9,000 gallons (34,000 liters) per year of transuranic caustic wastewater. Redundant tanks would handle overflows and drainage.

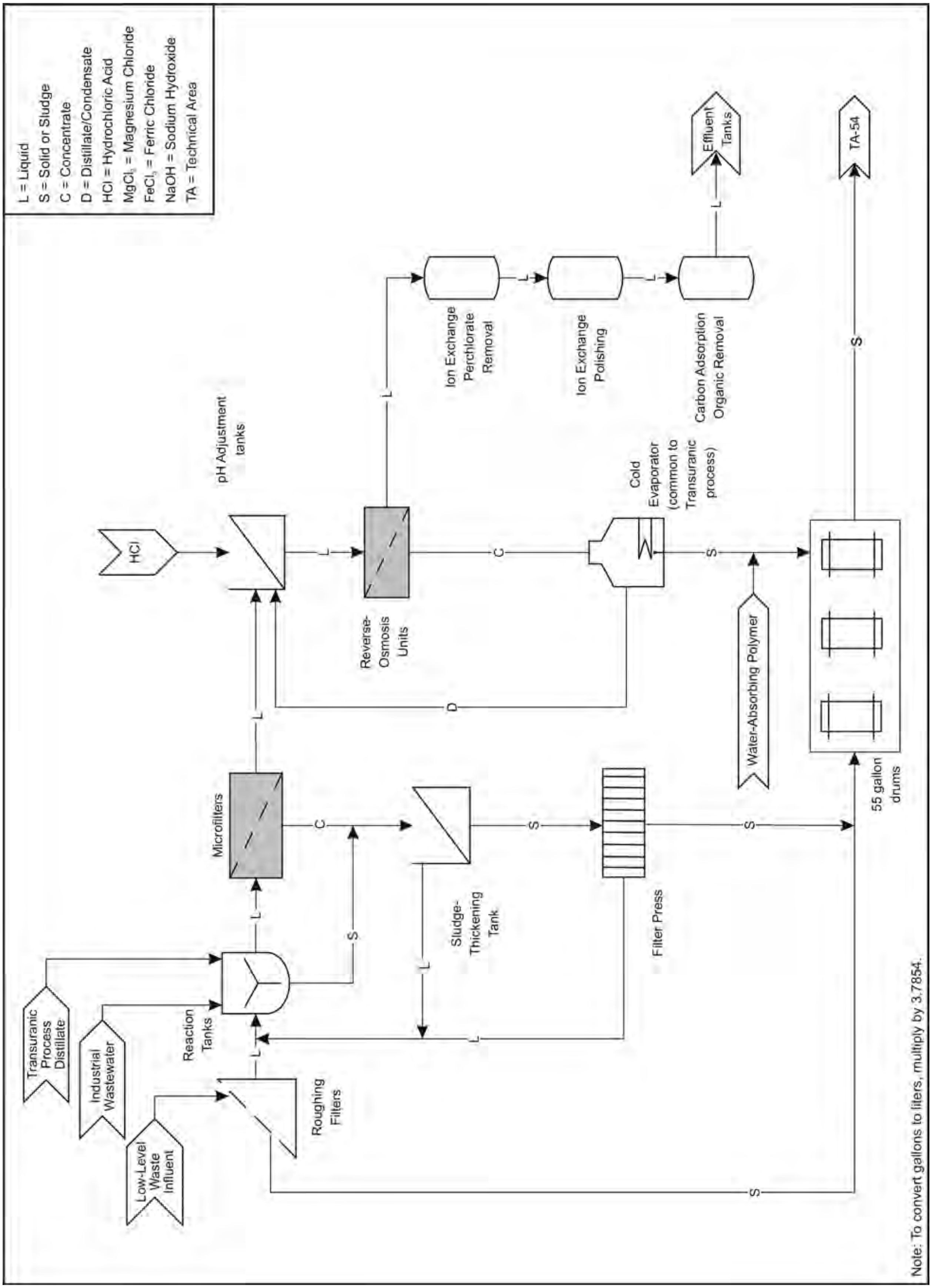


Figure G–7 Proposed Low-Level Radioactive Waste Treatment Process

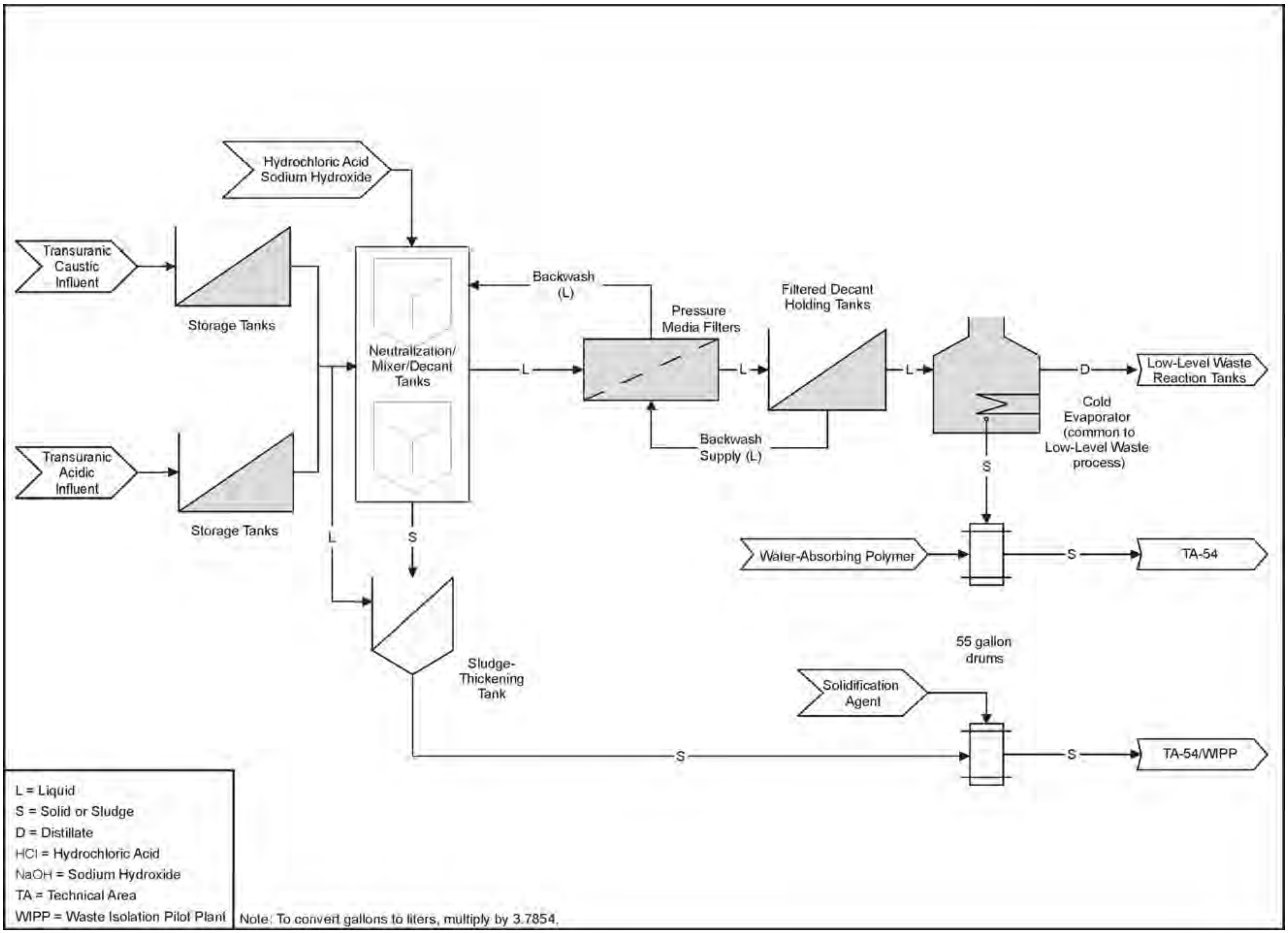


Figure G–8 Proposed Transuranic Waste Treatment Process

G.4.2.3 Option 2: Two Liquid Waste Treatment Buildings Option

This option would involve construction and operation of two new treatment facilities: one for low-level radioactive waste and one for transuranic waste (see **Figure G–9**). A central utilities building would also be constructed. The new low-level radioactive waste facility would have a footprint between 25,000 and 35,000 square feet (2,323 to 3,150 square meters) and would be located on the north side of the Radioactive Liquid Waste Treatment Facility. The transuranic waste facility would be located close to the point where transuranic waste lines enter TA-50, southwest of the existing Radioactive Liquid Waste Treatment Facility, to minimize the distance this wastewater must flow to reach the treatment facility. The transuranic waste facility would require approximately 15,000 square feet (1,350 square meters) of floor space. Like the low-level radioactive waste facility, it would contain processing areas, mechanical rooms, a control room, and access control areas. Additionally, either one of the auxiliary actions (evaporation tanks or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

Locating the new low-level radioactive waste facility north of the existing Radioactive Liquid Waste Treatment Facility would necessitate demolition of the North Annex, in addition to the East Annex, as well as a transformer located on the north side of the existing facility. The existing transuranic waste storage tank vault (TA-50-66) would be demolished. Some remediation of contaminated soils would be required. The new facilities would use the same treatment process as that described for the proposed project. All other aspects of this option are the same as those of the proposed project (Option 1).

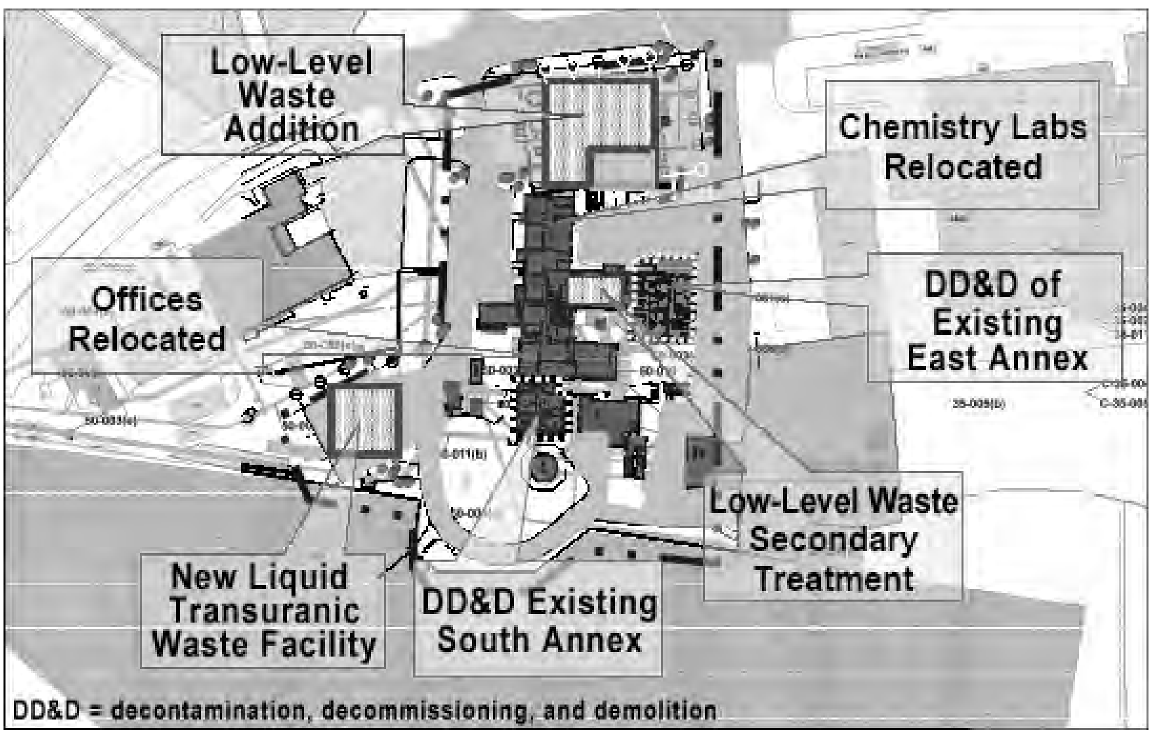


Figure G–9 Proposed Layout under the Two Liquid Waste Treatment Buildings Option

As a variation on this option, treatment functions to be housed in two facilities may be housed in multiple facilities in addition to the central utilities building. For example, separate structures may be constructed for portions of the transuranic waste treatment train rather than being consolidated into one structure.

G.4.2.4 Option 3: Two Liquid Waste Treatment Buildings and Renovation Option

Under Option 3, new buildings would be constructed to house the low-level radioactive waste and transuranic waste treatment processes, as in Option 2. As for Option 2, two new treatment buildings are envisioned, in addition to a central utilities building, although separate functions of the liquid waste treatment trains may be optionally housed in separate structures. In addition, the existing Radioactive Liquid Waste Treatment Facility would be renovated and reused for offices, chemistry laboratories, and drying of various solid residues (secondary waste) from the low-level radioactive waste treatment system.

Upon completion of the new facilities, the low-level radioactive waste and transuranic waste processes would be established in the new facilities and renovation of the existing facility would begin. When renovation is completed, equipment needed to dry the solid residues would be installed and operated in the renovated facility. In the interim, solid wastes would continue to be shipped off site for dewatering. The wastewater streams would be treated in the same way as under the proposed project (Option 1), and the treated effluent would similarly be discharged into Mortandad Canyon, reused, or evaporated. One of the auxiliary actions (evaporation tanks or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

This Two Liquid Waste Treatment Buildings and Renovation Option (Option 3) would entail major structural and infrastructure changes to the existing Radioactive Liquid Waste Treatment Facility. Existing external walls would be removed and replaced with seismically appropriate materials and construction as required to meet LANL engineering standards for Hazard Category 2 facilities. Electrical and plumbing systems that do not meet current building codes would be replaced. Piping that does not conform to spill control requirements would also be replaced. The North, South, and East Annexes would be demolished, as they do not meet seismic requirements; failure of these structures could have a detrimental effect on existing and new construction. Under this option, the process of characterizing, demolishing, and removing contaminated materials would be the same as that under the proposed project (Option 1).

G.4.2.5 Auxiliary Actions

For the Radioactive Liquid Waste Treatment Facility Upgrade, two auxiliary actions are proposed to reduce or eliminate this discharge. The auxiliary actions could be applied to the No Action Option or any of the action options.

The first auxiliary action consists of constructing evaporation tanks and allowing the wastewater to evaporate using passive solar energy. The tanks would consist of up to three individual tanks constructed of lined, self-supporting concrete structures having walls approximately 4 feet high. Each tank would be open on top and have a surface area for evaporation of about an acre, with a total surface tank area of about 3 acres (1.2 hectares). The tanks would be surrounded by a security fence slatted with inserts to provide a wind screen. Except for periodic cleaning to eliminate the buildup of dissolved solids in the water, the tanks would be managed to always retain a minimum level of water. During cleaning, salt (and blown-in dirt) on the floor and sidewalls of the tanks would be flushed to a sump for solids removal, and the filtrate from solids removal returned to the evaporation tanks. The evaporation tanks could be constructed at a site in TA-52, located about a mile east of the Radioactive Liquid Waste Treatment Facility. A pipeline would be constructed to transport effluent from the Radioactive Liquid Waste Treatment Facility to the evaporation tanks.

The second auxiliary action option consists of the use of mechanical evaporation. Evaporative equipment would be purchased and installed at or near the proposed low-level radioactive waste treatment building.

G.4.2.6 Options Considered but Dismissed

Two additional action options were considered but dismissed from further evaluation. The first of these would be to construct the new radioactive liquid waste treatment facilities in another location. This site option was dismissed because the collection system, which is already in place to deliver wastewater to the current Radioactive Liquid Waste Treatment Facility, would need to be rebuilt in new locations. Constructing a new collection system has the potential for negative impacts on a number of resources without a benefit over the options being considered. The existing facility is in reasonable proximity to the source of most of the transuranic wastewater. Any other location would entail additional collection infrastructure and a longer distance over which wastewater would be transferred. In addition, the current facility has an existing NPDES permit to discharge at its current location.

The second option considered but dismissed from further evaluation would be to renovate the existing Radioactive Liquid Waste Treatment Facility to house the new transuranic waste and low-level radioactive waste treatment processes. This option is not feasible, as the capability to treat radioactive liquid wastewater must be maintained so that LANL missions are not impacted. Engineering and process reviews have determined that it is not feasible to install additional treatment equipment in the existing facility while the current treatment process is operating due to lack of space. The existing treatment processes must be maintained with no more than 10 days of downtime to ensure that mission-critical activities in facilities that generate liquid radioactive waste can be maintained. The time required to renovate the existing facility would far exceed 10 days.

G.4.3 Affected Environment and Environmental Consequences

This section presents an analysis of environmental consequences for each of the four options presented in Section G.4.2. Affected environment descriptions are also included where information is available that is specific to the project site and has not been included in Chapter 4 of this SWEIS. Detailed information about the LANL environment is presented in the main volume of this SWEIS. The auxiliary actions (see Section G.4.2.5) are not evaluated separately, but are largely evaluated as part of each of the action options (Options 1, 2, and 3). These auxiliary action evaluations would be also applicable to the No Action Option.

Proposed sites for the new transuranic and low-level radioactive waste buildings are within the developed area of TA-50, adjacent to the existing Radioactive Liquid Waste Treatment Facility. The area has been designated as an industrial area focused on Nuclear Materials Research and Development in *LANL's Comprehensive Site Plan*. Mortandad Canyon, which lies north of the proposed project, is largely undeveloped.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary.

- *Noise* – Would be managed with standard worker protective measures; no impact on the public due to location.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is mainly confined to already-developed areas of TA-50, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – Potential facility accidents associated with this proposed project are addressed as part of the No Action Alternative of this SWEIS.

Resource areas examined in this analysis include: land resources, geology and soils, water resources, air quality, ecological resources, human health, cultural resources, site infrastructure, waste management, and transportation.

G.4.3.1 No Action Option

No changes in air emissions or biological resources are expected under the No Action Option. Although the Radioactive Liquid Waste Treatment Facility is currently able to meet existing discharge standards, the facility may not meet more stringent discharge standards in the future. Implementation of the auxiliary action options would greatly reduce or eliminate liquid effluent discharges and therefore beneficially effect water quality. Construction impacts from particulate or radioactive emissions would not occur. There would be no effects on land resources, cultural resources, human health, transportation, traffic, or infrastructure under the No Action Option.

Between 1998 and 2004, the Radioactive Liquid Waste Treatment Facility received a range of about 2.2 million to 5.9 million gallons (8.4 million to 22.3 million liters) of low-level radioactive waste influent per year (LANL 2005e). During that same period, solid low-level radioactive waste volumes ranged from 173 to 510 cubic yards (132 to 390 cubic meters) per year (LANL 2003b, 2004d, 2006a).

During 2005, the facility treated and discharged about 1.8 million gallons (6.8 million liters) of effluent to a permitted outfall. Also during 2005, 339 cubic yards (259 cubic meters) of solid low-level radioactive waste, very small quantities of mixed low-level radioactive waste, and

15.9 pounds (7.2 kilograms) of chemical waste were generated. About 75 cubic yards (57.5 cubic meters) of the low-level radioactive waste was construction soil and debris from installing influent storage tanks for the Cerro Grande Rehabilitation Project (LANL 2006f).

Under the No Action Option, low-level radioactive waste volumes are expected to be similar to the past few years of Radioactive Liquid Waste Treatment Facility operation, when more-efficient treatment equipment was brought online and radioactive solids were more effectively removed than in previous years. Because the treatment process would not be improved under the No Action Option, the amount of solid low-level radioactive waste to be generated would be largely a product of the influent volume and contamination concentrations. The average influent volume for 2003–2004 was 2.7 million gallons (10.3 million liters), while average low-level radioactive waste generation was 488 cubic yards (373 cubic meters) (LANL 2003b, 2004d, 2006a). Influent and waste generation levels were smaller than those averages in 2005 (LANL 2006f). If all pollution prevention measures and mission changes are implemented as scheduled, low-level radioactive waste influent volumes are expected to decrease slightly from current levels by about the year 2014 (LANL 2005e). Solid low-level radioactive waste volumes are expected to decrease slightly as well.

Similarly, because the treatment process would not be improved under the No Action Option, transuranic waste quantities would be a function of the influent volume and influent contamination concentrations. For the years 1998-2002, the Radioactive Liquid Waste Treatment Facility received on average 1,412 gallons (5,346 liters) of caustic transuranic and 8,792 gallons (33,276 liters) of acid transuranic influent per year. In that same period, the Radioactive Liquid Waste Treatment Facility produced approximately about 6.5 to 7.8 cubic yards (5 to 6 cubic meters) of solid transuranic and mixed transuranic waste annually. Under the No Action Option, the transuranic waste influent would approximately double if mission changes and pollution prevention measures are implemented. The amount of transuranic solid waste generated by treatment of the influent is likely to increase in a similar way.

Construction and operation of the evaporation tanks would have the same impacts as those detailed for Options 1, 2, and 3 in Section G.4.3.2.

G.4.3.2 Option 1: Single Liquid Waste Treatment Building Option – Proposed Project

Land Resources—Land Use

Land in TA-50 where the new building would be constructed is in the immediate vicinity of the Radioactive Liquid Waste Treatment Facility, a highly developed area with a land use designation of Waste Management (see Section 4.1 for a land use map and description). If evaporation tanks were constructed, the pipeline to them would be routed east through TA-63 and TA-52 in areas with current land use designations of Physical and Technical Support, Experimental Science, and Reserve. The proposed location of the evaporation tanks near the border of TA-52 and TA-5 is designated Reserve (LANL 2003b).

Construction Impacts—Construction of the new liquid waste management building would occur in a developed area and result in no changes to current or future land use designations. If the option to construct evaporation tanks is implemented, the land use designation for the tank areas and along a portion of the pipeline would likely change from Reserve to Waste Management. The tanks themselves could occupy approximately 3 acres (1.2 hectares), but a somewhat larger area (up to 4 acres [1.6 hectares]) would undergo a change in land use designation. Removing this land from the Reserve designation was not previously accounted for in land use plans (LANL 2004d).

Land Resources—Visual Resources

As noted previously in the land use discussion, the area in which the treatment buildings would be constructed is a highly developed area. This area currently has an industrial look, with a mix of buildings of different design. The area proposed for construction of the tanks is currently undeveloped and wooded.

Construction Impacts—There would be temporary local visual impacts associated with construction of the new treatment building, and during excavation from the use of construction equipment. The current natural setting in the area of the evaporation tanks, and a portion of the pipeline, would be disrupted by removal of vegetation, establishment of a construction staging area, and construction activities. Construction would entail excavation of soils to construct the tanks and pipeline, and possibly the temporary establishment of a soil pile. Excess soils would be removed and used or stockpiled elsewhere.

Operations Impacts—The new treatment building would not result in a change to the overall visual character of the area within TA-50. The facility would be a maximum of two stories and constructed in accordance with site guidelines, which establish acceptable color schemes for building exteriors. Establishment of evaporation tanks would result in a permanent change to the visual environment in the area near the border of TA-52 and TA-5. Although this change would result in a noticeable break in the forest cover when seen from higher elevations to the west of LANL, due to their low profile and the presence of nearby forest vegetation, the tanks would not likely be visible from the east. Additionally, the tanks would be surrounded by a fence that would be colored to blend with the surrounding environment. Following regrowth of vegetation, the area disturbed for pipeline construction would not be noticeable.

DD&D Impacts—Removal of the East Annex and TA-50-66 would result in temporary local visual impacts in the form of construction equipment and the presence of partially demolished buildings. Long-term effects would be a slightly improved local visual environment, once the annex and TA-50-66 are removed.

Geology and Soils

The existing Radioactive Liquid Waste Treatment Facility is categorized as a potential release site; other potential release sites representing possible historic spills, polychlorinated biphenyls, or leakage of radioactive wastewater are present in the vicinity of the proposed construction at TA-50. A large radioactive waste material disposal area (MDA), designated MDA C, is immediately south of the existing Radioactive Liquid Waste Treatment Facility. NNSA is implementing environmental investigation and remediation measures for MDA C and other potential release sites at TA-50 in accordance with DOE requirements and the Consent Order.

TA-50 is approximately 0.8 miles (1.25 kilometers) east of the nearest mapped fault, a subsidiary of the Rendija Canyon Fault (see Section 4.2 of this SWEIS). However, previous study indicates that the level of seismic risk is low and is manageable through facility design. Any new facilities would be designed in accordance with current DOE seismic standards and applicable building codes.

Because building construction would occur within areas already disturbed by previous facility construction, there would be no impact on native soils. Construction of the new facilities would require removal of facility soils as well as new excavation of shallow bedrock in some areas. As a result, construction activities would generate excess soil and excavated bedrock that may be suitable for use as backfill. Uncontaminated backfill would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater, other water discharges, or wind.

Construction Impacts—Approximately 36,000 cubic yards (28,000 cubic meters) of soil and rock would be disturbed during building excavation. If construction of the evaporation tanks and associated pipeline also occurs, an additional 69,000 cubic yards (53,000 cubic meters) of excavation work would be required. Nevertheless, the proposed project would initiate removal of contaminated areas adjacent to the Radioactive Liquid Waste Treatment Facility and would have a positive effect. The East Annex and TA-50-66 would also be demolished, and remediation of associated potential release sites would be initiated.

Operations Impacts—There would be minimal operations impacts on geology and soils. Evaporation of liquid effluent would eliminate addition of contaminants to soil and sediment below the existing permitted outfall. As noted above, construction activities may remove contaminated media, resulting in a reduced potential for contamination spread from past releases.

DD&D Impacts—Contaminated material would be removed from the areas affected by demolition and construction, and would be managed according to waste type and LANL procedures.

Water Resources

The Radioactive Liquid Waste Treatment Facility currently releases treated effluent to Mortandad Canyon at a permitted outfall. Other industrial outfalls and stormwater also discharge into Mortandad Canyon, both upstream and downstream from the Radioactive Liquid Waste Treatment Facility. Mortandad Canyon crosses lands belonging to the Pueblo of San Ildefonso before discharging into the Rio Grande. Existing contaminants are known to be present in Mortandad Canyon. A permeable reactive membrane barrier designed to trap contaminants and to prevent their movement downstream toward the Pueblo of San Ildefonso is located downstream from TA-50.

Construction Impacts—Construction could result in movement of contaminated and uncontaminated materials. The effects of construction would be mitigated by implementation of a stormwater pollution prevention plan to contain sediments and prevent erosion.

Operations Impacts—The overall effect of implementing the proposed project is expected to be positive. This option would ensure that both current and projected future discharge requirements could be met. During operations, effluent water quality is expected to improve due to improved processing and potentially more-stringent discharge requirements. If discharges are eliminated or greatly decreased through recycling or evaporation, movement of contaminants in groundwater and surface water in Mortandad Canyon is expected to decrease. If liquid discharge is not reduced or completely eliminated by recycling or evaporation, the permeable reactive membrane barrier is expected to mitigate the downstream movement of contaminants. The potential for spills of contaminated water would be greatly reduced by replacing single-walled piping with double-walled pipes and by use of secondary containment structures.

DD&D Impacts—Demolition could result in mobilization of particulates that could be entrained in offsite sediments. However, erosion control measures specified in a stormwater pollution prevention plan would be implemented. Movement of contaminated or uncontaminated materials is, therefore, expected to be negligible.

Air Quality

The Radioactive Liquid Waste Treatment Facility contributes less than 1 microcurie of radioactive emissions to LANL's total radioactive emissions. Likewise, Radioactive Liquid Waste Treatment Facility emissions of criteria air pollutants (nitrogen oxides, sulfur oxides, particulate matter, carbon monoxide, and volatile organic compounds) and other hazardous air pollutants are small relative to LANL's overall emissions.

Construction Impacts—Construction and demolition would result in temporary increases in particulate emissions.

Operations Impacts—Sufficient information to assess emissions and doses from a new treatment building is not yet available. The effect of the proposed project on air quality is expected to be minimal. During operations, radioactive air emissions are expected to be within an order of magnitude of current air emissions. Because current radioactive air emissions are very low, radioactive emissions from the processes to be implemented under any of the new construction options would likely not be major contributors to the total LANL radioactive emissions. Stack monitoring requirements would be adjusted as necessary based on the final design. New combustion equipment installed as part of any of the new construction options would be low-nitrogen-oxide emitters compared to existing equipment. Radiological and nonradiological emissions associated with solar evaporation of effluent are expected to be small, and dominated by evaporation of water containing tritium.

DD&D Impacts—Demolition of the East Annex and the transuranic waste influent storage tanks (TA-50-66) would likely produce radioactive or hazardous emissions. These emissions would be temporary, but released particulates could be dispersed to other areas. Because of the presence of contaminated soils and structural materials, there is potential to release radioactive or other hazardous constituents. Standard measures for controlling fugitive emissions would be employed.

Ecological Resources

The Radioactive Liquid Waste Treatment Facility is located within a highly developed industrial area of TA-50 and contains no important biological resources. However, the evaporation ponds would be located in an open field containing scattered trees. Mortandad Canyon contains breeding and foraging habitat for the Mexican spotted owl. The industrial area where the Radioactive Liquid Waste Treatment Facility is located is within developed Mexican spotted owl core habitat and its developed buffer zone. The area where the evaporation tanks would be located is also within the buffer and cores zones of the Sandia and Mortandad Canyon Area of Environmental Interest (LANL 2000).

Construction Impacts – Construction of the new Radioactive Liquid Waste Treatment Facility would not disturb any natural habitat. The biological assessment prepared by DOE, however, determined that constructing the evaporation tanks and pipeline would remove about 5.4 acres (2.2 hectares) of undeveloped core and buffer habitat of the Mexican spotted owl (LANL 2006b). It was also determined that construction of the Radioactive Liquid Waste Treatment Facility would likely result in noise levels greater than 6 dB(A) above background levels in the core zone; however, these levels should attenuate to below this level within 0.25 miles (0.4 kilometers) of the construction site. The biological assessment concluded that with the application of reasonable and prudent alternatives the project may affect, but is not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives would include not permitting work to start between March 1 and the completion of surveys aimed at determining if owls were present in order to avoid a sudden increase in noise levels during the breeding season (LANL 2006b). Additional reasonable and prudent alternatives would be similar to those addressed in Section G.3.3.2. The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

The bald eagle Area of Environmental Interest is not located near the proposed project site. However, because the entire LANL site is considered potential bald eagle foraging area, there may be some habitat degradation associated with the project. Provided reasonable and prudent alternatives are implemented to protect adjacent foraging habitat from detrimental cumulative effects (see Section G.2.3.2), the DOE biological assessment concluded that construction of the Radioactive Liquid Waste Treatment Facility may affect, but is not likely to adversely affect, the bald eagle. Because the proposed project is not within or upstream of the southwestern willow flycatcher Area of Environmental Interest, the biological assessment determined that the project would not affect this species (LANL 2006b). The USFWS has concurred with the DOE biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations and DD&D Impacts – No direct effects on sensitive species are expected from Radioactive Liquid Waste Treatment Facility Operations. However, a biological assessment prepared by DOE predicted that if water is evaporated and not discharged to Mortandad Canyon the reduction in flow would decrease the extent of perennial and intermittent stream reaches and associated wetland and riparian habitat. This could in turn reduce the abundance and diversity of prey species for the Mexican spotted owl. Thus, the biological assessment concluded that zero discharge may adversely affect the Mexican spotted owl (LANL 2006b). But after reviewing the assessment, the USFWS determined that the affects to the Mexican spotted owl would be insignificant and discountable, and would not result in adverse affects (see Chapter 6, Section 6.5.2).

DD&D effects are expected to be temporary and to have no direct impact on sensitive species.

Human Health

The Radioactive Liquid Waste Treatment Facility has very low radioactive emissions. These emissions do not have a distinguishable effect on the projected dose to the public. Current Radioactive Liquid Waste Treatment Facility operations are conducted with a commitment to maintaining radiological doses to workers at ALARA levels.

Construction Impacts—Construction would have potential for affecting only worker health. Based on an estimated 141,000 projected person-hours and accident rates for construction at DOE sites and for the general construction industry, 2 to 6 recordable injuries and no fatalities could be expected from construction of the new treatment buildings and associated structures. If the evaporation tanks and pipeline were built, an additional 420,000 person-hours would be required, with a possibility of 5 (DOE 2004) to 18 (BLS 2003) recordable injuries.

Operations Impacts—Emissions from operating the new treatment processes would remain very low, so there would be no distinguishable contribution to the dose to the public from all LANL activities. Emissions from effluent evaporation would be small and dominated by tritium, assuming operation of the evaporation tanks as described in Section G.4.2.5. The potential quantity of evaporated tritium would be minimal compared to the quantity of tritium emitted from other Key Facilities (for example, the Tritium Facility and the Plutonium Facility). The associated radiation dose would be small and enveloped by the impacts to the public discussed in Chapter 5, Section 5.6.1.

Worker health and safety at the facility would improve during operations under this option for two reasons: (1) the new buildings, equipment, and infrastructure would be more reliable and require less maintenance; and (2) because the buildings and process are being designed together (rather than retrofitting new equipment into an old building), when maintenance is needed, prolonged periods of time in zones with potential for radiation doses would be less than those in the current Radioactive Liquid Waste Treatment Facility. Maintenance of the evaporation tanks including periodic cleaning may cause occupational exposures to workers. However, radiation doses would be maintained to levels as low as reasonably achievable below DOE occupational dose limits in 10 CFR Part 835, and exposures to non-radioactive materials would be maintained well below established occupational exposure limits.

DD&D Impacts—Under this option, workers could be exposed to radiologically or chemically contaminated materials during demolition activities. Worker risks would be mitigated by use of personal protective equipment and pre-established safety procedures. Based on an estimated 56,000 person-hours and construction accident rates, 1 to 2 recordable injuries could be expected to occur from DD&D (DOE 2004, BLS 2003).

Cultural Resources

There are no archaeological remains within the developed area of TA-50. Archaeological sites in the vicinity of the proposed evaporation tanks and pipeline would be avoided. The existing Radioactive Liquid Waste Treatment Facility qualifies as a historic building. Any removal of process equipment or demolition of portions of the structure requires historic building documentation to mitigate any adverse effects.

Construction Impacts—Under Option 1, construction would not affect cultural resources. Changes in the Radioactive Liquid Waste Treatment Facility process area would require historic documentation before any equipment is removed from the building. Any mitigation plans would have to be implemented before or during project implementation.

The pipeline and tanks would be sited to avoid impacts on nearby archaeological sites to the extent practical. However, if the pipeline alignment or the tanks encroached on cultural sites, the sites would be fenced for avoidance or excavated.

Operations Impacts—Operations conducted under the proposed project would not affect historic buildings.

DD&D Impacts—Effects on historic buildings under this option are expected to be minimal. Removal of the East Annex is not likely to affect the original historic fabric of the Radioactive Liquid Waste Treatment Facility. Removal of both the East Annex and the transuranic waste influent storage vault (TA-50-66) would require historic documentation before the demolition process began.

Socioeconomics and Infrastructure

Major infrastructure (potable water, sewage, natural gas, and electricity) is available at TA-50. As necessary, utility infrastructure and capacity will be evaluated under a separate action to determine upgrade requirements due to demand from proposed new projects, including the Radioactive Liquid Waste Treatment Facility. Recently installed natural gas infrastructure would adequately accommodate the Radioactive Liquid Waste Treatment Facility. The radioactive liquid waste collection system, which pipes radioactive liquid waste to the Radioactive Liquid Waste Treatment Facility, requires improvements such as replacing manholes and installing monitoring equipment. Within the Radioactive Liquid Waste Treatment Facility, the piping is largely single-walled and has inadequate leak and spill protection. The electrical system within the existing facility does not meet current codes.

Construction—Utility infrastructure resources would be needed for Radioactive Liquid Waste Treatment Facility construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 190,000 gallons (720,000 liters) of liquid fuels and 1.0 million gallons (3.8 million liters) of water.

If evaporation tanks and pipeline were constructed, an additional 850,000 gallons (3.2 million liters) of liquid fuels and 6.5 million gallons (25 million liters) of water would be required.

The existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure.

Operations Impacts—Utility demands in TA-50 are expected to increase. Operations at both the new Chemistry and Metallurgy Research Building Replacement and the Radioactive Liquid Waste Treatment Facility would potentially require more natural gas and electric power over time. As stated previously, utility infrastructure needs are being separately evaluated. Nevertheless, the proposed project would be subject to an energy efficiency study as it reaches detailed design phases. The preliminary facility design limits energy use to some extent by the use of cold evaporators instead of more energy-consumptive driers or other evaporative equipment.

DD&D Impacts—Activities associated with DD&D of facilities to be replaced by the new facility would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be very minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities are shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities. DD&D is estimated to require 1,700 gallons (6,500 liters) of liquid fuel and 52,000 gallons (197,000 liters) of water.

Waste Management

The existing Radioactive Liquid Waste Treatment Facility does not contain RCRA regulated treatment, storage, and disposal facilities. All RCRA-regulated waste is managed in less-than-90-day storage areas before being packaged and trucked to TA-54 for offsite treatment and disposal. In 2005, the Radioactive Liquid Waste Treatment Facility produced approximately 16 pounds (7.2 kilograms) (LANL 2006f) of chemical waste compared to about 4,850 pounds (2,200 kilograms) of chemical waste projected by the *1999 SWEIS* (DOE 1999a).

The Radioactive Liquid Waste Treatment Facility typically generated about 170 to 262 cubic yards (130 to 200 cubic meters) of solid low-level radioactive waste annually between 1998 and 2002 (LANL 2003b). In 2003, 510 cubic yards (390 cubic meters) of low-level radioactive waste were generated, in 2004, 464 cubic yards (355 cubic meters) were generated (LANL 2004d, 2005c), and in 2005, 339 cubic yards (259 cubic meters) were generated (LANL 2006f). Less than 4 percent of the low-level radioactive waste volume was mixed low-level radioactive waste (LANL 2003b, 2004d). Between 1998 and 2002, the Radioactive Liquid Waste Treatment Facility generated about 39 cubic yards (30 cubic meters) of transuranic or mixed transuranic solid waste, of which about one-third was mixed transuranic waste (LANL 2003b). Due to operational interruptions in 2003 and 2004, the Radioactive Liquid Waste Treatment Facility generated no transuranic waste and only 4 cubic yards (2.7 cubic meters) of mixed transuranic waste during those 2 years (LANL 2004d, 2005c). No transuranic or mixed transuranic waste was generated during 2005 (LANL 2006f).

Construction and DD&D Impacts – **Table G–25** lists the types and volumes of waste expected to be generated during construction and demolition of buildings under Option 1. Nearly 4,900 cubic yards (3,700 cubic meters) of low-level radioactive waste is projected to be soil and debris containing so little radioactive or hazardous material that it can be disposed in bulk using lift liners or similar disposal containers that are transported in reusable transport packages such as Intermodals. Packaged low-level radioactive waste would include small quantities of low-level radioactive waste from one-time transitioning from the existing Radioactive Liquid Waste Treatment Facility, and additional one-time waste from facility stand-down. This waste would include low-level radioactive waste sludges that would be drummed, solidified, and disposed of at TA-54 or any other authorized facility, as well as small quantities of used filters, membranes, and expendable supplies. A small amount of mixed low-level radioactive waste is expected to be generated from DD&D activities.

Table G–25 Construction and Decontamination, Decommissioning, and Demolition Waste Volumes – Single Waste Liquid Treatment Building Option

Waste Type	*Cubic Yards*
Low-level radioactive waste (bulk)	4,860
Low-level radioactive waste (packaged)	1,620
Mixed low-level radioactive waste	44
Transuranic waste (contact-handled)	94
Demolition debris [a]	820
Construction waste [b]	980
Hazardous waste with asbestos	200
Solid hazardous waste with organics	< 1
Solid hazardous waste with metals	< 1

[a] Includes solid sanitary wastes.
[b] Includes 427 tons (387 metric tons) of solid waste from constructing evaporation tanks with associated pipeline. Construction waste density is 2 cubic yards per ton.
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Contact-handled transuranic waste would include small quantities of transuranic sludge that would be drummed, solidified, and transferred to TA-54 for eventual disposal at WIPP. DD&D may also generate waste from roofing materials that may contain asbestos and would require disposal at a permitted offsite facility, as well as possibly small quantities (less than 1 cubic yard [0.8 cubic meter]) of other wastes containing organics or metals. Otherwise, all potentially recyclable materials from construction or DD&D would be characterized; if contaminated with radioactive materials or chemicals, they would be disposed of at an appropriate permitted facility (LANL 2005f).

Facility construction, transitioning, and DD&D are expected to also generate small quantities of liquids that would be processed and disposed of in accordance with LANL requirements. Construction liquids are expected to include wash water from concrete trucks (less than 100 gallons [380 liters]). Transitioning liquids are expected to include 2,640 gallons (10,000 liters) of clean water used for testing the new process that would be processed through the existing Radioactive Liquid Waste Treatment Facility treatment system. Rinsing and flushing of the piping at the existing Radioactive Liquid Waste Treatment Facility would be treated at the new or the existing facility. Any remaining treated effluent would be evaporated assuming the auxiliary action options discussed in Section G.4.2.5 are implemented; otherwise the effluent would be released to the outfall in Mortandad Canyon.

Operations Impacts—Operations would generate liquid effluent, transuranic waste, and low-level radioactive waste. The volumes of waste generated would be a function of the level of operations occurring at LANL; these volumes are presented in Chapter 5, Section 5.9 of this SWEIS.

Transportation

Pecos Drive, a secondary road that intersects Pajarito Road, provides access to TA-55, TA-50, and TA-35. Traffic is restricted to the LANL workforce and official visitors. Sufficient parking is available to accommodate the existing workforce on the site.

Construction Impacts—Construction would result in some local adverse transportation effects. Construction traffic would increase temporarily. Parking would be eliminated by construction of the new facility.

Operations Impacts—Implementation of this option would eliminate the need to ship radioactive waste to Tennessee, thus reducing the risks of waste transportation off site.

DD&D Impacts—As with construction, traffic on Pecos Road and employee parking would be disrupted during demolition. Demolition traffic would increase temporarily.

The generated construction and DD&D wastes would be transported to disposal sites, either at LANL TA-54 or an offsite location. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported long the routes and highways. Traffic accidents could result both in injuries or deaths from collisions and in an additional radiological dose to the public from radioactivity that may be released during the accident.

The effects of incident-free transportation of construction and DD&D wastes on the worker population and general public is presented in **Table G–26**. Effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project, estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is smaller than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed.

The risk for development of excess LCFs is highest for the workers under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–26, disposal of low-level radioactive waste at the Nevada Test Site, which is located farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low for all disposal options.

Table G–26 Incident-Free Transportation – for Single Liquid Waste Treatment Building Option Impacts

Disposal Option	Low-Level Radioactive Waste Disposal Location [a]	Crew		Public	
		Collective Dose (person-rem)	Risk (LCF)	Collective Dose (person-rem)	Risk (LCF)
Onsite disposal	LANL TA-54	0.26	0.000155	0.082	0.000049
Offsite disposition	Nevada Test Site	2.02	0.0012	0.59	0.00036
	Commercial facility	1.96	0.0012	0.58	0.00035

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes would be disposed of at WIPP.

Table G–27 presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents from both the collisions themselves and from excess LCFs from exposure to releases of radioactivity. The analyses assumed that all transuranic and nonradioactive wastes would be transported to offsite disposal facilities.

Table G–27 Transportation Accident Impacts – for Single Liquid Waste Treatment Building Option

Low-Level Radioactive Waste Disposal Location [a, b]	Number of Shipments [c]	Distance Traveled (million kilometers)	Accident Risks	
			Radiological (excess LCFs)	Traffic (fatalities)
LANL TA-54	462	0.057	3.6×10^{-10}	0.00089
Nevada Test Site	462	1.04	5.2×10^{-8}	0.0106
Commercial facility	462	0.94	3.9×10^{-9}	0.0095

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported off site.
[b] Transuranic wastes would be disposed of at WIPP.
[c] Approximately 87.7 percent of shipments are radioactive wastes. Others include 10 percent industrial and sanitary wastes and about 2.4 percent asbestos and hazardous wastes.
Note: To convert kilometers to miles, multiply by 0.6214.

Because all estimated LCFs and traffic fatalities, as shown in Tables G–26 and G–27, are much less than 1.0, the analysis indicates that no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from traffic collisions and accidental release.

G.4.3.3 Option 2: Two Liquid Waste Treatment Buildings Option

The overall effect of implementing this option would be positive. Effects on land use, cultural resources, ecological resources, human health, and infrastructure are expected to be similar to those under the proposed project (Option 1). Resource area impacts that would differ from the proposed project are discussed in detail below.

Land Resources—Visual Resources

As noted previously in the land use discussion, the area in which the treatment buildings would be constructed is highly developed. This area currently has an industrial look, with a mix of buildings of different design. The area proposed for construction of the tanks is currently undeveloped and wooded.

Construction Impacts—There would be temporary local visual impacts associated with construction of the new treatment buildings and during excavation from the use of construction equipment. The current natural setting, in the area of the evaporation tanks and a portion of the pipeline, would be disrupted by removal of vegetation, establishment of a construction staging area, and construction activities. Construction would entail excavation of soils to construct the tanks and pipeline, and possibly the temporary establishment of a soil pile. Excess soils would be removed and used or stockpiled elsewhere.

Operations Impacts—The new treatment buildings would not result in a change to the overall visual character of the area within TA-50. Buildings would be a maximum of two stories and constructed in accordance with site guidelines, which establish acceptable color schemes for building exteriors. Establishment of evaporation tanks would result in a permanent change to the visual environment in the area near the border of TA-52 and TA-5. Impacts would be similar to those described for Option 1 (see Section G.4.3.2). Following regrowth of vegetation, the area disturbed for pipeline construction would not be noticeable.

DD&D Impacts—Removal of the North and East Annexes and TA-50-66 would result in temporary local visual impacts in the form of construction equipment and the presence of partially demolished buildings. Long-term effects would be a slightly improved local visual environment, once the annexes and TA-50-66 are gone.

Geology and Soils

Construction Impacts—About 80,000 cubic yards (61,000 cubic meters) of soil and rock would be disturbed during building construction; installation of the evaporation tanks and pipeline would disturb the same quantities of soil and rock as those given for Option 1.

This option would initiate removal of some potential release sites and would have a positive effect. This option would be likely to affect more potential release sites than would the proposed project because of its larger footprint.

DD&D Impacts—The major indirect impact on geologic and soil resources at DD&D locations would be associated with the need to excavate any contaminated soil and tuff from beneath and around facility foundations. Under this option, the North and East Annexes and TA-50-66 would be demolished and remediation of associated potential release sites would be required. Borrow material such as crushed tuff and soil would be required to fill the excavations to grade, but such resources would be available from onsite borrow areas (see Chapter 5, Section 5.2 of this SWEIS). Potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination. All excavated contaminated media would be characterized and managed according to waste type and all LANL procedures and regulatory requirements.

Water Resources

DD&D Impacts—Effects on water quality could be larger under this option because more demolition is proposed under this option. However, erosion control measures specified in a stormwater pollution prevention plan would be implemented to mitigate impacts of sediment movement by stormwater. Water quality effects would be similar to those under Option 1.

Air Quality

DD&D Impacts—Nonradioactive emissions would be slightly larger under this option because the amount of demolition is greater. Other air quality impacts would be similar to those under Option 1.

Ecological Resources

Possible impacts would be the same as those for Option 1.

Human Health

Construction Impacts—Option 2 would result in somewhat larger worker hours and risks than would Option 1. Based on 317,000 worker hours, 4 to 13 recordable injuries could occur during construction (DOE 2004, BLS 2003). If the evaporation tanks and pipeline were built, an additional 420,000 person-hours would be required, with a possibility of 5 (DOE 2004) to 18 (BLS 2003) recordable injuries.

DD&D Impacts—Under this option, workers could potentially be exposed to radiologically or chemically contaminated materials during demolition activities. Worker risks would be mitigated by use of personal protective equipment and pre-established safety procedures. Based on an estimated 59,800 worker hours and construction accident rates, one to three recordable injuries could occur from DD&D (DOE 2004, BLS 2003).

Operations Impacts—Impacts would be the same as those for Option 1.

Cultural Resources

Construction Impacts—Under this option, effects of construction on cultural resources would be the same as those for Option 1.

Operations Impacts—This option would result in minimal effects on historic buildings. The original portion of the Radioactive Liquid Waste Treatment Facility would remain, but would undergo internal changes such as process equipment removal. As required by mitigation plans, documentation would occur before any equipment is removed from the building. Mitigation plans would have to be implemented before or during project implementation.

DD&D Impacts—Removal of the North and East Annexes to the Radioactive Liquid Waste Treatment Facility and TA-50-66 under this option should not affect the original historic fabric of the building, but would require historic documentation before the demolition process began.

Socioeconomics and Infrastructure

Construction Impacts—Construction of the new buildings would require more infrastructure resources than Option 1. Construction is estimated to require 420,000 gallons (1.6 million liters) of liquid fuels and 2.3 million gallons (8.7 million liters) of water. If the evaporation tanks and pipeline were constructed, then similar impacts to those described in Option 1 would occur. The existing LANL infrastructure would be capable of supporting Option 2 without exceeding site capacities.

Operations Impacts—Electricity and natural gas requirements would be slightly more than Option 1 since additional new buildings would be operating. This would increase the use of utilities for lighting and heating as compared to Option 1.

DD&D Impacts—Activities associated with facilities to be replaced by the new facilities in Option 2 would be similar to those described in Option 1. However, the infrastructure needs for Option 2 would be somewhat higher than for Option 1 because one additional annex would be removed. DD&D is estimated to require quantities of liquid fuel and water similar to those in Option 1.

Waste Management

Waste types are expected to be similar to those under the proposed project. **Table G–28** provides the types and volumes of wastes generated during construction, transition, and demolition of buildings. Uncontaminated construction waste volumes would be larger than those under the proposed project because two or more new treatment facilities would be built. Transition and standdown wastes would be identical to those under the proposed project (Option 1). Volumes of demolition wastes would be greater than those under the proposed project because of the additional demolition of the North Annex. Operational waste is expected to be similar to that under the proposed project. Chemical and radioactive wastes generated through decontamination processes would be managed within the LANL waste management system. The low-level radioactive waste may be disposed of onsite or sent to an offsite facility, depending upon onsite capacities and waste acceptance priorities at TA-54 Area G. Solid wastes would be transferred to a permitted municipal landfill.

Operations Impacts—Operations would generate liquid effluent, transuranic waste, and low-level radioactive waste. The volumes of waste generated would be a function of the level of operations occurring at LANL; these volumes are presented in Chapter 5, Section 5.9, of this SWEIS.

Transportation

Pecos Drive, a secondary road that intersects Pajarito Road, provides access to TA-55, TA-50, and TA-35. Traffic is currently restricted to the LANL workforce and official visitors along Pecos Drive. Sufficient parking is available to accommodate the existing workforce in the area.

Construction Impacts—Traffic on Pecos Road and employee parking would be disrupted during construction. Pecos Road would be realigned slightly near the new low-level radioactive waste treatment buildings, but would not alter traffic flow over the long term. Traffic associated with construction would cause a temporary increase in local traffic.

Table G–28 Construction and Decontamination, Decommissioning, and Demolition Waste Volumes – Two Liquid Waste Treatment Buildings Option

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste (bulk)	5,250
Low-level radioactive waste (packaged)	1,750
Mixed low-level radioactive waste	44
Transuranic waste (contact-handled)	94
Demolition debris [a]	1,650
Construction waste [b]	1,110
Hazardous waste with asbestos	210
Solid hazardous waste with organics	< 1
Solid hazardous waste with metals	< 1

DD&D = decontamination, decommissioning, and demolition.
[a] Includes solid sanitary wastes.
[b] Includes 427 tons (387 metric tons) of solid waste from constructing evaporation tanks. Construction waste density is 2 cubic yards per ton (1.4 cubic meters per metric ton).
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Operations Impacts—Under this option, there would be no change in local traffic. Implementation of the proposed treatment technologies would eliminate the need to ship radioactive waste to and receive residues back from Tennessee, thus reducing the risks of offsite waste transportation.

The waste generated by construction and DD&D activities would have to be moved to a different location for disposal, mostly using over-the-road truck transportation. Effects of incident-free and accident conditions of transporting construction and DD&D wastes to disposal locations on or off site are presented in **Tables G–29** and **G–30**. All nonradiological and transuranic wastes would be transported to offsite facilities. The results in these two tables indicate that no traffic fatalities or excess LCFs are expected from transportation of generated wastes.

Table G–29 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings Option

		Crew		*Public*	
Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Collective Dose (person-rem)*	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.26	0.000156	0.082	0.000049
Offsite disposal	Nevada Test Site	2.16	0.0013	0.63	0.00038
	Commercial facility	2.10	0.00126	0.62	0.00037

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed of at WIPP.

Table G–30 Transportation Incident Impacts – Two Liquid Waste Treatment Building Option

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL [b]	540	0.076	3.6×10^{-10}	0.0011
Nevada Test Site	540	1.14	5.6×10^{-8}	0.0117
Commercial facility	540	1.03	4.2×10^{-9}	0.0105

LCF = latent cancer fatality.
[a] All nonradiological wastes would be transported offsite.
[b] Transuranic waste would be disposed of at WIPP.
[c] Approximately 81 percent of these are radioactive. Others include 17 percent industrial and sanitary waste and about 2 percent asbestos and hazardous waste.
Note: To convert kilometers to miles, multiply by 0.6214.

G.4.3.4 Option 3: Two Liquid Waste Treatment Buildings and Renovation Option

Under this option, the effects on ecological resources would be similar to those under the proposed project (Option 1). Resource area impacts that would differ from the proposed project are discussed in detail below.

Land Resources – Visual Resources

Activities in this option would be the same as those conducted in Option 2, with the additional renovation of a portion of the existing facilities. The renovated structure would have new external walls that would have color schemes that would match the new structures built as part of Option 2. Local visual impacts would therefore be similar to those described for Option 2.

Geology and Soils

About 95,000 cubic yards (73,000 cubic meters) of soil would be disturbed during building construction. Installation of the evaporation tanks and pipeline would disturb the same quantities of soil and rock as those given for Option 1.

This option would have a long-term positive effect by removing contaminated materials. More demolition would occur under this option than under Options 1 or 2, and a larger area of the associated potential release sites could be disturbed. More contaminated materials would be removed under this option. Contaminated material from demolition and construction would be managed according to waste type and LANL procedures. The long-term potential for spread of air- and waterborne contamination would be reduced.

Water Resources

Effects on water quality could be larger than those under Option 1 because more demolition is proposed under this option. However, implementing sediment and erosion control measures is expected to control possible consequences. Other water quality effects would be similar to those under Option 1.

Air Quality

Radioactive and nonradioactive emissions would be slightly greater under this option than under the proposed project because the amount of demolition would be greater. Other air quality impacts would be similar to those under Option 1.

Ecological Resources

Possible impacts on ecological resources would be the same as those for Option 1.

Human Health

Construction Impacts—Option 3 would result in somewhat larger worker hours and risks than would Option 2. Based on 377,000 worker hours, 4 to 16 recordable injuries could occur from construction (DOE 2004, BLS 2003). If the evaporation tanks and pipeline were built, an additional 420,000 person-hours would be required, with a possibility of 5 (DOE 2004) to 18 (BLS 2003) recordable injuries.

DD&D Impacts—Potential for worker exposure to radiological and hazardous material (such as asbestos) contamination would be greater under this option than under Option 2 due to the increased amount of demolition and the renovation in the existing facility. This greater potential exposure would result in very small increases in worker risk. DD&D activities would require 108,000 person-hours resulting in the possibility of 1 to 5 recordable injuries (DOE 2004, BLS 2003).

Operation Impacts—Impacts would be the same as those under Option 1.

Cultural Resources

Under this option, additional adverse effects on cultural resources are expected. In addition to impacts addressed under Option 2, changes to the structure of the existing Radioactive Liquid Waste Treatment Facility would alter the original appearance of the historic building. Removal of equipment, modification to the building, and demolition of the annexes would require documentation and consultation with the New Mexico Historic Preservation Office. Any mitigation plans would be implemented before DD&D began.

Socioeconomics and Infrastructure

Construction Impacts—Option 3 would require more infrastructure resources than Options 1 and 2 because Option 3 includes Option 2 plus renovating the existing facilities. Construction is estimated to require 500,000 gallons (1.9 million liters) of liquid fuels and 2.7 million gallons (10 million liters) of water. If the evaporation tanks and pipeline were constructed, then similar impacts to those described in Option 1 would occur. The existing LANL infrastructure would be capable of supporting Option 3 without exceeding site capacities.

Operations Impacts—Electricity and natural gas requirements would be slightly more than Options 1 and 2 since two new buildings would be constructed and existing facilities would be reused.

DD&D Impacts—Activities associated with facilities to be replaced by the new facilities in Option 3 would be similar to those described for Options 2. As in Option 2, a second annex would be removed. Option 3 would require quantities of liquid fuel and water similar to those for Option 1.

Waste Management

Construction, transition, and standdown waste volumes would be similar to those under Option 2. Under this option, contaminated wastes from demolition and renovation would exceed those of Options 1 and 2, as the South Annex would be demolished in addition to the East and North annexes. Existing external walls would be removed and replaced with seismically appropriate materials and construction as required to meet the LANL's standard for Hazard Category 2 facilities. In addition, electrical and plumbing systems that do not meet the current building codes would be replaced. Operational waste would be similar to that of the proposed project. All wastes would be managed in accordance with LANL procedures and the project's waste management plan. **Table G–31** provides the types and volumes of wastes generated during construction (contaminated soil and rubble volumes), transition, and demolition of buildings.

Table G–31 Construction and Decontamination, Decommissioning, and Demolition Waste Volumes – Two Liquid Waste Treatment Buildings and Renovation Option

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste (bulk)	7,720
Low-level radioactive waste (packaged)	2,570
Mixed low-level radioactive waste	153
Transuranic waste (contact-handled)	228
Demolition debris [a]	1,810
Construction waste [b]	1,150
Hazardous waste with asbestos	211
Solid hazardous with organics	< 1
Solid hazardous with metals	1

DD&D = decontamination, decommissioning, and demolition.
[a] Includes solid sanitary waste.
[b] Includes 427 tons (387 metric tons) of solid waste from constructing evaporation tanks. Construction waste density is 2 cubic yards per ton (1.4 cubic meters per metric ton).
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Transportation

Traffic effects would be the same as those for Option 1, except that the disruption would be longer in duration due to the extended renovation and demolition activities.

The large amounts of waste generated by construction and DD&D activities would have to be moved to a different location for disposal, mostly using over-the-road truck transportation. The effects from incident-free transportation and accident conditions of transporting the construction and DD&D wastes to disposal locations on or off site are presented in **Tables G–32** and **G–33**. All nonradiological and transuranic wastes would be transported to offsite facilities.

Table G–32 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings and Renovation Option

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite	LANL TA-54	0.58	0.00035	0.185	0.00011
Offsite	Nevada Test Site	3.46	0.0021	1.02	0.00061
	Commercial facility	3.35	0.0020	1.00	0.00060

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed of at WIPP.

Table G–33 Transportation Incident Impacts – Two Liquid Waste Treatment Building and Renovation Option

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL [b]	771	0.100	8.3×10^{-10}	0.0014
Nevada Test Site	771	1.68	8.3×10^{-8}	0.017
Commercial facility	771	1.52	6.2×10^{-9}	0.015

LCF = latent cancer fatality.
[a] All nonradiological wastes would be transported offsite.
[b] Transuranic waste is disposed of at WIPP.
[c] Approximately 85 percent of these are radioactive. Others include 13 percent industrial and sanitary wastes, and about 2 percent asbestos and hazardous wastes.

The results in these two tables indicate that no traffic fatalities or excess LCFs would be expected from transportation of generated wastes.

G.5 Los Alamos Neutron Science Center (LANSCE) Refurbishment Impacts Assessment

This section provides an impact assessment for activities to be taken to refurbish LANSCE. Section G.5.1 provides background information on the proposed project. Section G.5.2 provides a brief description of the proposed options for LANSCE. Section G.5.3 presents the environmental consequences of the No Action Option and the proposed project.

G.5.1 Introduction

In the late 1960s and early 1970s, the Los Alamos Meson Physics Facility was constructed as a world-class medium-energy physics machine with the primary mission of studying production of subatomic particles called pions and their interaction with nuclei. At that time, the nuclear weapons program needed an intense source of neutrons that the new machine could provide. As a result, an accelerator was designed and constructed to have an extraordinarily flexible beam structure capable of accelerating both positive and negative hydrogen ions and delivering those beams to multiple experimental areas simultaneously. In 1996, the Los Alamos Meson Physics Facility was renamed the Los Alamos Neutron Science Center (LANSCE) (LANL 2004a).

Since the LANSCE linear accelerator first accelerated protons in 1972, the facility mission has evolved considerably. However, investment in the physical infrastructure has not kept pace with that required for long-term sustainable operation at high reliability. NNSA now needs to make repairs to the facility and its operating systems and equipment to address its continued use. In addition, the refurbishment would eliminate the following sources of operational inefficiencies that could improve operational effectiveness: single-point failures with an estimated time to repair of greater than 30 days; equipment beyond its predicted end of life that could severely impact facility operations; obsolete equipment with no available spare parts; and environmental, safety, and health or code compliance issues necessary to continue safe operation.

G.5.2 Options Considered

Two options identified for LANSCE Refurbishment are the No Action Option and proposed project option.

G.5.2.1 No Action Option

Under the No Action Option, no action to refurbish the facility would be taken. The existing programs would be operated as they are today, and there would be limitations on the full expanded use of the facility; corrective maintenance and actions would continue to be performed as failures occur or certain activities would cease. If systems proposed for replacement on this project are neither modified nor upgraded, they are expected to fail. Based on currently available information, the nature, timing, or type of all failures cannot be predicted. However, many failures would delay programmatic work, campaigns, critical experiments, and their activities. All of this would result in higher program costs and lengthier schedules. Because the facility is over 30 years old, it would experience more and more severe failures over time, until either equipment would have to be replaced on a piecemeal basis through corrective maintenance (resulting in increased operating costs) or the facility would have to be shut down if unreliability adversely impacts safety. If this No Action Option is selected, there is a high probability that the research and development for the Stockpile Stewardship Program and radioactive isotope production would be shut down in 4 to 5 years.

G.5.2.2 Proposed Project

NNSA has identified a series of refurbishment activities that would ensure reliable facility operations well into the next decade. Refurbishment would prevent long nonoperational periods and costly emergency expenditures. This proposed project would entail replacing facility equipment, enhancing cost-effectiveness, and stabilizing the overall beam availability reliability, while imposing minimal disruption to user programs.

NNSA proposes to: (1) replace facility equipment where necessary to address code compliance or end-of-life issues that could severely impact facility operations, (2) enhance cost-effectiveness by system refurbishments or improvements that stabilize decreasing facility reliability and maintainability, (3) stabilize the overall beam availability and reliability in a manner that is sustainable over the longer term, and (4) accomplish the above with minimal disruption to scheduled user programs.

Achieving the above requires undertaking the following activities (LANL 2005b):

- Replacing a minimum set of klystrons, transmitters, high-voltage power systems, and ancillary hardware with new and modern equivalents to achieve high reliability of the 805-megahertz radiofrequency system
- Replacing the power amplifier, intermediate power amplifier, and ancillary hardware with a modern system to maintain and improve reliability of the 201-megahertz radiofrequency system
- Replacing antiquated hardware and software in the accelerator control, data acquisition, and timing systems that have become virtually nonmaintainable because of obsolescence
- Refurbishing and replacing vacuum and cooling systems and magnet power supplies for the accelerator and beam-transfer lines to substantially reduce the increasing amount of beam downtime due to these systems
- Refurbishing and improving beam-diagnostics systems to provide much-needed efficient beam-tuning capabilities to maintain reliability
- Replacing injector components to increase the negative-hydrogen beam intensity by a factor of two (LANL 2005b).

There is substantial evidence that many components needed to sustain reliable operation are near the end of life, are so obsolete that replacement parts can no longer be found, need replacement to comply with Federal law, or could have single-point failures with long lead time replacements (LANL 2004a).

All refurbishment and upgrade work for the LANSCE Refurbishment Project would be performed within the existing complex at TA-53. The activities proposed constitute a refurbishment of existing, operating facilities that would provide the same basic operational conditions that currently exist. The proposed project would be limited to the Accelerator Complex and experimental facilities. The proposed schedule has overall design beginning in fiscal year 2007, with refurbishment activities completed in fiscal year 2014. Under this schedule, an extended outage in the 2010 to 2012 timeframe may be required; however, work would be performed during these outages to minimize disruption to operations and would be conducted over the course of about 7 years (LANL 2005b). The project is not expected to result in material changes to the permitting basis (for example, air and water emissions), and the subprojects would fall within the bounds of existing permits.

Specifically, LANSCE Refurbishment would enhance cost-effectiveness by system refurbishments or improvements that reduce operating costs, improve decreasing facility reliability by replacing systems that have an impact of 15 percent or greater on reliability for those systems, and increase the negative-hydrogen beam intensity for improved proton radiography data (LANL 2005b).

G.5.2.3 Options Considered but Dismissed

Move the mission to another facility

Moving the mission from LANL to another location would reduce the amount of capital that must be invested at LANL; however, LANSCE continues to be the major LANL experimental-science facility and is a critical feature of LANL's science-based mission. The LANSCE facility is unique to LANL, and there is no foreseeable future substitute for this capability. A list of other DOE facilities that could be possible sites for portions of the mission need was identified by capability type. Technical capabilities for evaluation included: proton radiography, fast-burst neutron sources, neutron irradiation of weapons components, fast-neutron nuclear science, low-energy neutron nuclear science, and neutron scattering in support of weapons materials science. No one DOE facility was identified that could fulfill the entire mission of LANSCE, and no combination of facilities was identified that could complete the required missions without a new investment several times the cost of LANSCE refurbishment (LANL 2005b). Therefore, this action was dismissed from further consideration.

Construct a new facility and demolish the existing TA-53 facility at the end of its life

Construction of a new LANSCE facility at LANL or elsewhere would require more resources and is not a viable fiscal option at this time. Therefore, this option was dismissed from further consideration.

G.5.3 Affected Environment and Environmental Consequences

The LANSCE complex is located in TA-53 (see **Figure G–10**). NNSA proposes activities that constitute a refurbishment of an existing, operating facility that would provide the same basic operational conditions that currently exist (LANL 2006a). Therefore, the affected environment is TA-53, although the region of influence for each resource evaluated may extend beyond TA-53 and LANL.

The analysis of environmental consequences relies heavily on the affected environment descriptions in Chapter 4 of the main volume of this SWEIS, and care has been taken not to repeat this information. Resource areas or disciplines not expected to be affected by the LANSCE Refurbishment Project or that would not directly or indirectly affect project implementation have not been included. Otherwise, where information specific to TA-53 and LANSCE is available and aids understanding the TA-53 affected environment and potential environmental consequences, it has been included.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources* – Refurbishment takes place within existing structures and would not change land use designations or visual resources.

- *Geology and Soils* – Refurbishment takes place within existing structures.

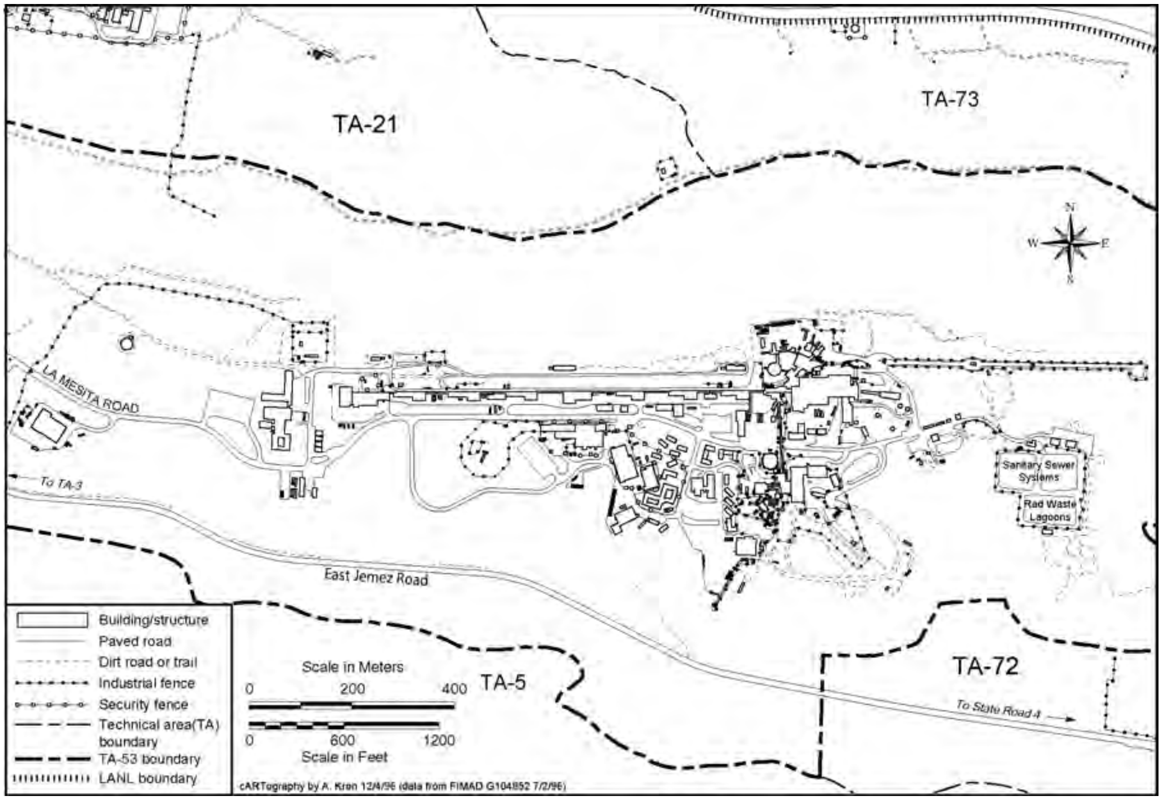


Figure G–10 Location of Los Alamos Neutron Science Center at Technical Area 53

- *Ecological Resources* – Refurbishment takes place within existing structures with no new land disturbed.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and refurbishment workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Transportation* – Refurbishment takes place within existing structures with no additional traffic effects.

- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-53, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – The proposed project would not implement new activities associated with radiological materials; only industrial accidents may occur.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: water resources, air quality and noise, human health, cultural resources, site infrastructure, and waste management.

G.5.3.1 No Action Option

Lack of investment in critical structural upgrades and replacements would delay programmatic work, campaigns, critical experiments, and their activities. Over time, this would result in higher program costs and lengthier schedules. Because no new buildings or facilities would be built under the No Action Option and operations would not change, there would be no impact on land use, water resources, human health, or transportation. Impacts of the No Action Option are included in the impacts of the No Action Alternative discussed in Chapter 5 of this SWEIS.

G.5.3.2 Proposed Project

All the refurbishment and upgrade work for the LANSCE Refurbishment Project would be performed inside the existing LANSCE complex at TA-53. The project is not expected to result in material changes to the permitting basis (air and water emissions), and the subprojects are assumed to fall within the bounds of existing permits.

Water Resources

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase annual discharge of nonradiological cooling water effluent due to potential increased use of the accelerator facilities. However, discharge levels are still expected to remain below those that were forecast for the *1999 SWEIS* (DOE 1999a).

Air Quality and Noise

LANSCE operations have historically accounted for more than 90 percent of all radioactive air emissions and 95 percent of the total offsite dose from LANL (LANL 2005a, 2006a). These emissions have historically come predominantly from stacks ES-3 and ES-2. Stack ES-3 ventilates Building 53-003, the linear accelerator and adjacent experimental stations. Stack ES-2 exhausts the proton storage ring and experimental stations at the Manuel Lujan Neutron-Scattering Center and Weapons Neutron Research Facility buildings. However, the shutdown of beam operations in Area A in the 1998 timeframe resulted in decreased radiological air emissions from the ES-3 emission point. Air activation products from the LANSCE stacks contributed over 95 percent of the total LANL radiological air emissions during 2005 (LANL 2006d).

Construction Impacts—As LANSCE Refurbishment Project activities would primarily involve upgrades and repairs or replacements of existing structures, systems, and components, including electrical, electronic, and mechanical systems; most work would be performed using portable equipment and hand tools. There would be some emissions of criteria and toxic pollutants from fuels, solvents, acids, and epoxies associated with project activities. Because implementation of individual subprojects would be spread out over a period of 7 years and emissions would be small, any impacts on ambient air quality would be negligible to minor and of short duration. Minor impacts of vehicle emissions from transport of materials and construction workers would occur off site. No radiological releases to the environment are expected in association with LANSCE Refurbishment Project activities.

Project activities could result in a temporary increase in noise levels near the TA-53 complex and near specific work areas. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from project workers' vehicles and materials shipments. Noise sources would not include loud impulsive sources such as blasting.

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase air emissions due to increased use of the accelerator facilities as described in Chapter 5, Section 5.4.2, of this SWEIS. The dose to the MEI from these emissions would be limited by operational controls to 7.5 millirem per year.

The acoustic environment of the more intensely developed TAs such as TA-53, in which administrative, research and development, and various industrial processes are collocated, includes noise from mechanical equipment (such as cooling systems, vents, motors, and material-handling equipment), in addition to employee motor vehicle and truck traffic. This level of noise at LANSCE would not change from existing levels and does not generally pose a hazard to workers. In situations requiring workers to enter high-noise environments, appropriate hearing protection is provided. LANSCE operations do not result in impulse noises that would be distinguishable by the public.

Human Health

During LANSCE operations, short-lived positron emitters, and activation products such as carbon-11, nitrogen-13, and oxygen-15, are released from the stacks and diffuse from the buildings. These products would release photon radiation as they decay, producing a potential radiation dose. Based on atmospheric modeling of actual releases and dose calculations, the dose to the MEI (at East Gate) from LANSCE in 2005 was 6.31 millirem. The total dose from all LANL operations to an individual at East Gate was approximately 6.46 millirem. This dose is under the EPA limit of 10 millirem per year, and approximately 1 percent of the naturally occurring background radiation dose (LANL 2006d).

Construction Impacts—No radiological risks would be incurred by members of the public from proposed LANSCE Refurbishment Project activities. Project workers would be at a small risk for work-related accidents and radiological exposures. However, as the majority of the scoped work would be performed in areas outside of the beam line, doses to workers performing these tasks would be minimal (LANL 2006a). These workers would be protected through appropriate training, monitoring, and management controls. Their exposure would be limited to ensure that doses were kept ALARA.

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase air emissions, including radiological emissions and consequential dose, due to increased use of the accelerator facilities. However, the dose would be limited by operational controls to 7.5 millirem per year.

Cultural Resources

The LANSCE Accelerator Building has been determined to be eligible for listing on the National Register of Historic Places. Although project-related modifications would not affect the external appearance of the structure, it would be necessary to make a determination of potential adverse effects and document existing conditions, as appropriate. Such documentation could include production of archival photographs and drawings. Additionally, any other significant historic buildings at TA-53 that could experience internal modifications would have to be evaluated for National Register of Historic Places eligibility status; these buildings must be considered potentially eligible until formally assessed.

Socioeconomics and Infrastructure

Utility infrastructure at the LANSCE complex encompasses the electrical power, natural gas, and water supply systems needed to support mission requirements. LANL's total electrical energy consumption was 421,413 megawatt-hours in fiscal year 2005, with LANSCE using 93,042 megawatt-hours. These values are well below the *1999 SWEIS* annual forecasts of 782,000 and 437,000 megawatt-hours, respectively. LANL's total electric peak demand was about 69.4 megawatts in fiscal year 2005 with LANSCE accounting for 21.9 megawatts of the total. Again, these values are well below the *1999 SWEIS* forecasts of 113 and 63 megawatts, respectively (LANL 2006f). Full-power operation of the 800-million electron volt linear accelerator alone requires 21 megawatts of power from the LANL electric grid. Natural gas is also consumed by boilers within TA-53 for space heating and also to operate and maintain the cooling water system (LANL 2003a, 2006a). LANSCE's boilers consumed approximately 65,283 decatherms (equivalent to about 65.3 million cubic feet [1.85 million cubic meters]) of natural gas in fiscal year 2005 (LANL 2006a). LANL's total natural gas consumption was 1,187,855 decatherms (equivalent to about 1.19 billion cubic feet [33.7 million cubic meters]) in fiscal year 2005. Site-wide natural gas consumption remained below the *1999 SWEIS* annual forecast of 1,840,000 decatherms (equivalent to about 1.84 billion cubic feet [52.1 million cubic meters]) (LANL 2006f). LANSCE's natural gas consumption was not individually forecast in the *1999 SWEIS*.

Cooling water requirements for accelerator operations drive total water demand at LANSCE. Operations have historically required about 77 million gallons (291 million liters) of water annually, or about 15 percent of the water consumption for all of LANL (LANL 2006a). LANL used about 359 million gallons (1.36 billion liters) of water in fiscal year 2005 (LANL 2006f); LANSCE's metered water use was approximately 54.8 million gallons (207 million liters) in 2005 (LANL 2006a). Nevertheless, recent LANL site-wide and historic LANSCE usages are well below the *1999 SWEIS* annual forecasts of 759 million gallons (2.87 billion liters) and 265 million gallons (1.0 billion liters), respectively (LANL 2006a, 2006f).

Overall, LANSCE demands for electric power and water have trended well below those forecast in the *1999 SWEIS* in part because those projections included operation of the Low-Energy Demonstration Accelerator. Operation of this facility was forecast to more than double LANSCE's electric peak load demand and its water demand for cooling tower operation (LANL 2006a). Nonetheless, this facility only operated from late 1998, and at lower power than originally proposed, until it was shut down in December 2001. The facility has been decommissioned and is being dismantled (LANL 2006f).

Construction Impacts—Requirements for utility infrastructure resources are expected to be negligible and well within the capacities of existing TA-53 utility systems (LANL 2006a). Although small quantities of gasoline and diesel fuel would be required for such uses as operation of vehicles associated with project activities and possibly for portable generators to power hand tools, spotlighting, and other construction equipment, fuel would be procured from offsite sources and, therefore, would not be a limited resource.

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation would likely indirectly increase utility demands over more recent levels due to increased use of the accelerator facilities as analyzed and described in Chapter 5, Section 5.8.2.3, of this SWEIS. However, levels are still expected to remain below those forecast in the *1999 SWEIS* (DOE 1999a).

Waste Management

LANL generates chemical and radioactive wastes as a result of research, production, maintenance, construction, and remediation service activities. For 2005, waste quantities generated from operations at the key facilities were below *1999 SWEIS* projections for all waste types (LANL 2006f). At LANSCE, low-level radioactive liquid waste is collected and allowed to decay in three process tanks, located in Building 53-945, prior to discharge to two lined evaporation tanks. Sanitary wastewater is collected and sent to the Sanitary Wastewater Systems Plant at TA-46. Chemical wastes include hazardous, toxic, and special wastes. Small quantities of hazardous wastes such as liquid solvents, solvents on wipes, lead, and solder are produced from accelerator maintenance and development (LANL 2006a). **Table G–34** presents the latest available waste generation data for LANSCE operations.

Table G–34 Waste Generation from Existing Los Alamos Neutron Science Center Operations at Technical Area 53

Waste Type	*1999 SWEIS ROD Projection*	*2005 Generation*
Low-level radioactive waste (cubic yards per year)	1,420	67
Mixed low-level radioactive waste (cubic yards per year)	1	< 1
Chemical (pounds per year)	36,600	1,980

ROD = Record of Decision.
Note: To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456.
Source: LANL 2006f.

Construction Impacts—LANSCE Refurbishment Project activities are expected to generate small quantities of low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous solid wastes. In particular, low-level and mixed low-level radioactive wastes would be generated from refurbishment of beam-line components, but operating experience would be combined with recognized waste minimization techniques to eliminate or reduce all waste streams (LANL 2004a). All wastes would be managed and disposed of in a fully compliant method that minimizes volume while minimizing exposure to workers. Liquid low-level radioactive waste would be processed directly through LANSCE's Radioactive Liquid

Waste Treatment Facility. Greater than 75 percent of all nonhazardous solid waste generated, including steel, wire and piping, and packing materials (such as pallets and packing crates), would be recycled (LANL 2006a).

Operations Impacts—While LANSCE Refurbishment Project activities are not intended to materially change LANSCE complex operations, project implementation may indirectly increase air emissions, including radiological emissions and consequential dose, due to enhanced operational availability of the accelerator facilities. However, levels are still expected to remain below applicable standards and levels that were forecast in the *1999 SWEIS*. In addition, an increase in LANSCE operations may result in generation of additional volumes of wastes, but quantities are expected to remain within the *1999 SWEIS* projections.

G.6 Technical Area 55 Radiography Facility Impacts Assessment

This section provides an assessment of environmental impacts for the proposed TA-55 Radiography Facility. Section G.6.1 provides background information on radiography facilities throughout LANL. Section G.6.2 provides a description of the TA-55 Radiography Facility proposed options. Section G.6.3 presents environmental consequences of the No Action Option and the new Radiography Building Option.

G.6.1 Introduction

The NNSA proposes to relocate high-energy x-ray radiography[1] (radiography) of nuclear items and components from the former location at TA-8 to facilities within restricted access areas of TA-55. This would involve an incremental development of the capability within TA-55.

In the ROD (61 *Federal Register* [FR] 68014) for the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996), LANL was assigned responsibility for ensuring the safety and reliability of weapons systems in the stockpile for the foreseeable future, in the absence of underground testing. LANL was also assigned responsibility for stockpile management, which addresses NNSA's production and maintenance of nuclear weapons, including component production and weapon disassembly, as well as stockpile surveillance and process development. Nondestructive examination of nuclear weapons components using dye penetrant testing, ultrasonic testing, and radiography of nuclear items and weapons components is a necessary piece of these responsibilities.

Many of the facilities for carrying out stockpile stewardship and management are located within the PIDAS at TA-55. Access to this area is highly restricted by physical barriers and security personnel. Research and development of nuclear weapons items and components are carried out in the Plutonium Facility, Building 55-4.

Radiography on nuclear items and components has been performed at Building 8-23 within TA-8 at LANL. This radiography facility has several types of radiographic equipment that provide extensive and flexible capabilities for nondestructively examining a wide range of materials and assembly configurations. Nuclear components and items were shipped by truck from TA-55 to

[1] *X-ray radiography is a nondestructive test method that uses penetrating radiation to probe the volume of an item or component. Different materials and thicknesses of the item or component require x-rays of different energies.*

radiography facilities at TA-8, a distance of approximately 4.5 miles (7.2 kilometers). A rolling roadblock was used when the materials were transported, and a temporary material accountability area was set up at TA-8 while the nondestructive examination procedures took place. These procedures required that security personnel accompany the transportation vehicles and be in place for the duration of the examinations; thus, significant security resources were required. This process was expensive, inconvenient, and logistically difficult. Since the events of September 11, 2001, there have been increased demands on security personnel, and adequate resources were not always readily available to safeguard the transportation and examinations. In addition, Building 8-23 required extensive renovation to continue to function as a nuclear facility. LANL ceased the movement of nuclear items and components out of TA-55 to TA-8, and radiography at LANL for these materials was stopped. This has prevented NNSA from effectively carrying out part of its mission for stockpile stewardship and management.

NNSA has developed a strategy for incremental development of the capability within the TA-55 PIDAS from low to high energy over a period of years. Under this strategy, NNSA has ceased radiography of nuclear items and components at TA-8, although radiography capability to support high-explosives operations remains at that location. The nuclear radiography capability is being relocated to TA-55 from TA-8 using near-term, interim, and long-term phases. The near-term phase utilizes low-energy radiography for nuclear items and components and uses destructive testing and other nondestructive examination information in lieu of high-energy radiography. This low-energy radiography capability is being developed in Building 55-4. The interim phase locates a mid-energy range capability (two 6 million electron volt machines) in a previously unused tunnel between Buildings 55-4 and the old 55-41. The long-term phase (the proposed project) would be to install a high-energy (up to 20 million electron volt) pit radiography capability. This document addresses the environmental impacts of locating the high-energy radiography capability at TA-55.

G.6.2 Options Considered

The two options identified for the TA-55 Radiography Facility are the No Action Option and the construction of a new facility within TA-55. Under the No Action Option, LANL would no longer be able to perform high-energy radiography. The new facility option would implement the strategy for developing high-energy radiography capability within the PIDAS at TA-55. NNSA would construct a new radiography facility at TA-55 to accommodate high-energy radiography and other nondestructive examination activities. Under both options, demolition activities within the TA-55 PIDAS that have no impact to the public, workers, or environment, and that have been categorically excluded, would continue.

G.6.2.1 No Action Option

Under the No Action Option, there would be no high-energy radiography capability for nuclear items and components at LANL. Some low-energy radiography would continue at Building 55-4, and the mid-energy radiography would take place in the tunnel adjacent to Building 55-4. No new structure would be built at TA-55 for high-energy radiography.

G.6.2.2 New Radiography Building Option

Under the New Radiography Building Option, NNSA would construct and operate a new facility within TA-55 in the area of Building PF-41; Building PF-41 is scheduled for demolition (see **Figure G–11**). The new facility would have 5,000 square feet (460 square meters) of available floor space. The New Radiography Building Option would include construction of a 400-square-foot (37-square-meter) accessory structure, which would contain the boiler for the facility. The new radiography building would be no more than two stories high, with one floor below ground level.

Figure G–11 Location of Building 55-41 Relative to Building 55-4 at Technical Area 55

G.6.2.3 Options Considered but Dismissed

A series of options for locating radiography capability were evaluated. The following sections describe options that were not further analyzed in this document because they do not meet the need for a more-efficient capability of nondestructive radiography of nuclear components and items as described in Section G.6.1.

Use of the TA-18 Radiography Facilities

Certain radiography capabilities exist at TA-18. However, use of these radiography facilities would require that nuclear items and components be transported approximately 2.5 miles (4 kilometers) to TA-18. Conducting the full suite of proposed radiography examinations at TA-18 would require installation of additional shielding materials and would conflict with existing space requirements for current TA-18 operations. In the *Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the*

Los Alamos National Laboratory (DOE 2002c) and ROD (67 FR 79906), NNSA stated its decision that many of the TA-18 capabilities would be relocated to the Nevada Test Site. Relocation of materials from TA-18 has taken place, and TA-18 no longer meets the requirements of a Security Category I nuclear facility. This option does not meet NNSA's purpose and need for a permanent, secure, and cost-effective radiography capability at TA-55.

Construct New Radiography Facility within Tunnels at TA-55

Another option was to construct a new high-energy radiography facility within or adjacent to the underground tunnel between Buildings 55-4 and 54-41. However, space within the tunnels is not large enough to accommodate high-energy radiography, access to and from the tunnels is restricted, and costs for conversion of tunnel space into a radiography facility would be excessive. Due to these limitations, this option was dismissed from further consideration.

Establish a Radiography Capability at the Chemistry and Metallurgy Research Building

The possibility of establishing a radiography capability at the Chemistry and Metallurgy Research Building was also investigated. This option would require transportation of nuclear items and components to and from the Chemistry and Metallurgy Research Building. In addition, the amount of nuclear material that can be located within the Chemistry and Metallurgy Research Building is highly restricted and the process of radiographic examination of nuclear items would exceed these limits (DOE 2003). In the *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2003) and ROD (69 FR 6967), NNSA stated its decision to relocate the analytical chemistry and materials characterization capabilities to a new facility at TA-55; however, the new facility does not include radiography capabilities or space to establish these capabilities. Due to these limitations, this option does not meet the purpose and need and was dismissed from further consideration.

Use of Building TA-55-41

Two options originally considered for a Radiography Facility would have used parts of Building TA-55-41, which was originally designed and constructed for storage of nuclear material. The options were to renovate the building or to demolish part of the building and construct a new radiography facility within the original high bay. However, the decision was made to totally demolish Building TA-55-41 and these options are not further considered.

G.6.3 Affected Environment and Environmental Consequences

Chapter 4 of this SWEIS describes the natural and human environment that could be affected by the options described. TA-55 is located on Pajarito Road, which is restricted to LANL-badged personnel. Building 55-4 is located within the PIDAS. Nuclear components are manufactured and nuclear research and development is conducted in Building 55-4.

Based on the option descriptions, environmental resources that may potentially be affected as a result of implementing the action options have been considered. An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources* – Land use and visual resources would not be affected, as construction would take place within an existing and previously disturbed industrial area.
- *Water Resources* – There would be no effect on water quality. Operation of the radiography facility would not result in any effluent discharges.
- *Ecological Resources* – The action option would be located within previously disturbed and developed land or adjacent to disturbed areas within an industrialized area of LANL. Facilities under the action options would not be located in a floodplain or wetland.
- *Socioeconomics and Infrastructure* – No new employment is expected. Construction workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.
- *Cultural Resources* – Because the proposed New Radiography Building Option would be constructed on previously disturbed land, no impacts to cultural resources are expected.
- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-55, with no disproportionate human health impacts to low-income or minority populations expected.

Resource areas examined in detail in this analysis include: geology and soils, air quality and noise, human health, site infrastructure, waste management, transportation, and facility accidents.

G.6.3.1 No Action Option

Under the No Action Option, the high-energy radiography capability would not be located in a new building at TA-55. Facilities at TA-8 and TA-55 could continue to be used in their current fashion. Under this option, there would be no construction activities.

There would be no change in ambient air quality effects associated with implementing the No Action Option. Ambient noise levels would remain unchanged in the vicinity of TA-55. Potential noise from construction and operational activities associated with the New Radiography Building Option would not occur.

There would be no potential for injuries to construction workers from activities planned under the action option. Potential radiation doses to radiography and nuclear material handlers would diminish because high-energy radiography of nuclear items and components would be discontinued.

The No Action Option would require no modification of existing utilities and infrastructure in TA-55. There would be no construction wastes generated and shipment of construction waste to landfills or recycling centers would not occur. There would be no additional effects to consider.

G.6.3.2 New Radiography Building Option

Geology and Soils

The 9-mile-long (14-kilometer-long) Rendija Canyon Fault is located approximately 0.8 miles (1.3 kilometers) west of Building 55-41 (see Section 4.2 of this SWEIS). Most of the small faults observed in the area have been inferred to represent ruptures subsidiary to the major faults, and as such their potential rupture hazard is very small (Gardner et al. 1999). Any new facilities would be designed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Construction of the new buildings would require excavation of up to 8,000 cubic yards (6,100 cubic meters) of soils as well as shallow bedrock in some areas. As a result, construction would generate excess soil and excavated bedrock that may be suitable for use as backfill. Uncontaminated backfill would be stockpiled at an approved material management area at LANL for future use. Best management practices would be implemented to prevent erosion and migration of disturbed materials from the site caused by stormwater, other water discharges, or wind.

Operations Impacts—Facility operations would not result in additional impacts on geologic and soil resources at LANL.

Air Quality and Noise

Construction Impacts—Construction activities as a result of implementing the new Radiography Building Option could result in temporary, localized emissions associated with vehicle and equipment exhaust as well as particulate (dust) emissions from excavation and construction activities. Effects on air quality would be temporary and localized. There would be no long-term degradation of regional air quality. Air emissions are not expected to exceed either National Ambient Air Quality Standards or New Mexico Ambient Air Quality Standards. Effects of the proposed project on air quality would be negligible compared to potential annual air pollutant emissions from LANL as a whole.

Implementing appropriate control measures would mitigate fugitive dust. Frequent watering with watering trucks would be used to control fugitive dust emissions. Emissions from diesel engine combustion products could result from construction activities involving heavy equipment. Air pollutant emissions associated with construction equipment operation would not result in exceedances of ambient air quality standards.

Implementation of the New Radiography Building Option would result in limited short-term increases in noise levels associated with various construction activities. Following completion of these activities, noise levels would return to preexisting levels. Noise generated by the New Radiography Building Option is not expected to have an adverse effect on LANL workers, members of the public, or the environment. New construction would require the use of heavy equipment for moving materials and for removal of debris and soil. Truck traffic would occur infrequently but would generally produce noise levels below that of the heavy equipment. Personal protective equipment would be required to protect workers' hearing if site-specific work produced noise levels above the LANL action level of 82 dB(A) on average. Noise from these construction activities should not be noticeable to most members of the public and should not disturb most local wildlife.

Operations Impacts—In general, radiography operations do not require hearing protection. When actual radiography work is being conducted, x-ray machines or devices are used to generate radiographs (or pictures) of objects. Cooling water circulators for x-ray machines can generate elevated noise levels, but employees are not located in the direct vicinity of these machines when they are in operation.

The proposed new radiography capability at TA-55 would include equipment that generates noise at levels well below the LANL action level of 82 dB(A) on average. Noise levels that exceed the action level would typically trigger implementation of a hearing conservation program for workers. However, this is not expected to be required for workers under the New Radiography Building Option.

Traffic noise from commuting workers is not expected to noticeably increase over present traffic noise level on roads at LANL. Worker vehicles would remain parked during the day and would not contribute to background noise levels except during rush hour. Therefore, noise levels from commuter traffic are not expected to change.

Human Health

The health of construction workers and LANL project staff is considered in this analysis because they would be involved in either facility construction or high-energy radiography equipment operation under the New Radiography Building Option. The radiography operations would take place in rooms protected by shielding, so that there would be no offsite radiation doses to the public under normal operations. Members of the general public are not affected because access to Pajarito Road, and thence to buildings within TA-55, is restricted. Unescorted, untrained members of the public are not routinely admitted to TA-55.

The health of LANL workers is routinely monitored depending upon the type of work they perform. Health monitoring programs for LANL workers consider a wide range of potential concerns, including exposure to radioactive materials, hazardous chemicals, physical or environmental hazards, and routine workplace hazards. In addition, LANL workers involved in hazardous operations are protected by various engineering or process controls and are required to wear appropriate personal protective equipment. Training is also required to identify and avoid or correct potential hazards typically found in the work environment and to respond to emergency situations. Workers with the potential to be exposed to radiation, such as radiography workers or nuclear material handlers, are monitored through the use of personnel radiation dosimeters. Because of the various health monitoring programs, requirements for personal protective equipment, and routine health and safety training, LANL workers are generally considered a healthy workforce, with a below-average incidence of work-related injuries and illnesses.

Construction Impacts—The most common hazards associated with construction activities are falls, heavy-equipment hazards, being struck or caught by objects or equipment, and transportation incidents. Potential fatalities can be considered by comparing national statistics on construction with project worker information for the New Radiography Building Option. Potentially serious exposures to various hazards or injuries are possible during the construction phases of the proposed project. Adverse effects could range from relatively minor (such as lung irritation, cuts, or sprains) to major (such as lung damage, broken bones, or fatalities). The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 32,400 person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be none (DOE 2004) to less than two (BLS 2003).

The New Radiography Building Option is not expected to result in adverse long-term effects on the health of construction workers; however, construction workers would be actively involved in potentially hazardous activities under this option. Construction activities would involve the use of heavy equipment (such as bulldozers and front-end loaders). Potentially serious exposures to various physical hazards or injuries are possible during the construction phases. To prevent serious injuries, all construction workers would be required to adhere to a contractor safety plan for construction activities. Adherence to an approved plan, use of personal protective equipment and engineered controls, and completion of appropriate hazards training would aid in prevention of adverse long-term health effects on construction workers.

Operations Impacts—Routine operation and maintenance of the proposed new radiography capability would be performed in accordance with standard practices used at LANL for conducting work with radiation-generating machines, such as Laboratory Implementation Requirement 402-700, *Occupational Radiation Protection Requirements*. Operation of the proposed new facility would pose potentially serious worker health hazards, such as high-radiation fields, when operating. To avoid potentially serious worker doses, radiography operations would be designed and constructed so that workers would not be exposed to high-radiation fields. This would be accomplished by use of warning alarms, mandatory evacuation of certain work areas or establishment of exclusion areas in and around the building, closed-circuit television monitors of high-radiation areas, and interlocks on all doors that would prevent inadvertent entry by staff but would allow workers to exit an area if they failed to respond to warning alarms. Occupied work areas, such as the control room, would be shielded, and radiation alarm monitors would be appropriately located to alert workers to high-radiation fields produced during routine operations. Workers would also be issued personnel radiation dosimeters and would utilize ALARA principles in their work.

Radiation levels at the target can cause injury or death; no workers would be in the vicinity of the target when x-ray machines are operating. Radiation dose levels would be greatly reduced in adjacent rooms and throughout the rest of the building. Work areas would be designed to shield workers in adjacent rooms to ensure that exposures are kept to less than 20 millirem per week, and routine radiography operations would result in worker radiation doses much less than 20 millirem per week for all site workers.

In addition to potential radiation doses from radiography operations, workers could also be exposed to radiation from handling, transporting, and testing various items containing nuclear materials. Engineering and administrative controls would be developed to keep worker doses as low as reasonably achievable. In addition, the amount of nuclear material allowed in the radiography room and adjacent test areas would be kept to a minimum, and no materials would be stored in the building.

Radiography workers and nuclear material handlers supporting the proposed project would be drawn from workers that currently perform these duties at LANL. Therefore, the dose to workers from the nondestructive examination operations would not be additive to doses typically received by these workers, nor would operations expose a new population of workers to radiological doses. The dose to individual workers and to the pool of workers that perform these tasks is not expected to change if the New Radiography Building Option is implemented.

Socioeconomics and Infrastructure

Utility infrastructure at the TA-55 Complex encompasses the electrical power, natural gas, steam, and water supply systems needed to support mission requirements. TA-55 used approximately 15,715 megawatt-hours of electricity in fiscal year 2005. TA-55 also uses natural gas to fire boilers for facility heating and other uses that are housed in Building 55-6. Natural gas consumption totaled 20,427 decatherms (equivalent to about 20.4 million cubic feet [0.58 million cubic meters]) in fiscal year 2005. TA-55 water usage is not metered (LANL 2006a). TA-55's electric power and natural gas consumption represented about 4 percent and 2 percent, respectively, of LANL's site-wide consumption in fiscal year 2005.

Construction—Utility infrastructure resources would be needed for construction of the new facility. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 42,000 gallons (159,000 liters) of liquid fuels and 234,000 gallons (886,000 liters) of water.

Operations Impacts—Utility infrastructure requirements for operation of the new Radiography Building would be limited to building connections, and no upgrades to existing utilities would be required. Usage in the new facility would be equivalent to or less than that of the former radiography facilities because contemporary building design includes water and energy conservation features. As such, operation of the new facility is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

Waste Management

About 24 cubic yards (18 cubic meters) of solid waste would be generated during construction of the new building. Construction and installation of the radiography facility would incorporate, to the extent practical, recommendations that would be provided in the pollution prevention design assessment for this project. Construction debris would be minimized through recycling, reuse, or reselling, if the cost benefits, resources, and available technologies permit. Material that cannot be recycled would be disposed of at the Los Alamos County Landfill or other New Mexico solid waste landfills. Recyclable material would be transported directly to an appropriate recycling facility or would be staged at the Los Alamos County Landfill for recycling. No potential release sites are known to be present at the proposed construction sites. The radiography project, in consultation with the environmental restoration activities, would perform characterization and confirmatory sampling to determine the soil disposition.

Transportation

Operations Impacts—Under the New Radiography Building Option, nuclear items and components would be transported within the PIDAS at TA-55. Radioactive materials and items would not be transported for radiography on LANL or public roads, and traffic would not be affected by road closures. Under the New Radiography Building Option, there would be reduced trips of nuclear components to TA-8. Fewer trips would result in less traffic and fewer potential roadway accidents.

Facility Accidents

Operations Impacts—In preparing this SWEIS, a large suite of accident scenarios was identified and grouped by material at risk. Accident types and initiators that could produce an accident with a frequency in excess of 10^{-7} (1 in 10 million) per year when realistically estimated or in excess of 10^{-6} (1 in a million) per year when conservatively estimated were treated as "credible" and "reasonably foreseeable." Rigorous evaluations were performed for the potentially risk-dominant scenarios, meaning those that were credible and led to offsite consequences beyond insignificant.

Under the New Radiography Building Option, radiographic capability would be moved from the High-Energy Processing Key Facility at TA-8 to TA-55. These radiographic procedures were evaluated for potential accidents for this SWEIS, and any potential accident is bounded by other accidents.

The New Radiography Building Option would not result in additional nuclear material at TA-55. Under the current procedure, nuclear items and components are stored and worked on at Building 55-4 and moved to TA-8 on a temporary basis for nondestructive examination. Thus, these nuclear items and components are part of the inventory at TA-55 that was used in the accident screening analysis.

G.7 Plutonium Facility Complex Refurbishment Project Impact Assessment

This section provides an impact assessment for the Plutonium Facility Complex Refurbishment Project in TA-55. Section G.7.1 provides background information on the refurbishment project and the proposed project to modernize and upgrade facility and infrastructure portions of the TA-55 Complex. Section G.7.2 provides a description of the proposed options for modernizing and upgrading the facility infrastructure at TA-55. Section G.7.3 presents the environmental consequences of the proposed infrastructure modernization and upgrade activities at TA-55.

G.7.1 Introduction

The TA-55 Plutonium Facility Complex (TA-55 Complex) encompasses about 40 acres (16 hectares) and is located about 1 mile (1.6 kilometers) southeast of TA-3. Most of TA-55 is situated inside a restricted area surrounded by a double security fence. The main complex has five connected buildings: the Administration Building, Support Office Building, Support Building, Plutonium Facility, and Warehouse. The Nuclear Materials Storage Facility (Building 55-41, discussed in the previous section) is separate from the main complex. Various other support, storage, security, and training structures are located throughout the complex.

To address the threats of the 21st century, the U.S. nuclear deterrent strategy requires a safe, secure, and reliable capability to design and manufacture replacement plutonium weapons components. This capability is provided through the Stockpile Stewardship Program. The TA-55 Complex is needed to support the Stockpile Stewardship Program and other nuclear programs. It must continue to operate to achieve its programmatic milestones, safely and cost-effectively, for at least the next 25 years. The Plutonium Facility Complex Refurbishment Project would enable an extension of the facility's lifetime by recapitalizing selected major facility systems to help ensure the facility's continuing capability and reliability to support NNSA's missions. In this project, major (also referred to as "critical") systems are defined as those facility and infrastructure systems whose loss of functionality or reliability due to an emergent disability could disrupt TA-55 Complex operations for an unacceptably long duration pending repair.

The TA-55 Complex, constructed in the mid-1970s, is the primary nuclear facility in the Nation for plutonium research and development. It consists of a Security Category I special nuclear materials laboratory and processing facility as well as support systems and structures. It is the most modern and well-equipped nuclear facility at LANL; however, it is aging, and critical systems are beginning to require excessive maintenance. The goal of this project is to support the Stockpile Stewardship Program and other efforts delineated in DOE and NNSA strategic plans for the next 25 years. An investment is necessary in the near term (the next 10 years or so) to upgrade electrical, mechanical, safety, security, facility control, and other selected facility-related systems.

The scope of the overall project is to modernize and upgrade facility and infrastructure portions of the TA-55 Complex that are approaching the end of life. This project is part of a comprehensive, long-term strategy to extend the life of TA-55 so that it can operate safely, securely, and effectively for at least another 25 years (LANL 2006a).

The project would be executed through a series of subprojects. The subprojects focus on priority facility systems and components that would improve overall facility reliability and that are critical to facility and program operations. Subproject sequencing would minimize disruptions to operations. The process of subproject sequencing requires consideration of a number of factors that have direct bearing on the way this project would be accomplished. Factors considered in prioritization of subprojects include:

- *Regulatory Requirements*: Is there a regulatory mandate or driver, law, policy, or order that would be satisfied by completion of the subproject?
- *Environmental Impact and Minimize Waste*: Will completion of the subproject reduce the possibility of an adverse environmental impact or reduce current waste generation?
- *Personnel Safety*: Will completion of the subproject result in improvement of personnel safety?
- *Mission*: Will completion of the subproject improve the facility's ability to support mission requirements?
- *Security*: Will completion of the subproject lead to an improvement in security?
- *Maintainability*: Will completion of the subproject lead to an improvement in maintainability?
- *Reliability*: Will the equipment or system be more reliable after completion of the subproject?
- *Availability*: Will completion of the subproject lead to an improvement in facility availability?
- *Maintain Authorization Basis*: Is the item classified as Safety, Structures, Systems and Components and will completion of the subproject strengthen the Facility Authorization Basis?
- *Condition Assessment System Status*: If the system is listed in the Condition Assessment System, will completion of the subproject improve its condition assessment?

G.7.2 Options Considered

The two options identified for the Plutonium Facility Complex Refurbishment are the No Action Option and the proposed project option.

G.7.2.1 No Action Option

Under the No Action Option, operations at TA-55 would continue at the level they are today. There would be no renovations or remodeling to improve reliability of pit production or actinide processing. Corrective maintenance and actions would continue to be performed as failures occur. However, maintenance cost would increase to support the aging systems until the systems must be shut down or replaced. If systems proposed for replacement on this project are neither modified nor upgraded, they are expected to fail in the next 10 to 15 years. Based on available information, it is not possible to predict the nature, timing, or type of failures. However, many failures would delay programmatic work, possibly damage equipment, and possibly pose a risk to personnel safety, campaigns, critical experiments, and other activities where plutonium analysis and capabilities are required. Because the facilities are over 25 years old, they would experience more and more severe system failures over time, until either the systems would have to be replaced on a piecemeal basis through corrective maintenance (resulting in increased operating costs) or the facility would have to be shut down.

G.7.2.2 Proposed Project

Existing facilities would be renovated for purposes of life extension rather than just maintenance. This option would entail renovating building systems in the Plutonium Facility or systems supporting the Plutonium Facility. The approach of this project is to renovate or refurbish only systems most in need of upgrading. However, renovations would have to be conducted in an operating nuclear facility, with the attendant programmatic impact and reduction of construction efficiency. Contamination control and safeguards and security issues would not be trivial and would have to be addressed.

All work would be performed inside the existing TA-55 Complex. Most of the work would be inside existing structures or would entail modifications to existing structures that are relatively minor in scope. The proposed project would be limited to the TA-55 Complex and is organized as follows:

- Inside the Plutonium Facility
- Exterior to the Plutonium Facility, including closely related support work (for example, the Plutonium Facility roof)

This section lists a series of upgrades that would compose Phase 1 of the TA-55 Refurbishment Project based on current planning assumptions. Although the list may change based on future planning decisions, and subprojects currently scheduled for a later phase may be moved up in priority, the impacts of the current Phase I upgrades would be similar.

- Heating and cooling systems (preheat coils in intake stacks)
- Heating, ventilation, and air conditioning plenums and associated Zone 1 plenums
- Roof (membrane) for the Plutonium Facility
- Confinement doors in the Plutonium Facility
- Heating, ventilation, and air conditioning ductwork Zone 1
- Criticality alarm system
- Fire water sprinkler piping
- Vault water tanks
- Air dryers
- Stack upgrade and replacement
- Fire alarm panel and wiring
- Fire alarm devices – buildings
- Fire alarm devices – gloveboxes
- Heating, ventilation, and air conditioning plenums (non-safety class portions)

- Glovebox stands
- Chiller replacement
- Replacement of cooling towers
- Elevator
- Waste transfer system
- Uninterruptible power supply replacement

This section lists the types of upgrades that are scheduled for later phases of the Plutonium Facility Complex Refurbishment Project, based on current planning assumptions. Depending on mission requirements and funding availability, any of the following subprojects could be reprioritized for earlier completion.

- Heating and cooling systems (except preheat coils in intake stacks)
- Non-plutonium-facility heating, ventilation, and air conditioning
- Heating, ventilation, and air conditioning plenums
- Heating, ventilation, and air conditioning ductwork intakes, bleed-off, exhaust
- Heating, ventilation, and air conditioning fans and motors
- Facility control system
- Nonprocess cooling water system
- Fire suppression system
- Fire suppression – halon system
- Fire doors electrical distribution system
- 13.2-kilovolt distribution
- Paging system
- Process air
- Continuous air monitoring systems
- Fixed-head air sampler blower system
- Steam system
- Positive pressure chilled water
- Bubbler bypass features
- Chlorine gas delivery system
- Remove selected gloveboxes from throughout the building
- Hot water system
- Utility gas systems
- Industrial gas systems (trailers)

- Radiation protection systems
- Wet vacuum
- Acid distribution
- Water storage tank exteriors
- Sanitary waste
- Site drainage
- Material control and accounting systems
- Tie in Facility Improvement Technical Support (FITS) Building (TA-55) and Manufacturing Technology Support Facility (protocol) to classified local area network
- Communications capacity
- Roofs
- Structure (confinement system)
- Lockers and change facilities
- Operations Center
- Attic
- Laboratories – doors
- Vault racks and shelving, Kardex Unit, and special nuclear material storage drawers
- Trolley systems
- Perimeter road and site paving
- Upgrade tunnel – Plutonium Facility to Building 55-41
- Facilities for site support service contractor
- Warehouse capability
- Cafeteria
- Training Center and mockup for TA-55
- Equipment and glovebox mockup and assembly area

The subprojects would be designed and installed so that any changes in operation would be consistent with approved environmental permits issued by the EPA and the State of New Mexico. The subprojects would not materially change any aspect of LANL's ability to comply with permits. While the new structures, systems, or components may not function in precisely the same way as the existing ones and may be constructed, fabricated, and operated in a different manner, they would fulfill the same function and provide at least the same level of protection and monitoring as the existing ones. One exception is the stack upgrade and replacement subproject for the Plutonium Facility. The proposed modifications are in part in anticipation of more stringent stack release requirements. These modifications would result in stacks that are different in size and would have better performance parameters than the existing stacks.

All proposed work would be performed inside or adjacent to the existing TA-55 Complex. Most of the work would be inside existing structures or would entail modifications to existing structures, systems, or components that would result in relatively minor changes to their operational performance.

G.7.2.3 Options Considered but Dismissed

Move the Stockpile Stewardship Program to another location

DOE prepared the *Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996) to analyze mission assignments. In its ROD (61 FR 68014), DOE assigned pit production and associated activities to support stockpile stewardship and management to LANL. Thus, the option of moving the Stockpile Stewardship Program to another location within the nuclear weapons complex was already considered and dismissed from further consideration.

G.7.3 Affected Environment and Environmental Consequences

In the case of the proposed project, it is difficult to upgrade an operating nuclear facility with high levels of security because of the organizational, programmatic, safety, and security constraints involved. The constraints and requirements are necessarily much more formal and detailed than those for an office building, for example. The proposed project involves existing, required assets. As such, it must be constructed at TA-55 within the existing systems and infrastructure; there are no other options as to location. Therefore, the affected environment is TA-55, although the region of influence for each resource evaluated may extend beyond TA-55 and LANL.

The analysis of environmental consequences relies heavily on the affected environment descriptions in Chapter 4 of this SWEIS, and care has been taken not to repeat this information. Resource areas or disciplines not expected to be affected by the Plutonium Facility Complex Refurbishment Project, or that would not directly or indirectly affect project implementation, have not been included. Otherwise, where information specific to TA-55 is available and aids understanding the TA-55 affected environment and potential environmental consequences, it has been included.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Land Resources-Visual* – Visual resources would not be affected because subprojects would occur indoors or in a previously disturbed industrial area.
- *Ecological Resources* – The project would occur in an already-developed area of TA-55. No parts of the project would be located in a floodplain or wetland.
- *Cultural Resources* – The proposed upgrades to the main TA-55 Plutonium Facility Complex buildings are likely exempt under the Programmatic Agreement between the

State Historic Preservation Office and NNSA and, therefore, would not require any formal compliance consultation.

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D (refurbishment) workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-55, with no disproportionate human health impacts to low-income or minority populations expected.

- *Facility Accidents* – Potential facility accidents associated with this proposed project are addressed as part of the No Action Alternative of this SWEIS.

This impact assessment focuses on those areas of the affected environment where potential impacts would occur: land use, geology and soils, water resources, air quality and noise, human health, site infrastructure, waste management, and transportation.

G.7.3.1 No Action Option

Under the No Action Option, the project to refurbish systems in the Plutonium Facility Complex would not be implemented, necessitating a continued high level of maintenance activity to keep the facility operating safely. The overall environmental impacts of the Plutonium Facility Complex would be as described under the No Action Alternative in Chapter 5 of this SWEIS. However, as systems continue to require replacement and maintenance, there would be collateral impacts. The two Plutonium Facility stacks are corroded, and surveillance and sampling is becoming problematic, which could degrade regulatory compliance. In addition, the stacks no longer meet American National Standards Institute stack requirements or New Mexico State requirements. Although utility demand would reflect continuation of current activities, as existing radiological facilities age and associated utility systems deteriorate, utility usage would increase as utility system efficiency decreases over time. No changes in waste types are expected in the short term under the No Action Option. As systems and equipment age and the level of required maintenance increases, there could be a commensurate increase in the amount of waste generated. Waste generation rates are expected to remain within LANL waste management infrastructure capabilities.

G.7.3.2 Proposed Project

Under the Plutonium Facility Complex Refurbishment Project, work related to the subprojects would be performed primarily within or around existing structures at TA-55.

Land Resources – Land Use

TA-55 is situated in the west-central portion of LANL along Pajarito Road between Twomile and Pajarito Canyons approximately 1.1 miles (1.8 kilometers) south of the Los Alamos townsite. The Plutonium Facility Complex within TA-55 encompasses 40 acres (16.2 hectares) of land, 43 percent of which is developed (DOE 2003). Existing land uses within TA-55 are designated

Nuclear Materials Research and Development and Reserve (LANL 2003c). TA-55 falls within the Pajarito Corridor West Development Area. In general, the plan designates land use north of Pajarito Road as Infill (the area around existing structures), Primary Development (to the west and south of developed areas), or Parking (to the southeast of developed areas) (LANL 2001).

Construction Impacts—Implementation of several subprojects to the existing project scope would involve varying degrees of land-disturbing activities ranging from grading work and roadway replacement to construction of accessory structures or additions to existing structures within the TA-55 Complex. These subprojects would collectively have a negligible-to-minor incremental impact on land resources at LANL and would be consistent with prevailing land uses of the TA-55 Complex.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in additional impacts on land resources at LANL.

Geology and Soils

The 9-mile-long (14-kilometer-long) Rendija Canyon Fault is located approximately 0.8 miles (1.3 kilometers) west of the Plutonium Facility at TA-55 (see Section 4.2 of this SWEIS). Most of the small faults observed in the area have been inferred to represent ruptures subsidiary to the major faults, and as such their potential rupture hazard is very small (Gardner et al. 1999). Proposed new and upgraded structures, systems, or components would be designed, constructed, and operated in compliance with applicable DOE orders, requirements, and governing standards established to protect public and worker health and the environment.

Construction Impacts—Refurbishment project activities at TA-55 would have no or negligible direct impact on geologic and soil resources, as all work would be performed inside and adjacent to existing TA-55 facilities. Potential release sites that could be impacted by refurbishment project activities at TA-55 would be addressed in accordance with DOE requirements and the Consent Order. That is, prior to commencing ground disturbance, potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with procedures established for environmental remediation. Other buried objects would be surveyed and removed as appropriate.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in any additional impacts on geologic and soil resources at LANL. The structural integrity and seismic safety basis of TA-55 facilities would be improved because a number of the proposed project subprojects would involve structural upgrades that specifically include installation of seismic bracing to meet current performance category standards.

Water Resources

TA-55 is located on a narrow mesa (Mesita del Buey). The mesa is flanked by Mortandad Canyon to the north and Twomile Canyon to the south. TA-55 is primarily a heavily developed facility complex, with surface drainage occurring primarily as sheet-flow runoff from the impervious surfaces within the complex. No developed portions of the complex are located within a delineated floodplain. One TA-55 facility discharges cooling-tower blowdown directly to Mortandad Canyon (via National Pollutant Discharge Elimination System Outfall 03A-181) (DOE 2003). In 2005, discharges through this outfall totaled 2.40 million gallons (9.08 million liters) (LANL 2006f).

Construction Impacts—Impacts on water resources would be negligible under this option, as there are no natural surface water drainages in the TA-55 Complex vicinity and ground-disturbing activities would be minor. Appropriate soil erosion and sediment control measures (sediment fences, stacked hay bales, and mulching disturbed areas) and spill prevention practices would be employed to minimize suspended sediment and material transport and potential water quality impacts. No onsite discharge of sanitary wastewater is planned, nor impact on surface water expected.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would result in no additional impacts on water resources at LANL. The proposed refurbishment activities are not intended to materially change TA-55 operations, and no measurable increase in effluent discharge is expected (LANL 2006a).

Air Quality and Noise

Estimates for selected toxic and hazardous air pollutant emissions from key LANL facilities were made in the *1999 SWEIS* (DOE 1999a) based on chemical use at LANL and assumed stack and building parameters. Chemical purchasing records for these key facilities have been reviewed each year and estimated emissions reported in the annual *SWEIS Yearbooks* (LANL 2003b, 2004d, 2005c, 2006f). **Table G–35** presents estimated toxic and hazardous air pollutant emissions for 2005 based on chemical usage at TA-55.

Table G–35 Toxic and Hazardous Pollutant Air Emissions from Existing Operations at Technical Area 55

Chemical and Form	*2005 Air Emissions (kilograms)*
Acetone	4.56
Acetylene	0.00
Ammonium Chloride (Fume)	0.28
Ethanol	82.07
Hydrogen Chloride	9.14
Hydrogen Peroxide	0.18
Magnesium Oxide Fume	0.35
Methyl Alcohol	0.28
Nitric Acid	9.35
Oxalic Acid	0.53
Potassium Hydroxide	0.18
Propane	0.00
Tributyl Phosphate	1.36

Note: To convert kilograms to pounds, multiply by 2.2046.
Source: LANL 2006f.

Radiological air emissions from operations at TA-55 in 2005 are described in Chapter 4, Section 4.4.3.1, Radiological Monitoring. TA-55 typically produces a minimal amount (less than 3 percent) of the total LANL air emissions.

Construction Impacts—As execution of the higher-priority subprojects would primarily involve upgrades to and repairs or replacements of existing structures, systems, and components, including electrical, electronic, plumbing, and mechanical systems, most work would be performed using portable equipment and hand tools. There would be some criteria and toxic pollutant emissions from fuels, solvents, acids, and epoxies associated with subproject work. Because implementation of individual subprojects would be spread out over a number of years rather than performed concurrently, any impacts on ambient air quality would be negligible to minor and of short duration.

Construction activities would result in a temporary increase in emissions from construction equipment, trucks, and, to a lesser degree, employee vehicles. Incremental increases in toxic air pollutants would be small and would have a negligible-to-minor short-term impact on local ambient air quality.

Although no radiological releases to the environment are expected in association with construction activities at TA-55, the potential exists for contaminated soils and possibly other media to be disturbed during excavation and other site activities. Potential release sites at TA-55 that could be impacted during site activities would be addressed in accordance with DOE requirements and the Consent Order. To determine the extent and nature of any contamination, an assessment of the affected areas would be performed prior to commencing ground disturbance. If the contamination poses an unacceptable risk to the public or LANL workers, the sites would be cleaned up before proceeding.

Refurbishment project activities and new facility construction would result in some temporary increase in noise levels near the TA-55 Complex and near specific subproject work areas. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from project workers' vehicles and materials shipments. Noise sources associated with the proposed subprojects are not expected to include loud impulsive sources such as blasting.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in any measurable increase in air emissions. Implementation of the stack upgrade and replacement subproject would provide for improved in-stack mixing and emissions monitoring.

Further, implementation of the chiller replacement subproject would have a positive impact on environmental quality by removing ozone-depleting substances, and one subproject (steam system) would directly reduce emissions of criteria pollutants by replacing natural-gas-fired boilers with electric units.

Following completion of Plutonium Facility Complex Refurbishment Project activities, facility operations would not result in any measurable increase in noise levels.

Human Health

LANL workers receive the same dose as the general public from background radiation, but they also receive an additional radiation dose from working in facilities with nuclear materials, such as at TA-55. However, occupational radiation exposures for workers at LANL remain well below those projected for the *1999 SWEIS* ROD. The majority of the LANL offsite maximum exposed individual dose in 2005 (6.46 millirem) resulted from emissions from LANSCE stacks. The portion of that dose attributed to operations at TA-55 is minimal (less than 1 percent) (LANL 2005a). All worker doses in 2005 were below the 5-rem-per-year standard set by DOE (LANL 2006f). Further details can be found in Section 4.6.2.1 of this SWEIS.

No radiological risks would be incurred by members of the public from proposed project activities. Project workers would be at a small risk for work-related accidents and radiological exposures. They could receive doses above natural background radiation levels from exposure to radiation from other past or present activities at the site as well as from work in contaminated areas and encountering contaminated materials during subproject execution. However, these workers would be protected through appropriate training, monitoring, and management controls. Their exposure would be limited to ensure that doses were kept ALARA. The individual dose to involved workers would be less than 500 millirem per year for any subproject (LANL 2006a).

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, there would be no increase in radiological releases to the atmosphere from normal operations, as the proposed upgrades are not intended to materially change TA-55 Complex operations. Similarly, there would be no change in the basis for postulated accidents and resulting consequences from implementation of this option, as upgrades would not materially change facility operations and materials at risk would not be affected. A number of the higher-priority subprojects involve upgrades that would substantially improve the safety basis of the TA-55 Complex and the Plutonium Facility in particular. In addition, implementation of the stack upgrade and replacement subproject, as previously discussed, would provide for improved in-stack mixing and emissions monitoring in support of improved regulatory compliance.

Socioeconomics and Infrastructure

Utility infrastructure at the TA-55 Complex encompasses the electrical power, natural gas, steam, and water supply systems needed to support mission requirements. TA-55 used approximately 15,715 megawatt-hours of electricity in fiscal year 2005. TA-55 also uses natural gas to fire boilers for facility heating and other uses that are housed in Building 55-6. Natural gas consumption totaled 20,427 decatherms (equivalent to about 20.4 million cubic feet [0.58 million cubic meters]) in fiscal year 2005. TA-55 water usage is not metered (LANL 2006a). TA-55's electric power and natural gas consumption represented about 4 percent and 2 percent, respectively, of LANL's site-wide consumption in fiscal year 2005.

Construction Impacts—Requirements for utility infrastructure resources, including electricity, fuels, and water, are expected to be negligible for most subprojects and activities would be staggered over an extended period of time. Existing TA-55 utility systems would easily be capable of supporting project activities (LANL 2006a). Small quantities of gasoline and diesel fuel would be required for such uses as operation of construction vehicles and possibly for portable generators to power hand tools, spotlighting, and other construction equipment. This fuel would be procured from offsite sources and, therefore, would not be a limited resource.

Operations Impacts—The proposed refurbishment activities are not intended to materially change TA-55 operations. No net increase in utility infrastructure demands is expected that would be directly related to implementation of the proposed project.

Waste Management

LANL generates chemical and radioactive wastes as a result of research, production, maintenance, construction, and remediation service activities. For 2005, waste quantities generated from operations at the key facilities were generally below *1999 SWEIS* ROD projections for nearly all waste types (LANL 2006f). **Table G–36** presents the latest available waste generation data for TA-55 operations.

Table G–36 Waste Generation from Existing Operations at Technical Area 55

Waste Type	*1999 SWEIS ROD Projection*	*2005 Generation*
Low-level radioactive waste (cubic yards per year)	986	380
Mixed low-level radioactive waste (cubic yards per year)	17	17
Transuranic waste (cubic yards per year)	310	62
Mixed transuranic waste (cubic yards per year)	133	125
Chemical (pounds per year)	18,500	2,840

ROD = Record of Decision.
Note: To convert cubic yards to cubic meters, multiply by 0.76455; pounds to kilograms, by 0.4536.
Source: LANL 2006f.

The Plutonium Facility has capabilities to treat, package, store, and transport the radioactive waste produced by TA-55 operations. Liquid wastes are converted to solids or are piped to the TA-50 Radioactive Liquid Waste Treatment Facility. Some transuranic wastes are immobilized with cement in 55-gallon (208-liter) drums. Other transuranic waste is consolidated in 55-gallon (108-liter) drums or is packaged in waste boxes. Low-level radioactive wastes also are packaged in the Plutonium Facility, where care is taken to avoid combining hazardous waste with radioactive waste to form mixed waste. Solid wastes of all types are stored temporarily at TA-55 until they are shipped to onsite waste storage or disposal locations, primarily in TA-54 (LANL 2006a).

Construction Impacts—Refurbishment project activities are expected to generate transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous solid and sanitary wastes from removal of equipment being replaced and construction activities. Projected waste volumes, for those wastes where estimates have been made, are provided in **Table G–37**.

Table G–37 Total Waste Generation from Implementation of the Plutonium Facility Complex Refurbishment Project at Technical Area 55

Waste Type	*Projected Generation*
Low-level radioactive waste (cubic yards)	1,290 [a]
Mixed low-level radioactive waste (cubic yards)	216
Transuranic waste (cubic yards)	196
Mixed transuranic waste (cubic yards)	144
Chemical waste (pounds)	2,000
Nonhazardous solid waste (cubic yards)	2,740 [b]

[a] Includes 970 cubic yards (740 cubic meters) of bulk low-level radioactive waste and 320 cubic yards (240 cubic meters) of packaged low-level radioactive waste.
[b] Includes about 2,060 cubic yards (1,570 cubic meters) of demolition debris and 685 cubic yards (524 cubic meters) of construction waste.
Note: To convert cubic yards to cubic meters, multiply by 0.7644; pounds to kilograms, multiply by 0.4536.
Source: LANL 2006a.

Low-level radioactive waste would consist mainly of construction debris removed from radiological control areas. Chemical waste could include various materials removed from inside TA-55 facilities as part of the upgrades, including electronic components, wiring, batteries, and other materials (LANL 2006a). Chemical wastes may also include spent chemical wastes or leftover materials that could not otherwise be recycled, such as solvents or acids. Construction debris and miscellaneous removed equipment (water tanks, pumping units, heating and ventilating equipment, and roofing material) would be characterized to determine the appropriate waste classification. All wastes would be managed and disposed of in a fully compliant method that minimizes volume while minimizing exposure to workers. Subprojects would be designed and constructed to incorporate pollution prevention and waste minimization features. For some subprojects, DD&D would be performed after the new systems are in place; for others, DD&D would be part of the critical path. Waste volume estimates would be refined through conceptual design report activities. A waste management plan would be developed by the project as part of the conceptual design report. The existing LANL waste management infrastructure is adequate for management of the waste types and quantities generated by the Plutonium Facility Complex Refurbishment activities.

Operations Impacts—Following completion of Plutonium Facility Complex Refurbishment Project activities, there would be no increase in TA-55 waste generation rates, as the proposed upgrades are not intended to materially change TA-55 Complex operations.

Transportation

Construction Impacts—Traffic on Pajarito Road could be disrupted due to temporary increases during construction.

Operations Impacts—Under the proposed project, interstate waste transportation would decrease over the long term. However, local traffic would increase.

Waste generated during refurbishment activities would have to be transported for disposal at either LANL TA-54 or an offsite location, using over-the-road truck transportation. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure as the waste packages are transported along the highways. There is also increased risk from traffic accidents (without release of radioactive material) and radiological accidents (in which radioactive material is released).

The effects of accident-free transportation of wastes on the worker population and general public are presented in **Table G–38**. The effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project and estimated to occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risks of developing excess LCFs are highest for workers under the offsite disposition option because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. As shown in Table G–38, disposal of low-level radioactive waste at Nevada Test Site, which is farthest from LANL, would lead to the highest dose and risk, although the dose and risk are low under all disposal options.

Table G–38 Incident-Free Transportation Impacts – Plutonium Facility Complex Refurbishment

Disposal Option	*Low-Level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCF)*	*Collective Dose (person-rem)*	*Risk (LCF)*
Onsite disposal	LANL TA-54	0.85	0.00051	0.27	0.00016
Offsite disposal	Nevada Test Site	1.38	0.00083	0.43	0.00026
	Commercial Facility	1.34	0.00081	0.42	0.00025

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed of at WIPP.

Table G–39 presents the impacts of traffic and radiological accidents. This table provides population risks from traffic accidents in terms of LCFs caused by exposure to releases of radioactivity, and of fatalities caused by the collisions themselves. The analyses assumed that, all transuranic and nonradioactive wastes generated by refurbishment activities would be transported to offsite disposal facilities.

Table G–39 Transportation Incident Impacts – Plutonium Facility Complex Refurbishment

Low-Level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCFs)	*Traffic (fatalities)*
LANL TA-54	285	0.11	1.2×10^{-9}	0.0013
Nevada Test Site	285	0.34	1.2×10^{-8}	0.0036
Commercial facility	285	0.32	9.1×10^{-9}	0.0034

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed of at WIPP.
[b] All nonradiological wastes would be transported off site.
[c] Approximately 46 percent of these are radioactive. Others include 54 percent industrial and sanitary and about 0.4 percent asbestos and hazardous.
Note: To convert kilometers to miles, multiply by 0.6214.

The results in these two tables indicate that no traffic fatalities or excess LCFs are expected from transportation of generated wastes.

Because all of the LCFs estimated, as shown in Tables G–37 and Table G–38, are much less than 1.0, the analysis indicates that no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from accidental release. Likewise, no fatalities are expected from traffic accidents.

G.8 Science Complex Impact Assessment

This section provides an assessment of environmental impacts for the proposed project consisting of the construction and operation of the Science Complex at several alternate LANL sites. The Science Complex would be constructed within the timeframe under consideration in this SWEIS. More general descriptions of the affected environment at LANL are located in Chapter 4 of this SWEIS, while this appendix focuses on project-specific analyses of those resources that would be impacted by the Science Complex Project. The proposed Science Complex Project is categorized as one that would relocate existing operations to a completely new facility, and then conduct DD&D of an equivalent square footage of existing LANL facilities. Section G.8.1 provides background information and rationale for the proposed project to build the Science Complex, while Section G.8.2 provides descriptions of the location options for the Science Complex. Section G.8.3 describes the affected environment and impacts of the No Action Option and the proposed project (construction and operation of the proposed Science Complex) at all of the location options.

G.8.1 Introduction

NNSA and DOE are proposing to construct two buildings and one supporting parking structure. This facility, collectively referred to as the Science Complex, would aid NNSA in fulfilling its primary Defense Program Stockpile Stewardship mission, while supporting basic and applied scientific research and technology to be conducted on DOE-administered land that could be custodially transferred from one Federal agency to another or by long-term ground lease or government-approved land transfer. The Science Complex would replace 402,000 gross square feet (37,300 square meters) of LANL's 5,800,000-square-foot (538,800-square-meter) of outdated and inefficient occupied space.

The Science Complex would be used for light laboratories and offices. It would be a state-of-the-art, multi-disciplinary facility that would enable the performance of mission-related scientific research. Low hazard work would be conducted in the laboratories. Work would be nonradiological except for the use of ionizing radiation producing equipment (such as x-ray machines) and sealed sources (radioactive sources engineered to meet Department of Transportation special form testing at 49 CFR 173.469 or the American National Standards Institute N45.6 testing for Sealed Radioactive Sources, Categorization). Biological research laboratories would be designed and operated in accordance with applicable standards for work with Biosafety Level 1 agents (see Appendix C for a discussion of Biosafety Levels).

G.8.2 Options Considered

The four options identified for the Science Complex Project are the No Action Option and three action options. Option 1, the Northwest Technical Area 62 Site Option, has been identified as the Preferred Option for the Science Complex Project.

G.8.2.1 No Action Option

Under the No Action Option, the Science Complex would not be constructed. Operations and activities proposed for the Science Complex would continue at dispersed locations across LANL in aging facilities that are reaching the end of their useful lives and require major upgrades to meet future mission objectives.

G.8.2.2 Option 1: Northwest Technical Area 62 Site Option (Preferred Option)

The Science Complex would be constructed on a site in Northwest TA-62, located west of the Research Park area. The Northwest TA-62 site is bounded to the south by West Jemez Road, to the east by West Road, to the west by forested land, and to the north by a utility corridor unpaved access road with forested land beyond. Note that the "Northwest" name is a historical site name that has since been combined with the TA nomenclature and does not refer to the northwest portion of TA-62. The utility corridor access road may be paved in the future to provide all-weather access to areas of the Santa Fe National Forest and a local recreational ski facility.

The relatively undeveloped site is situated on slightly sloping terrain above the south rim of Los Alamos Canyon and is vegetated primarily with native grass, ponderosa pine, and some pinyon-juniper. The Science Complex would consist of two buildings: a four-story secured building of approximately 110,000 gross square feet (10,200 square meters), and a four-story unclassified work building, including an auditorium, of approximately 292,000 gross square feet (27,100 square meters) (LANL 2006a). In addition to these two buildings, a new six-story, 504,000-gross-square-foot (47,000-square-meters) parking structure would be constructed on site. A maximum area of 15.6 acres (6.3 hectares) would be required for the project, which includes an area of about 5 acres (2 hectares) for new construction and staging. General roadway improvements would include construction of a site access road to the Science Complex and a parking structure. Also, to mitigate non-construction-related traffic increases, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access. **Figure G–12** illustrates the conceptual layout of the Science Complex at the Northwest TA-62 site.

G.8.2.3 Option 2: Research Park Site Option

Under the Research Park Site Option, the Science Complex would be constructed at the Los Alamos Research Park site, located in the northwest portion of TA-3. The Research Park site is bounded to the west by West Road, to the south by West Jemez Road, to the east by the existing Research Park Buildings, and to the north by Los Alamos Canyon. Approximately 100 feet (30.5 meters) to the east lie the existing Los Alamos County Research Park Buildings and Los Alamos County Fire Station. The Los Alamos community access road may be developed in the future to provide all-weather access to areas in the Santa Fe National Forest and a local recreational ski facility. To mitigate non-construction-related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access could be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access.

The relatively undeveloped site is situated on slightly sloping terrain above the south rim of Los Alamos Canyon and is vegetated primarily with native grass, ponderosa pine, and some pinyon-juniper.

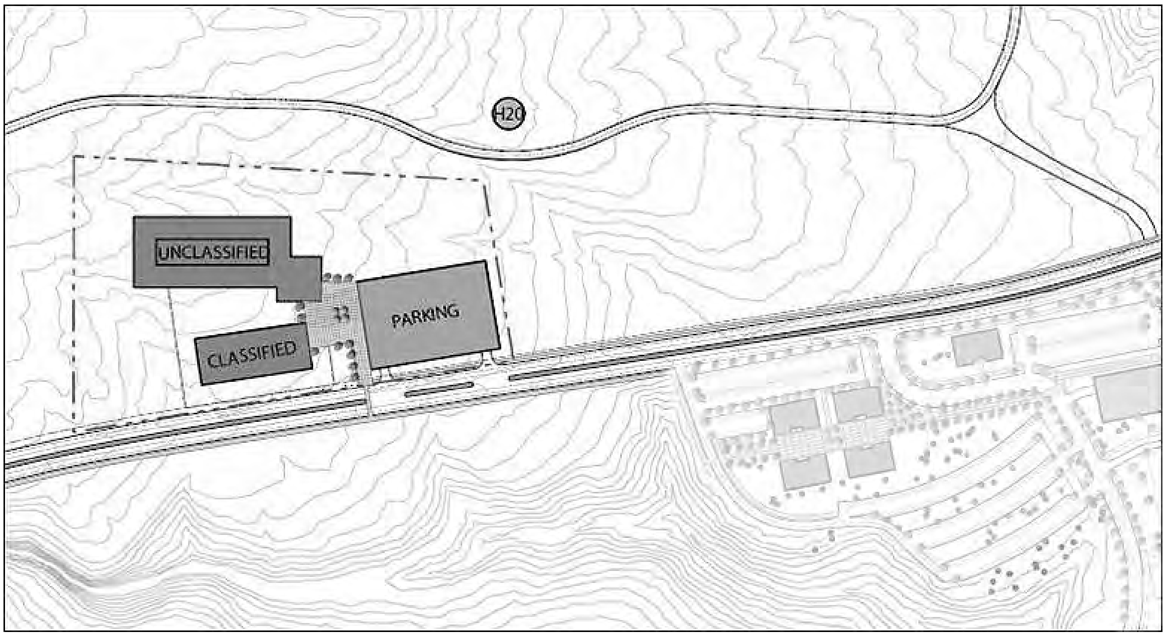


Figure G–12 Conceptual Layout of the Science Complex at the Northwest Technical Area 62 Site

G.8.2.4 Option 3: South Technical Area 3 Site Option

Under the South TA-3 Site Option, the Science Complex would be constructed on a site in the southeast portion of TA-3. The South TA-3 site is bounded to the south by Pajarito Road and to the west by Diamond Drive. The site is partially developed, with an existing parking lot situated in the center of the site, which is accessed from Diamond Drive. The eastern edge of the parking lot is constructed on fill material, which slopes downward to the east. At the toe of the slope lies a poorly defined drainage. South of the parking lot, between Pajarito Road and the parking lot, the area is relatively undeveloped. The undeveloped areas to the east and south of the parking lot are characterized by slightly sloping terrain and vegetated primarily with native grass, ponderosa pine, and some pinyon-juniper. To mitigate non-construction-related traffic, it would be necessary to construct south- and northbound left- and right-turn deceleration lanes on Diamond Drive approaching the site access.

G.8.2.5 Options Considered but Dismissed

Consistent with the Council on Environmental Quality and DOE NEPA regulations (40 CFR Part 1500 and 10 CFR Part 1021, respectively), several options were analyzed for comparison of potential effects with those options listed above. Two options were analyzed from a land use planning perspective, primarily based on location, which considered land use, traffic circulation, infrastructure, environmental compliance, security, safety, space consolidation opportunities and proximities, and work environment quality. The site options were located at the Gateway site, on the southeast corner of West Jemez Road and Diamond Drive, and on Twomile Mesa in TA-58. As a consequence of the planned Security Perimeter Road, access to both of these sites was made impractical. Therefore, both of these previously considered sites were eliminated from further consideration.

G.8.3 Affected Environment and Environmental Consequences

For construction and operation of the Science Complex at either the Northwest TA-62 or the Research Park sites, the affected environment would primarily be TA-62 and TA-3. For construction and operation of the Science Complex at the South TA-3 Site Option, the affected environment would primarily be TA-3.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussions.

- *Environmental Justice* – The proposed project would entail no disproportionate human health impacts to low-income or minority populations.

Resource areas examined in this analysis include: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, transportation, and facility accidents.

G.8.3.1 No Action Option

Under the No Action Option, the Science Complex would not be constructed at any of the location options. Under the No Action Option, new land tracts would not be developed at this time. The tracts could remain undeveloped or could be developed sometime in the future by NNSA for some as-yet-undetermined use. Potential effects associated with development and use of this land would not occur. No construction waste would be generated. However, the potential for increased efficiency due to more-modern construction and collocation would also not occur. Open space from DD&D of old, less-efficient structures would not be created.

G.8.3.2 Option 1: Northwest Technical Area 62 Site Option (Preferred Option)

Land Resources—Land Use

Under the Northwest TA-62 Site option a site located to the west of TA-3 would be used for construction of the Science Complex. Current land use within the entire 245-acre (99-hectare)

TA is classified as Reserve and land use should not change in the future (LANL 2003b). The Science Complex would disturb 5 acres (2 hectares) of undeveloped land and would result in a change in future land use from Reserve to Experimental Science.

Land Resources—Visual Resources

The southern rim of Los Alamos Canyon is relatively undeveloped, and the area possesses desirable aesthetic qualities that contribute to the natural viewshed. From West Jemez Road, the view north to the forest canopy at the site is unobstructed. From the site, the views west, north, and east, to Los Alamos Canyon below and to the mountains and valleys beyond Los Alamos, are relatively unobstructed. The principal manmade features that contrast with the existing natural environment are West Jemez Road and the TA-3 facilities to the south and the Los Alamos Canyon bridge and community buildings to the east and north, these being at a lower elevation than the site.

The Science Complex would encompass 5 acres (2 hectares) on the site and would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Buildings of this size would be visible from neighboring properties and roadways. Although the Science Complex at this site would be near existing industrial compounds at TA-3, and the area of existing development at TA-3 has already impacted the landscape, the addition of the Science Complex would result in an impact on visual resources in this area because views from the site, or from West Jemez Road, to the west, north, and east would be obstructed. Currently, LANL structures are largely contained on the south side of West Jemez Road. However, with the Science Complex construction on the north side of this road, the natural forested buffer area between LANL and Los Alamos Canyon at this site would be lost.

Because there is little nighttime activity at LANL, nighttime light sources would generally be security lighting. The sodium vapor lights used for this purpose can be distinguished from the lights of the nearby Los Alamos community by their slightly yellow color. At a distance across the viewshed, however, the color variation in light sources becomes negligible, and any nighttime distinction between LANL and the community is not apparent to the observer. Light sources for the proposed Science Complex would be associated primarily with security lighting. However, the security lighting near the north edge of the site may illuminate some portion of the south and north canyon walls of Los Alamos Canyon adjacent to the site. This increased illumination may impact nighttime movement of wildlife in the area, including the Mexican spotted owl, and Mexican spotted owl habitat.

Construction of new facilities would affect this viewshed. Preservation of existing vegetation and use of building design sand colors that complement the natural environment would mitigate viewshed degradation. In addition, limiting use of bright security lights on the north edge of the site and using directed lighting and shielded fixtures would limit illumination to the adjacent Los Alamos Canyon walls. To mitigate the visual impact of lighting, the project would conform to the New Mexico Night Sky Protection Act per architectural and design guidelines.

Geology and Soils

Data from geological studies indicate that TA-62 is located in a fault zone. In general, the density of seismic features increases to the west at LANL, and a number of faults are mapped in the TA-62 area (see Section 4.2 of this SWEIS). A probabilistic analysis of potential surface rupture was performed to evaluate the Chemistry and Metallurgy Research Building site in TA-3. TA-3 is located adjacent to and east of TA-62 (DOE 2003). The analysis indicates that the annual probability of surface rupture in TA-3 is less than 1 in 10,000, which is less than the required performance goal for the Chemistry and Metallurgy Research Building and is in accordance with DOE standards. If located in TA-62, an estimate of the seismic hazard at the site would be conducted, and the Science Complex would be designed in accordance with current DOE seismic standards and applicable building codes.

Soil resources in the area of the proposed location for the Science Complex are undisturbed and maintain natural vegetative cover. The arid soils in this area are largely sandy loam material alluvially deposited from tuff units on the slopes to the west and eroded from underlying geologic units. Soils in the proposed construction area are primarily classified as Typic Eutroboralfs, while there are smaller areas at the site where soils are classified as Typic Ustorthents. Both of these soil types are poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Construction of the Science Complex at the Northwest TA-62 site is expected to impact soil resources over several acres. Soil resources in this area, as well as the habitat it supports, would be irretrievably lost as a result of the construction. To mitigate this loss, valuable surface soil in this area would be scraped off of the building sites and stockpiled prior to beginning construction activities. In addition, some underlying rock (consisting of Bandelier tuff) would be excavated for building foundations. An estimated 840,000 cubic yards (640,000 cubic meters) of soil and rock would be excavated and stockpiled. The stockpiled soil and rock could then be used at other locations at LANL for site restoration following remediation. If soil and rock stockpiles were to be stored for longer than a few weeks, the stockpiles would be seeded or managed as appropriate to prevent stockpile erosion and impact on nearby drainages. In addition, care would be taken to employ all necessary erosion control best management practices during and following construction to limit impact on soil resources adjacent to the construction and building sites.

Water Resources

There are no natural surface water resources at the Northwest TA-62 Project site. An existing water tank is currently located on the site, approximately 50 feet (15 meters) north of one of the proposed structures. Regional groundwater occurs approximately 6,150 feet (1,875 meters) below ground surface at the site, and no groundwater pumping or monitoring wells exist at the site. Two existing, natural drainage swales transect the western half of the site.

Construction Impacts—No long-term effects on surface water quality would be likely. Vegetation reduction could expose soils due to excavation and heavy construction equipment.

Best management practices for runoff control, such as silt barriers and straw bales, would be used. The potential for downstream siltation would be minor and temporary in nature. A stormwater pollution prevention plan would be developed and implemented, including placement of best management practices to prevent erosion of disturbed soil by stormwater runoff or other water discharges.

Under the current conceptual site layout plan (see Figure G–12) some modification of the site's natural drainage patterns would be necessary. This would involve a consultation with the U.S. Army Corps of Engineers to determine if a Clean Water Act Section 404 Dredge and Fill Permit, and a State of New Mexico Section 401 Water Quality Certification are required.

Operations Impacts—The addition of new impermeable surfaces would increase stormwater runoff and would decrease surface water infiltration. While decreased infiltration is not expected to have an adverse effect on groundwater quality, the increased amount of runoff from impervious surfaces may have a slight effect on surface water quality and on residual contaminant transport within canyon sediments. Best management practices integrated as part of the site design would minimize the potential for sediment and residual contaminant transport.

Air Quality and Noise

Construction Impacts—Construction of the proposed Science Complex would result in temporary, localized emissions associated with vehicle and equipment exhaust as well as particulate (dust) emissions from excavation and construction activities. Emissions from gasoline and diesel engines would result from excavation and construction activities. Air emissions associated with excavation and construction equipment operation would not result in exceedances of ambient air quality standards, except for possible short-term concentrations of carbon monoxide and nitrogen oxides. Estimated concentrations for PM_{10} would be greatest for the site work phase. The maximum estimated ground-level concentration for PM_{10} would be an annual average of 4.5 micrograms per cubic meter and a 24-hour average of 92.2 micrograms per cubic meter offsite or along the perimeter road to which the public has regular access.

Soil disturbance during construction would result in small air emissions, but would be controlled by best management practices and would not exceed ambient air quality standards, thereby resulting in no impacts on workers or the public.

The proposed project would result in limited short-term increases in noise levels associated with construction activities and increased long-term noise levels associated with operation of the proposed Science Complex. Noise generated by the proposed project is not expected to have an adverse effect on either construction workers or workers at the new facility once it is operating.

Sound levels would dissipate to background levels before reaching publicly accessible areas or undisturbed wildlife habitats, and they would not be noticeable to nearby workers or members of the public, nor would they disturb local wildlife. Traffic noise from construction workers or operations would not increase the present traffic noise level on West Jemez Road.

Operations Impacts—In terms of Science Complex operation, as existing LANL capabilities and organizations are consolidated at the Science Complex, there could be fewer emissions resulting from individuals driving to various points at LANL throughout the day for meetings and other purposes.

Ecological Resources

Areas in the region of TA-62 burned in the Cerro Grande Fire, including a portion of the area contained within the Northwest TA-62 Option. There are no wetlands or aquatic resources within the Northwest TA-62 Option area, although wetlands are located to the north in Los Alamos Canyon. A portion of the project area falls within the core and buffer zone of the Los Alamos Canyon Area of Environmental Interest for the Mexican spotted owl. Areas of environmental interest for the bald eagle and southwestern willow flycatcher are not located near the project site (LANL 2006b).

Construction Impacts—Science Complex construction would involve clearing and grading approximately 5 acres (2 hectares) of ponderosa pine forest within TA-62. This would result in loss of less-mobile wildlife, such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they moved. If the area were at its carrying capacity, displaced animals would not likely survive. Indirect impacts of construction, such as noise, light, or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. These impacts could be mitigated by clearly marking the construction zone to prevent equipment and workers from disturbing adjacent habitat, including the Mexican spotted owl habitat, and properly maintaining equipment. Construction of the new buildings and parking structure would not impact wetlands, as none are located in or near the construction zone.

The Science Complex would remove areas of undeveloped core and buffer habitat within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. Further, noise from the project would potentially exceed 6 dB(A) above background in the core zone; however, this level would drop below that level within 450 feet (135 meters) from the construction zone. The biological assessment prepared by DOE noted that it is unlikely that the Mexican spotted owl would be denied access to adequate nesting and foraging habitat as a result of the project. Thus, provided all reasonable and prudent alternatives are implemented (see Section G.2.3.2), the project may affect, but is not likely to adversely affect, the Mexican spotted owl (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher are not located near the proposed Science Complex. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation would be associated with the project, the DOE biological assessment concluded that with appropriate reasonable and prudent alternatives (see Section G.2.3.2), the project may affect, but is not likely to adversely affect, the bald eagle. Since the nearest southwestern willow flycatcher Area of Environmental Interest is not within or downstream of the project site there would be no effect on this species (LANL 2006b). The USFWS has concurred with the biological assessment as it relates to the bald eagle and southwestern willow flycatcher (see Chapter 6, Section 6.5.2).

Operations Impacts—Science Complex operation would have minimal impact on terrestrial resources within or adjacent to TA-62. Because the wildlife residing in the area has already adapted to levels of noise and human activity associated with development in the area surrounding the project area, it would not likely be adversely affected by similar types of activity involved with operation of the new buildings.

Human Health

Construction Impacts—During Science Complex construction, some construction-related accidents would potentially occur. The potential for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 3.2 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 36 (DOE 2004) to 135 (BLS 2003).

Cultural Resources

Three archaeological sites are situated in the vicinity of the proposed Northwest TA-62 location, and each site has been determined to be eligible for the National Register of Historic Places. Two of these prehistoric sites are listed as nonstructural, and both traverse the proposed project area. One site is a 1-acre (0.4-hectare) prehistoric artifact scatter. The second site is about 0.6 acres (0.2 hectares) in size and is a prehistoric artifact site comprised of a dense lithic scatter. The third site is a cavate.

Construction Impacts—The three prehistoric archaeological sites are at risk of either direct or indirect impact by the proposed construction of Northwest TA-62. Construction activity, traffic, and ground disturbance could damage portions of these sites. If buried cultural deposits are encountered during construction, activities would cease and procedures as set forth in *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006c) would be implemented. Those buildings to be replaced by the two Science Complex Buildings have not been evaluated for their historic importance; thus, an eligibility assessment would have to be conducted prior to their demolition.

Socioeconomics and Infrastructure

The site is currently developed with aboveground electrical distribution lines, a water tower, underground water transmission lines with valves and pumps, and communication lines. Electrical and communication lines are located in a utility corridor along the water tower access road near the north boundary of the proposed site. A gas line is located approximately 250 feet (76 meters) from the southeast corner of the site. There are no sanitary sewer lines within 300 feet (91 meters) of the site boundary.

Construction Impacts—Utility infrastructure resources would be required for Science Complex construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used, requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection.

For Science Complex construction, total liquid fuel consumption is estimated to be 4.3 million gallons (16 million liters) and total water consumption is estimated to be 23 million gallons (86 million liters) over the 2-year construction phase. Development of the proposed Science Complex Project would require addition of a natural gas line. The conceptual plan includes extending a new gas line approximately 500 feet (150 meters) east along the utility corridor to connect with existing lines. Local electrical and data or communication lines would be accessed through the utility corridor. In addition, the Science Complex Building must be connected to existing sewer lines. Primary vehicle access to the site would be from a signalized intersection along West Jemez Road. However, the existing LANL infrastructure would be capable of supporting requirements for new facility construction without exceeding site capacities, resulting in negligible impact on site utility infrastructure.

Operations Impacts—Utility resource usage in the proposed structures would be equivalent to or less than the usage of the replaced structures. This is due to contemporary building design, which includes water and energy conservation features. As such, Science Complex operation is expected to have no or negligible incremental impact on utility infrastructure capacities at LANL.

Waste Management

There are currently no LANL operations located at the site, and therefore no waste volumes are produced. However, the activities that would be relocated to the Science Complex currently produce waste at other LANL locations. There would be no change to overall waste types or volumes.

Construction Impacts—The proposed project would generate solid waste from construction that would be disposed of at the Los Alamos County Landfill or other New Mexico solid waste landfills. Based on the total gross square footage of newly constructed office and light laboratory space for the Science Complex, approximately 3,320 cubic yards (2,540 cubic meters) of waste would be generated during construction. This estimate would be refined as additional information becomes available during project design development.

Operations Impacts—Regulated wastes from site development, facility operations, and DD&D of other structures as a result of the new Science Complex would be handled through existing waste management programs at LANL and carried out in accordance with applicable laws, regulations, and DOE orders.

Transportation

Site development would primarily affect traffic on West Jemez Road. Level of service is a quantitative measurement indicating the level of delay and congestion at an intersection, ranging from A to F (where level of service A indicates very little congestion or delay, and level of service F indicates a high level of congestion or delay). West Jemez Road currently operates at level of service A during morning and afternoon peak hours.

Construction Impacts—Traffic generated by Science Complex construction would have only minor impacts on the adjacent roadway system, including West Jemez Road. No mitigation measures would be necessary to accommodate construction-related traffic.

Operations Impacts—To evaluate Science Complex impacts on traffic at LANL and in Los Alamos, a traffic analysis was conducted for the Science Complex at the Northwest TA-62 site. The analysis evaluated short- and long-term impacts on traffic resulting from an estimated 1,600 employees at the Science Complex. Short-term background traffic volumes are the sum of existing traffic volumes (counted in the fall of 2004) plus the traffic volumes estimated to be generated by the Wellness Center and adjacent development. Long-term background traffic volumes assumed a 20 percent increase in traffic volumes on West Jemez Road. The study estimated that the Science Complex would generate about 5,790 vehicle trips on the average weekday (2,895 vehicles entering and exiting in a 24-hour period) (LSC 2005b). To mitigate non-construction related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access could be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access.

Facility Accidents

Operations Impacts—As an office building and light laboratory, the Science Complex is not considered a credible threat to the health and safety of personnel outside of the complex in the event of an accident. If the Science Complex is not fully used by LANL site employees, it is possible that some or all of this space could be occupied by a commercial company. Therefore, an analysis of the potential risk to an occupant of this building from an accident in another LANL facility was evaluated. From the list of accidents analyzed in the Appendix D of this SWEIS, the accident at the Chemistry and Metallurgy Research Building in TA-3 would be the most likely to impact the occupants at the Science Complex. The accident is identified as a HEPA filter fire with a likelihood of occurrence of one in 100 years (see Appendix D). If such an accident were to occur, the dose to an occupant of the Science Complex, which is about 6,600 feet (2,000 meters) northwest of the Chemistry and Metallurgy Research Building, would be 0.30 rem or less, with a risk of less than 1.8×10^{-4} (1 in 5,600) that an exposed individual would develop an LCF. Taking into account the likelihood of occurrence of such an accident, the risk of an LCF would be 1.8×10^{-6} (1 chance in 560,000) per year of occupancy. DD&D of the Chemistry and Metallurgy Research Building would reduce this radiological risk.

G.8.3.3 Option 2: Research Park Site Option

The effects on air quality and noise, human health, and waste management are expected to be similar to those of the proposed project (Option 1). Resource area impacts or conditions that would differ from the proposed project are discussed below.

Land Resources—Land Use

Under the Research Park Site option, the Science Complex would be built in TA-3 just to the west of the Los Alamos County Research Park. TA-3, which is located in the northwestern portion of LANL, encompasses 359 acres (145 hectares), most of which is occupied by buildings and other structures. It contains the director's office, administrative offices, support facilities, and a number of laboratories (DOE 1999a). As with the Northwest TA-62 Site option, the new Science Complex would occupy 5 acres (2 hectares) of undeveloped land. Currently land use in this area is classified as Reserve and future land use was predicted to remain unchanged (LANL 2003b). However, if this option is selected, future land use would change from Reserve to Experimental Science.

Land Resources—Visual Resources

The principal manmade features that contrast with the existing natural environment are West Jemez Road and the TA-3 facilities to the south, the existing Research Park Building to the east, and the Los Alamos Canyon bridge and community buildings to the east and north, these being at a lower elevation than the site.

Operations Impacts—The Science Complex would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Buildings of this size would be visible from neighboring properties and roadways. Although the Science Complex at this site would be near and adjacent to existing industrial compounds at the Research Park and TA-3, and the area of existing development at TA-3 has already impacted the landscape, the addition of the Science Complex would result in a significant impact on visual resources in this area because views from the site, or from West Jemez Road, to the west, north, and east would be obstructed. With the Science Complex construction on the north side of West Jemez Road, the natural forested buffer area between LANL and Los Alamos Canyon would be further reduced. Impacts of the Research Park Site Option would be similar to those of the proposed project.

Construction of new facilities would further affect this viewshed. Impacts of the Research Park Site Option would be similar to those of the proposed project (Option 1). In addition, limiting use of bright security lights on the north edge of the site and using directed lighting and shielded fixtures would limit illumination to the adjacent Los Alamos Canyon walls. To mitigate the visual impact of lighting, the project would conform to the New Mexico Night Sky Protection Act architectural and design guidelines.

Geology and Soils

The site for the Science Complex at TA-3 lies within a part of the Pajarito Fault system characterized by subsidiary or distributed fault ruptures. Probabilistic analysis of potential surface rupture indicates that the annual probability of surface rupture in areas beyond the principal or main trace of the Pajarito Fault, such as at the Science Complex TA-3 site, is less than 1 in 10,000 (LANL 2004c). This probability is a less than the required performance goal for the facility and in accordance with DOE standards. Additionally, the Science Complex would be designed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Impacts on geology and soils associated with Science Complex construction at the Research Park Site in TA-3 would be similar to those discussed under the Northwest TA-62 Site Option (Option 1).

DD&D Impacts—The Research Park Site Option includes DD&D activities of unspecified facilities with a footprint equivalent to new facility construction. The impacts associated with DD&D of existing facilities would be the same as those discussed under the Northwest TA-62 Site Option (Option 1).

Water Resources

There are no surface water resources at the Research Park site, nor are there any significant surface water drainage features at the proposed project site, though the site does drain toward Los Alamos Canyon to the north. Regional groundwater occurs approximately 6,100 feet (1,859 meters) below ground surface at the site, and no groundwater pumping or monitoring wells exist at the site.

Construction Impacts—Because no watercourses would be directly impacted by construction, a Clean Water Act Section 404 Dredge and Fill Permit and a State of New Mexico Section 401 Water Quality Certification would not be required. All vehicles and equipment used for construction purposes would be inspected for leaks before arrival at the construction site to avoid inadvertent surface contamination from hydrocarbon fuel products.

Operations Impacts—Research Park Site Option operations impacts would be the same as those discussed under the Northwest TA-62 Site Option (Option 1).

Ecological Resources

The project area for the Research Park Site Option is not within an Area of Environmental Interest delineated for protection of the Mexican spotted owl, southwestern willow flycatcher, or the bald eagle. Other state-listed special status species would have a low probability of occurrence within the project area. The Research Park Site Option is situated within ponderosa pine forest and is adjacent to Los Alamos Canyon located to the north. Industrial development from LANL facilities is located to the south. There are no wetlands or aquatic resources within the proposed project area for this option, although wetlands are located beyond TA-62 to the north in Los Alamos Canyon (LANL 2006b).

Construction Impacts—The Research Park Site Option would result in clearing and grading approximately 5 acres (2 hectares) of ponderosa pine forest to construct the Science Complex. The area to the south and east is either already heavily developed or is planned for development. Impacts of construction on wildlife would be similar to those described for the proposed project (Option 1).

Operations Impacts—Under the Research Park Site Option, operation of the proposed Science Complex would not be likely to pose significant adverse effects on most wildlife. Activities would be restricted to within the facility grounds; therefore, most area wildlife would likely continue to use the area around the facility for foraging and migration after construction was complete. In addition, the site currently experiences human impact of the surrounding development; therefore, increased activity from the Science Complex under the Research Park Site Option is expected to cause minimal effects on area wildlife.

Human Health

Human health impacts would be the same as those for Option 1.

Cultural Resources

No archaeological sites are located within the boundaries of the leased Research Park tract. However, there is one National Register of Historic Places-eligible site located in the vicinity of the proposed Science Complex. It is situated to the immediate north of the Research Park on nonleased land.

Construction Impacts—Construction of the planned Research Park Site Option, including the access road, would not affect any recorded prehistoric or historic archaeological sites. If any buried material or cultural remains are encountered during construction, activities would cease until appropriate local authorities or a qualified professional is consulted. The buildings to be replaced by the new Science Complex have not been evaluated for their historic significance; thus, an eligibility assessment would be completed prior to demolition activities.

Socioeconomics and Infrastructure

Existing aboveground electrical distribution and communications lines, underground water transmission lines, storm drains, and buried gas lines transect portions of the proposed Research Park site. There are no identified sanitary sewer lines within 400 feet (120 meters) of the site. Roads in the vicinity of the proposed Research Park location include West Jemez Road and West Road.

Construction Impacts—Utility infrastructure resources required for Science Complex construction at the Research Park site location would be similar to those described for the Northwest TA-62 Site Option (Option 1).

Operations Impacts—Development of the proposed Science Complex at the Research Park location would likely require rerouting of many utilities currently located on the site, and rerouting may also be necessary outside the project area. A sanitary sewer trunk line would need to be extended from buildings to the south or from the existing building in the eastern portion of the Research Park. Primary vehicle access to the site would be from a signalized intersection along West Jemez Road.

Waste Management

Waste management impacts would be the same as those for Option 1.

Transportation

Site development would primarily affect traffic on West Jemez Road. West Jemez Road currently operates at level of service A during morning and afternoon peak hours.

Construction Impacts—Traffic generated by Science Complex construction would not have any significant impacts on the adjacent roadway system, including West Jemez Road. No mitigation measures would be necessary to accommodate construction-related traffic volumes.

Operations Impacts—To evaluate Science Complex impacts on traffic at LANL and in Los Alamos, a traffic analysis was conducted for the Science Complex at the Northwest TA-62 site (LSC 2005b). The proposed Research Park site is located adjacent to the Northwest TA-62 site and would also have primary access along West Jemez Road. Therefore, a signalized intersection would likely be used for access to West Jemez Road, and traffic impacts would be similar to those resulting from development at the Northwest TA-62 site. To mitigate non-construction-related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access could be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes could be constructed on West Jemez Road approaching the site access.

Facility Accidents

Operations Impacts—Under this option, Science Complex would be located about 3,400 feet (1,000 meters) meters to the north of the Chemistry and Metallurgy Research Building. Similar to the situation discussed under Option 1, the HEPA filter fire accident at the Chemistry and Metallurgy Research Building would be the most likely event to impact the occupants at the Science Complex. This accident would lead to an occupant dose of about 0.7 rem, or a risk of 4.2×10^{-4} (1 in 2,400) of developing an LCF. Taking into account the likelihood of the accident occurring, the risk of an LCF would be 4.2×10^{-6} (1 chance in 240,000) per year of occupancy. Again, DD&D of the Chemistry and Metallurgy Research Building would reduce this radiological risk.

G.8.3.4 Option 3: South TA-3 Site Option

The effects on air quality and noise, human health, and waste management are expected to be similar to those of the proposed project (Option 1). Resource area impacts or conditions that would differ from the proposed project are discussed below.

Land Resources—Land Use

Under this option, the Science Complex would be constructed in the southern part of TA-3 and would require 5 acres (2 hectares) of land. TA-3, which is located in the northwestern portion of LANL, encompasses 359 acres (145 hectares), most of which is occupied by buildings and other structures. It contains the Director's office, administrative offices, support facilities, and a number of laboratories (DOE 1999a). The portion of the TA within which the Science Complex would be located is presently classified as Experimental Science. This area is predicted to remain Experimental Science in the future; thus, construction of the new complex would not result in a change in land use (LANL 2003b).

Land Resources—Visual Resources

The South TA-3 site is located at the northeast corner of Diamond Drive and Pajarito Road, near the top of Mortandad Canyon within TA-3. The viewshed at this site is relatively developed, as it is located at the southeastern corner of heavily developed TA-3 and is adjacent to nearby TA's with parking lots and structures. The view from the South TA-3 site to the west is of Chemistry and Metallurgy Research Building parking lots, of multistory buildings to the north, buildings and parking lots across Pajarito Road to the south, and of a forested drainage, which lies at a lower elevation from the site to the east and leads down to Mortandad Canyon. The South TA-3 site is partially covered with a 1.5-acre (0.6-hectare) parking lot currently used by LANL employees. Currently, the viewshed from this site is impacted due to existing LANL structures.

Operations Impacts—The Science Complex would encompass the majority of the site and would consist of two four-story buildings and a six-story parking structure, as well as related supporting structures and utilities. Buildings of this size would be visible from neighboring properties and roadways. The Science Complex at this site would be near existing industrial buildings at TA-3, and the area of existing development at TA-3 has already impacted the landscape. If the existing small parcels of forested land to the south and east of the South TA-3 site remain undisturbed, Science Complex development at this site would retain the landscape's primary aesthetic attributes.

As there is little nighttime activity at LANL, nighttime light sources would generally be security lighting. Because this site is located in an area already developed with other LANL facilities and structures, the presence of lights at the Science Complex would not likely adversely impact visual resources of the surrounding area, nor are lights expected to impact nighttime movement of wildlife in the area.

Construction Impacts—Construction of new facilities at this site would not significantly affect the viewshed. Preservation of existing vegetation and use of building design sand colors that complement the natural environment would mitigate potential viewshed degradation. Because of the level of LANL development surrounding the site, Science Complex lighting at the site is not expected to adversely impact the surrounding area visual resources.

Geology and Soils

The probability of surface rupture for the South TA-3 site is the same as that for the other options. Soil resources in the area of the proposed location for the Science Complex are relatively disturbed, and only adjacent undisturbed areas maintain vegetative cover. The South TA-3 site is partially occupied by a parking lot that is partially built up on fill material. The fill material came from the site in the process of grading or was brought in from another area. The arid soils in this area, and presumably underlying the parking lot, are largely sandy loam material alluvially deposited from tuff units on the higher slopes to the west and eroded from underlying geologic units. Soils in the proposed Science Complex area at this site are classified as Typic Eutroboralfs. This soil type is poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area, result in only a limited number of plant species able to subsist on the soil medium, which, in turn, supports a very limited number of wildlife species.

Construction Impacts—Science Complex construction at the South TA-3 site would result in the same construction impacts as those discussed under the Northwest TA-62 Site Option (Option 1).

DD&D Impacts—Activities and impacts associated with DD&D of existing facilities would be the same as those discussed under the Northwest TA-62 Site Option (Option 1).

Water Resources

Because the South TA-3 site is located at the headwaters of Mortandad Canyon, there would be surface water considerations with Science Complex development. Regional groundwater occurs approximately 6,050 feet (1,844 meters) below ground surface at the site, and no regional groundwater pumping or monitoring wells exist at the site.

Construction Impacts—Science Complex construction at the South TA-3 site would have similar impacts as those discussed under the Northwest TA-62 Site Option. Additionally, if the adjacent drainage leading to Mortandad Canyon were affected by fill material or excavation during construction, a Clean Water Act Section 404 Dredge and Fill Permit and a State of New Mexico Section 401 Water Quality Certification would be required.

Operations Impacts—Science Complex operation at the South TA-3 site would have the same impacts as those discussed under the Northwest TA-62 Site Option.

Ecological Resources

The project area for the South TA-3 Site Option is partially developed and is not within an Area of Environmental Interest delineated for protection of the Mexican spotted owl, southwestern willow flycatcher, or the bald eagle. Other state-listed special status species would have a low probability of occurrence within the project area (LANL 2006a).

The South TA-3 site is generally located in a developed part of TA-3 but does contain areas of native grass, ponderosa pine, and some pinyon-juniper. There are no wetlands or aquatic resources within the proposed project area for this option. There are however, wetlands in upper Mortandad Canyon. The area is not within any areas of environmental interest for any federally listed threatened or endangered species (LANL 2006a).

Construction Impacts—Science Complex construction under the South TA-3 Site Option would result in impacts generally similar to those addressed in Section G.8.3.2. The proposed project would result in clearing and grading less than 5 acres (2 hectares) of land to construct the Science Complex. Much of the area around the buildings would be paved. A biological assessment would be needed if tree removal affects more than 5 acres (2 hectares) (LANL 2006b).

Operations Impacts—Operation of the proposed the Science Complex would not pose significant adverse affects on most wildlife under this option. Activities would be restricted to within the facility grounds, therefore, most area wildlife would likely continue to use the area around the facility for foraging and migration after construction was complete.

Human Health

Human health impacts would be the same as those for Option 1.

Cultural Resources

No archaeological sites are located in the vicinity of the proposed South TA-3 location for the Science Complex. The entire proposed project area was previously surveyed for cultural resources.

Construction Impacts—Construction planned for South TA-3, including roads and areas for construction traffic and staging, would not affect any recorded prehistoric or historic archaeological sites. If any buried material or cultural remains are encountered during construction, activities would cease until appropriate local authorities or a qualified professional is consulted before work resumes. The buildings to be replaced by the new Science Complex have not been evaluated for historical significance; thus, an eligibility assessment would be completed prior to demolition activities.

Socioeconomics and Infrastructure

Existing aboveground electrical distribution lines, belowground communications lines, underground water transmission lines, storm drains, and buried gas lines run parallel to both Diamond Drive and Pajarito Road adjacent to the site. In addition, a new buried steam line is planned near the center of the site for construction of the Information Management Division Operations Facility. Existing sanitary sewer lines are located somewhat farther from the site, and sewer service could be brought to the site from the same side of Diamond Drive. Roads in the vicinity of the proposed South TA-3 alternate site include Diamond Drive and Pajarito Road.

Construction Impacts—Utility infrastructure resources required for Science Complex construction at the South TA-3 Site Option location would be similar to those described for the Northwest TA-62 Site Option (Option 1).

Operations Impacts—Development of the proposed Science Complex Project at the South TA-3 alternate site would require addition of a natural gas line, connected from either the west side of Diamond Drive or the north side of Pajarito Road. In addition, the Science Complex Building must be connected to existing sewer lines that lie both north of the site, serving the Biosafety Level 3 Facility, and southwest of the Diamond Drive-Pajarito Road intersection. Any trenching associated with bringing utility service to the site that could potentially impact adjacent drainages would be done using erosion control best management practices.

Waste Management

Waste management impacts would be the same as those for Option 1.

Transportation

According to the 2002 environmental assessment for the proposed construction and operation of the Biosafety Level 3 Facility at LANL, which is north of the South TA-3 alternate site, Pajarito Road had approximately 8,000 average vehicle trips, while West Jemez Road had approximately 6,000 per day (DOE 2002b). The environmental assessment also noted that the intersection of Diamond Drive and West Jemez Road exhibited considerable congestion during peak traffic periods. Pajarito Road traffic levels have decreased slightly since access to the road has been limited to LANL badge holders, resulting in an increase in traffic on West Jemez Road.

Construction Impacts—Though traffic generated by Science Complex construction at Northwest TA-62 was not projected to have any significant impacts on the adjacent roadway system, including West Jemez Road, in the 2005 study, there would be additional impacts on traffic resulting from Science Complex construction at the South TA-3 site.

Operations Impacts—To evaluate Science Complex impacts on traffic at LANL and in Los Alamos, a traffic analysis was conducted for the Science Complex at the Northwest TA-62 site in 2005 (LSC 2005b). The analysis evaluated short- and long-term impacts on traffic resulting from the 1,600-employee Science Complex at this site. Results of this traffic study for the Northwest TA-62 Site Option are applicable for traffic evaluation at the South TA-3 site because the proposed Science Complex is unchanged. However, because the South TA-3 site would be within the planned Security Perimeter Road and not as easily accessible due in part to proximity and higher traffic flows on Diamond Drive relative to those on West Jemez Road, traffic impacts of the Science Complex at the South TA-3 site would be greater than the study determined for the Northwest TA-62 site. In the study, short-term background traffic volumes are the sum of existing traffic volumes (counted in the fall of 2004) plus the traffic volumes estimated to be generated by the Wellness Center and adjacent development. Long-term background traffic volumes assumed a 20 percent increase in traffic volumes on West Jemez Road. The study estimated that the Science Complex would generate about 5,790 vehicle trips on the average weekday (2,895 vehicles entering and exiting in a 24-hour period). To mitigate non-construction-related traffic, it may be necessary to construct south- and northbound left- and right-turn deceleration lanes on Diamond Drive approaching the site access.

Facility Accidents

Operations Impacts—Under this option, the Science Complex would be located about 800 feet (240 meters) to the southeast of the Chemistry and Metallurgy Research Building. Similar to the situation discussed under Option 1, the HEPA filter fire accident at the Chemistry and Metallurgy Research Building would be the most likely event to impact the occupants at the Science Complex. This accident would lead to an occupant dose of 2.8 rem or less, or a risk of 1.7×10^{-3} (1 in 600) of developing an LCF. Taking into account the likelihood of the accident occurring, the risk of an LCF would be 1.7×10^{-5} (1 chance in 60,000) per year of occupancy. The DD&D of the Chemistry and Metallurgy Research Building would reduce this radiological risk.

G.9 Remote Warehouse and Truck Inspection Station Impact Assessment

This section presents an assessment of environmental impacts for the proposed construction and operation of the Remote Warehouse and Truck Inspection Station at TA-72. Under the proposed project, existing operations would be relocated to a completely new facility. The existing warehouse in TA-3 would be demolished or reused for some other purpose; the existing temporary truck inspection station on East Jemez Road would be demolished. Section G.9.1 provides background information on the proposed project to build the Remote Warehouse and Truck Inspection Station. Section G.9.2 provides a description of the options for the proposed project. Section G.9.3 provides information supplementing the affected environment description presented in Chapter 4 and describes the environmental impacts of the No Action Option and the proposed project to construct and operate the Remote Warehouse and Truck Inspection Station at TA-72.

G.9.1 Introduction

The current warehouse located at TA-3 provides centralized shipping, receiving, distribution, packaging and transportation compliance, and mail services for all LANL organizations. Personnel at the current warehouse facility are responsible for part of the institutional physical handling, identification, acceptance of goods or materials, and distribution of these materials for LANL. Over 500,000 packages and shipments are received, processed, inspected, and delivered annually to 500 drop points at LANL. Nearly 4,000 radioactive or hazardous and classified shipments are received and delivered annually. The mail distribution function currently delivers 14,000,000 pieces annually to 620 LANL mail stops and processes over 500,000 pieces for external mailing. Approximately 18,000 outbound classified documents are handled annually. The volume of material received and shipped and the Federal administrative requirements for handling these shipments continue to increase. There are also approximately 80 daily commercial deliveries to the TA-3 warehouse location. Trucks accessing the TA-3 warehouse currently represent approximately 50 to 60 percent of the truck traffic volume for TA-3. The current TA-3 warehouse facility location requires offsite vehicles to travel through densely populated TA-3 areas (LANL 2006a).

G.9.2 Options Considered

The two options identified for the Remote Warehouse and Truck Inspection Station are the No Action Option and the proposed project option.

G.9.2.1 No Action Option

Under the No Action Option, the Remote Warehouse and Truck Inspection Station would not be constructed. Incoming commercial trucks would continue to be inspected at the temporary inspection station on East Jemez Road prior to continuing farther onto the LANL site. Receiving, warehousing, and mailing activities would continue to be conducted at the current TA-3 warehouse facility. Under the No Action Option, operational and security issues associated with operating the current TA-3 warehouse facility would not be resolved.

G.9.2.2 Proposed Project

The Remote Warehouse and Truck Inspection Station Project would relocate shipment receiving, warehousing, and distribution functions from TA-3 to a site in TA-72. In addition, the truck inspection station would be relocated from its current location on the northwest corner of New Mexico State Route 4 (NM 4) and East Jemez Road to the new Remote Warehouse and Truck Inspection Station site. The proposed site is located in Santa Fe County on the south side of East Jemez Road, about 1 mile (1.6 kilometers) west of NM 4 and 0.5 miles (0.8 kilometers) east of the Protective Technology Los Alamos shooting range, which is located north of East Jemez Road. The proposed location is not far from lands belonging to San Ildefonso Pueblo and is about 1 mile (1.6 kilometers) from the Tsankawi Unit of Bandelier National Monument. The proposed site is situated on gently sloping terrain in Sandia Canyon that is covered with pinyon-juniper and some ponderosa pine.

There would be an 85,000-square-foot (7,900-square-meter) warehouse, a 12,000-square-foot (1,100-square-meter) office building, a 400-square-foot (37-square-meter) truckers' rest lounge, a dog kennel, and a 600-square-foot (55-square-meter) guardhouse. In addition to the building footprints, the truck inspection station would comprise approximately 50,000 square feet (4,600 square meters) of paved area. Upon completion of the proposed project, the location of the current truck inspection station on the north side of East Jemez Road would be returned to a natural condition. **Figure G–13** illustrates the conceptual layout of the Remote Warehouse and Truck Inspection Station at the TA-72 site.

The area affected by Remote Warehouse and Truck Inspection Station Project construction would be about 4 acres (1.6 hectares) and would include the actual facilities, parking, staging areas, and perimeter fencing. There would also be modifications made along East Jemez Road to accommodate safety and access improvements.

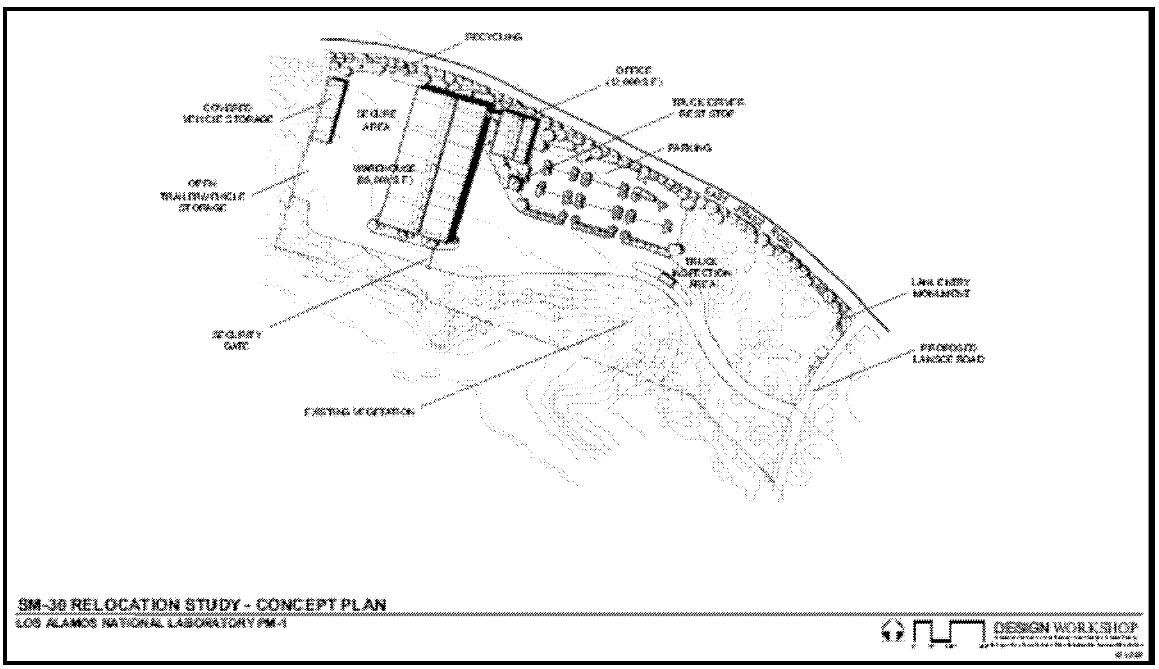


Figure G–13 Technical Area 72 Remote Warehouse and Truck Inspection Station Conceptual Layout

The warehouse facility would include loading docks, leveling ramps, conveyor belts, and a security vault. The facility would have areas for mail sorting, packaging, and storage of general mail, as well as shipments of hazardous chemicals and radioactive materials. There would also be a customer service desk and offices for shipping and receiving, postage, classified documents, mail room supervision, dispatcher, large-freight receiving, and warehouse supervision. The office building would house approximately 125 people involved with activities supporting consolidated warehouse and truck inspection functions.

The Remote Warehouse and Truck Inspection Station would accommodate the projected growth and changes in LANL materials management and provide adequate quality inspection and holding areas (cages) for chain-of-custody materials. The warehouse would enhance and support safety and security requirements by providing for greater separation between radioactive and hazardous materials and the majority of other materials shipping and receiving operations. The current plan is to have uncleared commercial trucks enter the warehouse area to unload and, after inspection, have smaller government trucks and vans with cleared drivers distribute the goods throughout LANL. At the Remote Warehouse and Truck Inspection Station, vendor vehicles and personnel would be separated from government vehicles and personnel. Materials being sent to secure areas and those being sent to the rest of LANL would also be segregated.

G.9.2.3 Options Considered but Dismissed

Ten location options for the Remote Warehouse and Truck Inspection Station were analyzed in a February 2004 siting study (Booth 2004). Many of these sites were not acceptable because of operational or environmental considerations, while other sites were eliminated due to security considerations. Specifically, one of the primary security objectives for the Remote Warehouse and Truck Inspection Station Project is to restrict large private trucks from TA-3 and adjacent areas. Therefore, options that did not achieve this objective were eliminated based on security and efficiency of operations. The TA-72 site (identified as the East Jemez and NM 4 site in the study) ranked highest for development of the Remote Warehouse and Truck Inspection Station, according to results of a model that accounted for all pertinent selection criteria, including environmental and physical, social and political, safety, operations, and economic factors. As a result of the siting study, all other sites previously identified were eliminated from further consideration.

G.9.3 Affected Environment and Environmental Consequences

The affected environment descriptions in this section provide the context for understanding the environmental consequences discussed in the impact assessments. They serve as a baseline from which any environmental changes brought about by implementing the proposed project can be evaluated; the baseline conditions are the currently existing conditions. For construction and operation of the Remote Warehouse and Truck Inspection Station at the proposed location on East Jemez Road, the affected environment would primarily be TA-72.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure* – No new employment is expected. Construction workers would be drawn from the pool of construction workers employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussions.
- *Environmental Justice* – The proposed Remote Warehouse and Truck Inspection Station would entail no disproportionate impacts to low-income or minority populations.

Resource areas examined in this analysis include: land resources, geology and soils, water resources, air quality and noise, ecological resources, human health, cultural resources, site infrastructure, waste management, transportation, and facility accidents.

G.9.3.1 No Action Option

Under the No Action Option, the Remote Warehouse and Truck Inspection Station would not be constructed at the East Jemez Road site, and LANL would continue to operate its warehouse and distribution operations from outdated facilities. As a result, there would not be any land disturbances or additional impacts on environmental resources at TA-72. Under the No Action Option, the objective of removing private commercial vehicles from TA-3 would not be met.

G.9.3.2 Proposed Project

Land Resources—Land Use

TA-72 is 1,189 acres (481 hectares) in size and is located in the northeastern portion of LANL. Current land designation within most of the TA is Reserve, except for a small area north of East Jemez Road categorized as Physical and Technical Support. Future land use was not projected to change prior to this project being proposed (LANL 2003b).

Construction Impacts—Remote Warehouse and Truck Inspection Station construction along the south side of East Jemez Road would require clearing about 4 acres (1.6 hectares) of land. Site development would represent a change in both current and projected land use from Reserve to Physical and Technical Support.

Land Resources—Visual Resources

Along East Jemez Road between NM 4 and the shooting range, Sandia Canyon is relatively undeveloped, and the area possesses desirable aesthetic qualities. There is a forest canopy, and certain spots along East Jemez Road afford views of the surrounding mesas and more distant mountains. The principal manmade features that contrast with the existing natural environment are East Jemez Road, the existing truck inspection station, and the shooting range.

Construction Impacts—During the construction phase, heavy equipment, hauling operations, staging areas, and site preparation activities would create local temporary adverse visual effects through disturbance of soil resources and subsequent release of airborne dust locally.

Operations Impacts—Impacts of site development, which would involve clearing approximately 4 acres (1.6 hectares), would be visible to passing travelers on East Jemez Road. The area proposed for the Remote Warehouse and Truck Inspection Station would be visible to motorists along East Jemez Road because the project would require clearing trees, and the resulting buildings would be taller than most remaining trees. Some screening would be possible by selectively cutting trees closest to East Jemez Road and by placement of buildings on the site with regard to its topographic features. Nighttime lighting would be required in a location that was previously unlit. Although the Remote Warehouse and Truck Inspection Station would not be visible from the trails or parking lot at the Tsankawi Unit of Bandelier National Monument, the nighttime sky glow from Remote Warehouse and Truck Inspection Station lighting could be visible from Tsankawi under normal conditions. However, the trails at Tsankawi are closed to the public after dusk. Installed lighting would comply with the New Mexico Night Sky Protection Act to the extent it does not compromise security.

Geology and Soils

Only small faults at the western periphery of the area have been identified in TA-72, so the seismic hazard would be minimal. Soil resources in the area of the Remote Warehouse and Truck Inspection Station proposed location are undisturbed and maintain the present vegetative cover.

Construction Impacts—Construction of the Remote Warehouse and Truck Inspection Station in TA-72 is expected to require excavation of approximately 90,000 cubic yards (69,000 cubic meters) of soil and underlying Bandelier tuff. Soil resources that are excess to project needs would be stockpiled in approved areas. These soil and rock stockpiles could then be used at other locations at LANL for site restoration following remediation. If soil and rock stockpiles are to be stored for longer than a few weeks, the stockpiles would be seeded or managed as appropriate to prevent erosion and loss of the resource. In addition, care would be taken to employ all necessary erosion control best management practices during and following construction to limit impact on soil resources adjacent to the construction site.

Water Resources

The proposed Remote Warehouse and Truck Inspection Station location is approximately 1,500 feet (460 meters) east (downgradient) of Los Alamos County water supply well PM-3, and 3,100 feet (950 meters) west of water supply well PM-1. Both wells are located on the north side of East Jemez Road, along with the ephemeral streambed in Sandia Canyon. Both wells tap the regional aquifer. Regional groundwater occurs at approximately 900 feet (270 meters) below ground surface. Intermediate, perched groundwater occurs in portions of Sandia Canyon at a depth of approximately 450 feet (140 meters) below ground surface, but is not used as a resource.

Construction Impacts—No long-term effects on surface water quality would be likely. Best management practices for runoff control, such as silt barriers and straw bales, would be used during construction. The potential for downstream siltation would be minor and temporary in nature. A stormwater pollution prevention plan would be developed and implemented, including best management practices to prevent erosion of disturbed soil by stormwater runoff or other water discharges. All Remote Warehouse and Truck Inspection Station construction would occur on the south side of East Jemez Road. Therefore, there would be no impact on the Sandia Canyon floodplain and ephemeral watercourse, located on the north side of the road.

Operations Impacts—The addition of new impermeable surfaces would increase stormwater runoff and would decrease surface water infiltration. While decreased infiltration is not expected to have an adverse effect on groundwater quality, the increased amount of runoff from paved surfaces may have a slight effect on surface water quality and on residual contaminant transport within canyon sediments. Best management practices integrated as part of the site design would minimize the potential for sediment and residual contaminant transport. Removal of paved surfaces at the existing truck inspection station would help offset potential increases in runoff in Sandia Canyon due to proposed Remote Warehouse and Truck Inspection Station development.

Air Quality and Noise

Construction Impacts—Construction of the proposed Remote Warehouse and Truck Inspection Station would result in temporary, localized emissions associated with vehicle and equipment exhaust, as well as particulate (dust) emissions from excavation and construction activities. Total emissions of criteria pollutants and other air emissions associated with heavy-equipment operation for excavation and construction activities would be greater than for other vehicles due to the types of engines and their respective emission factors. Air emissions associated with excavation and construction equipment operation would not exceed ambient air quality standards. Emissions resulting from soil disturbance during construction would be controlled by best management practices, thereby causing no impacts on workers or the public.

The proposed project would result in limited short-term increases in noise levels associated with construction activities. Noise generated would not have an adverse effect on construction workers. Sound levels are expected to dissipate to background levels before reaching the Tsankawi parking lot at the intersection of NM 4 and East Jemez Road.

Operations Impacts—Effects of Remote Warehouse and Truck Inspection Station operations on air quality would be negligible compared to potential annual air pollutant emissions from LANL as a whole. Remote Warehouse and Truck Inspection Station operation could result in fewer emissions by consolidating delivery trucks and trips going to various points at LANL throughout the day. Operations would not cause any radiological air emissions.

The project would result in increased long-term noise levels associated with the proposed Remote Warehouse and Truck Inspection Station operation. Noise generated by the proposed project would not have an adverse effect on workers at the new facility once it is operating. Operational sound levels are expected to dissipate to background levels before reaching the Tsankawi parking lot at the intersection of NM 4 and East Jemez Road. Noise from the facility may be noticeable to the public on East Jemez Road; however, undisturbed wildlife habitats in the surrounding area would not be adversely impacted by the increased noise.

Ecological Resources

The proposed project site is situated within a mixed pinyon-juniper woodland and ponderosa pine forest due to its elevation and orientation that includes north-facing slopes. The area is not within an Area of Environmental Interest delineated for protection of the Mexican spotted owl, southwestern willow flycatcher, or the bald eagle. Other state-listed special status species would have a low probability of occurrence within the project area (LANL 2006a). Furthermore, there are no wetlands or aquatic resources within the project area (ACE 2005).

Construction Impacts—The proposed project would result in clearing and grading approximately 4 acres (1.6 hectares) of ponderosa pine forest and pinyon-juniper woodland. Much of the area around buildings would be paved, and an industrial security fence would be installed at the perimeter. The project area contains large-diameter trees (greater than 8 inches

[20 centimeters]), primarily ponderosa pines, that would potentially require removal for the proposed project construction.

Remote Warehouse and Truck Inspection Station construction would also result in loss of less-mobile wildlife, such as reptiles and small mammals, and cause more-mobile species, such as birds or large mammals, to be displaced. The success of displaced animals would depend on the carrying capacity of the area into which they moved. If the area were at its carrying capacity, displaced animals would not likely survive. Indirect impacts of construction, such as noise or human disturbance, could also impact wildlife living adjacent to the construction zone. Such disturbance would span the construction period. These impacts would be mitigated by clearly marking the construction zone to prevent equipment and workers from disturbing adjacent habitat.

As noted above, the site of the Remote Warehouse and Truck Inspection Station would not be located within Areas of Environmental Interest for the Mexican spotted owl, bald eagle, or southwestern willow flycatcher. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with the proposed project, the biological assessment prepared by DOE concluded that if appropriate reasonable and prudent alternatives are followed to protect adjacent foraging habitat (see Section G.2.3.2), the project may affect, but is not likely to adversely affect, the bald eagle. The biological assessment further concluded that the project would not effect the Mexican spotted owl or southwestern willow flycatcher (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Operations Impacts—Operation of the proposed Remote Warehouse and Truck Inspection Station would not likely pose significant adverse effects on most wildlife in this portion of Sandia Canyon. Activities would be restricted to within the facility grounds; therefore, most area wildlife would likely continue to use the area around the facility for foraging and migration after construction was complete.

Human Health

Construction Impacts—During Remote Warehouse and Truck Inspection Station construction, some construction-related accidents could potentially occur. The rate of occurrence for industrial accidents is based on both DOE and Bureau of Labor Statistics data on construction injuries and fatalities. Based on an estimated 281,000 person-hours to construct the new facilities, no fatal accidents would occur. The number of nonfatal injuries would be between 3 and 12 (DOE 2004, BLS 2003).

Cultural Resources

Three archaeological sites are situated in the vicinity of the proposed Remote Warehouse and Truck Inspection Station location. These sites include two rock rings and a lithic scatter. Each site was recommended by LANL for a determination of eligibility for the National Register of Historic Places.

In addition to the above-mentioned sites, two nearby National Historic Landmarks are located outside of the proposed project boundary. They include the Mortandad Cave Kiva National

Historic Landmark, accessed by the Mortandad Trail, and the Sandia Canyon Cave Kiva National Historic Landmark. There are no historic structures in the project area.

Construction Impacts—The planned East Jemez Road Remote Warehouse and Truck Inspection Station could impact the recorded prehistoric archaeological sites at the proposed location. Additional consultation would be required to ensure the sites are clearly marked such that the sites are avoided and that construction activity, traffic, and ground disturbances would not result in damage to the sites. If buried cultural deposits are encountered during construction, activities would cease, and procedures as set forth in *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* would be implemented (LANL 2006c).

The Mortandad Trail, located east of the proposed project site, leads to the Mortandad Cave Kiva National Historic Landmark and is closed to public access except for organized tours. Although the proposed project would not affect normal access to the trail, it would incorporate fencing around the perimeter of the Remote Warehouse and Truck Inspection Station to protect sensitive areas, including the Mortandad Cave Kiva National Historic Landmark, from unauthorized increased visitation.

Socioeconomics and Infrastructure

Currently, there are no NNSA facilities at the site. In the vicinity of the proposed project area, there are no utilities on the north side of East Jemez Road. However, there are existing aboveground electrical distribution lines, underground water transmission lines (and water pumping wells), and underground telecommunications along the north side of East Jemez Road in the vicinity of the proposed Remote Warehouse and Truck Inspection Station.

Construction—Utility infrastructure resources would be needed for Remote Warehouse and Truck Inspection Station construction. Standard construction practice dictates that electric power needed to operate portable construction and supporting equipment be supplied by portable diesel-fired generators. Therefore, no electrical energy consumption would be directly associated with construction. A variety of heavy equipment, motor vehicles, and trucks would be used requiring diesel fuel, gasoline, and propane for operation. Liquid fuels would be brought to the site as needed from offsite sources and, therefore, would not be limited resources. Water would be needed primarily to provide dust control, aid in soil compaction at the construction site, and possibly for equipment washdown. Water would not be required for concrete mixing, as ready-mix concrete is typically procured from offsite resources. Portable sanitary facilities would be provided to meet the workday sanitary needs of project personnel on the site. Water needed for construction would typically be trucked to the point of use, rather than provided by a temporary service connection. Construction is estimated to require 420,000 gallons (1.6 million liters) of liquid fuels and approximately 2 million gallons (7.6 million liters) of water.

The existing LANL infrastructure would be capable of supporting the requirements for new facility construction without exceeding site capacities, resulting in a negligible impact on site utility infrastructure.

Operations Impacts—Development of the proposed Remote Warehouse and Truck Inspection Station Project would require addition of a natural gas line, extended from the intersection of

East Jemez Road and NM 4, east of the proposed site. In addition, a means of sanitary sewer treatment, conveyance, and disposal would be required for the proposed facility. Onsite disposal of sanitary wastes in this area would be intensive if a conventional leach field is used. Onsite disposal would require an New Mexico Environment Department groundwater discharge permit to ensure local groundwater resources are not adversely impacted. An option of local treatment with surface discharge to the Sandia Canyon watercourse would require modification to the LANL NPDES permit.

Waste Management

There are currently no LANL operations located at the site, and therefore no waste volumes are produced. However, the activities that would be relocated to the Remote Warehouse and Truck Inspection Station currently produce waste at other LANL locations. There would be no change to overall waste types or volumes.

Construction Impacts—Based on the scope of the proposed project and historical projects at LANL, it is estimated that approximately 610 cubic yards (470 cubic meters) of solid waste would be generated during construction. The solid waste from construction would be recycled or disposed of at a permitted solid waste landfill.

Operations Impacts—Wastes from operations that would be moved to the new warehouse site under the proposed project would generally be of the same types and quantities as those generated at the current warehouse, TA-3-30. No new radioactive or other wastewater or hazardous waste streams would be generated.

Under the proposed project, sanitary waste from the existing warehouse site (SM-30) would no longer be discharged to the Sanitary Wastewater System Plant (TA-46). Due to the Remote Warehouse and Truck Inspection Station location, sanitary sewage from the facility may require onsite treatment, which could result in permitted discharges from a new treatment system. The total volume of sanitary waste generated, treated, and disposed of at LANL would remain unchanged.

Transportation

The TA-3 area where the warehouse functions are presently located is accessed from Pajarito Road, East and West Jemez Roads, and Diamond Drive. Trucks going to LANL must use East Jemez Road and stop at the current truck inspection station at the NM 4 intersection.
Los Alamos County peak period traffic volumes and resulting congestion are greatly influenced by LANL (as it is the main employer in Los Alamos County), existing roadway network constraints, the Pajarito Plateau topography, and operational access restrictions. A traffic study was conducted in support of the proposed Remote Warehouse and Truck Inspection Station (LSC 2005a). The study reports existing average weekday peak-hour traffic along East Jemez Road in the proposed project area to be about 175 eastbound and 995 westbound vehicle trips in the morning and about 1,260 eastbound and 205 westbound vehicle trips in the afternoon.

East Jemez Road lies within the LANL site boundary and is under NNSA control. It serves as the primary public access road between LANL and White Rock and to locations west of

Los Alamos County. An access control station would be built on East Jemez Road close to Diamond Drive to screen all vehicles entering LANL from these roads. The only access to TA-53 (LANSCE) is along East Jemez Road. The Los Alamos County Landfill and proposed future waste transfer station and Royal Crest Trailer Park are also accessed by East Jemez Road. There are no sidewalks or improved bicycle lanes along East Jemez Road. Long-range transportation plans for TA-53 propose a secondary access road descending from the mesa, with an intersection across from the general proposed project area.

Operations Impacts—The traffic study evaluated the impact of the 125-employee Remote Warehouse and Truck Inspection Station on traffic along East Jemez Road for two different scenarios: a two-lane and a four-lane East Jemez Road (LSC 2005a). Traffic impact was evaluated in terms of level of service, a quantitative measurement indicative of the level of delay and congestion at an intersection, ranging from A to F (level of service A being very little congestion or delay, while level of service F is a high level of congestion or delay). The Remote Warehouse and Truck Inspection Station is projected to generate nearly 540 vehicle trips on the average weekday, with about 270 vehicles entering and 270 exiting in a 24-hour period. These vehicle trips would be moved from the existing access (to the east) to the proposed Remote Warehouse and Truck Inspection Station access. The shooting range is expected to generate about 100 vehicle trips on the average weekday, with about 50 vehicles entering and 50 exiting in a 24-hour period.

Under the two-lane East Jemez Road scenario, with shooting-range-site-generated traffic and the addition of the Remote Warehouse and Truck Inspection Station, the East Jemez Road and site access intersection (without a traffic signal) is projected to operate at a failing level of service (level of service F) for east- and westbound traffic during the afternoon peak hour. The entrance to the shooting range would also potentially become a part of the intersection, with the warehouse entrance and the estimated number of vehicles entering and exiting taken into account in estimating potential traffic impacts. Under the four-lane East Jemez Road scenario, with the addition of the distribution center to existing shooting-range-site-generated traffic, the East Jemez Road and site access intersection (without a traffic signal) would operate at an acceptable level of service during short-term peak hours (LSC 2005a).

The traffic study concluded that changes to roadway geometry, to include left-turn lanes and acceleration lanes for east- and westbound traffic on East Jemez Road, would be required to achieve an acceptable level of service for vehicles on East Jemez Road and vehicles entering the road from the proposed combined access intersection. Although truck and other traffic would increase at TA-72 relative to current levels, the proposed project could result in reduced traffic in and around TA-3 because deliveries would be consolidated for specific sites at LANL.

Facility Accidents

Operations Impacts—The Remote Warehouse and Truck Inspection Station would process and distribute all types of deliveries to LANL, including conventional mail and packages and some hazardous, biological, and radioactive materials. Locating the facilities along East Jemez Road in Sandia Canyon would isolate them from any residential or work areas in the event of an accidental release. East Jemez Road is the designated truck route for Los Alamos County and LANL.

The operational hazards of the proposed project have been previously assessed in the *1999 SWEIS* (DOE 1999a) at the current locations of those operations. Most operations proposed for the Remote Warehouse and Truck Inspection Station were eliminated from further analysis in the SWEIS on the basis of hazard categorization; it was determined that no hazards existed beyond those routinely encountered in an office or standard industrial laboratory environment. Because there would be no substantial changes (such as in quantities of hazardous materials at risk) in operations from implementing the proposed project, potential outcomes of accidents involving operations-related hazards would be bounded by the operational hazard analyses in the SWEIS.

G.10 References

ACE (U.S. Army Corps of Engineers) 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico,* Albuquerque, District, Albuquerque, New Mexico, October.

BLS (Bureau of Labor Statistics), 2003, *Incidence Rates of Nonfatal Occupational Injuries and Illnesses in 2003*, U.S. Department of Labor, Washington, DC.

Booth, S., 2004, *Site Options Study for New Warehouse at Los Alamos National Laboratory*, LA-UR-04-1283, Los Alamos National Laboratory, Los Alamos, New Mexico, February.

DOE (U.S. Department of Energy), 1996, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, DOE/EIS-0236, September.

DOE (U.S. Department of Energy), 1998, *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1250, Los Alamos Area Office, Los Alamos, New Mexico, December 18.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 1999c, *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico*, DOE/EIS-0293, Los Alamos Area Office, Los Alamos, New Mexico, October.

DOE (U.S. Department of Energy), 2000, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2002a, *DOE Standard, Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE-STD-1020-2002 (January), supersedes DOE-STD-1020-94 (April 1994), Washington, DC, January.

DOE (U.S. Department of Energy), 2002b, *Environmental Assessment for the Proposed Construction and Operation of a Biosafety Level 3 Facility at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1364, National Nuclear Security Administration, Office of Los Alamos Site Operations, February 26.

DOE (U.S. Department of Energy), 2002c, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, National Nuclear Security Administration, Washington, DC, August.

DOE (U.S. Department of Energy), 2003, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, November.

DOE (U.S. Department of Energy), 2004, *DOE and Contractor Facility Incident Rates,* Office of Environment, Safety, and Health, Washington, DC.

DOE (U.S. Department of Energy), 2005, *DOE Order 420.1B, Facility Safety*, Office of Environment, Safety and Health, Washington, DC, December 22.

Gardner, J. N, A. Lavine, G. WoldeGabriel, D. Krier, D. Vaniman, F. Caporuscio, C. Lewis, P. Reneau, E. Kluk, and M. J. Snow, 1999, *Structural Geology of the Northwestern Portion of Los Alamos National Laboratory, Rio Grande Rift, New Mexico: Implications for Seismic Surface Rupture Potential from TA-3 to TA-55*, LA-13589-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, March.

Knight, Terry, and W. Bruce Masse, 2001, *Identification and Management of Native American Traditional Cultural Properties at Los Alamos National Laboratory*, LA-UR-01-1354, Los Alamos, New Mexico, available at http://www.esh.lanl.gov/~esh20/pdfs/MasseKnight.pdf.

LANL (Los Alamos National Laboratory), 1998, *Threatened and Endangered Species Habitat Management Plan Overview*, LA-LP-98-112, ESH-20, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2000, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2001, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2002a, *Site + Architectural Design Principles*, LA-UR-01-5383, Site Planning and Development Group, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2002b, *LANL Sustainable Design Guide*, LA-UR-02-6914, Site and Project Planning Group, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2003a, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, Meteorology and Air Quality Group, Environmental Stewardship Division, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2003b, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003c, *Physics Facility Strategic Plan*, LA-UR-03-8251, Physics Division, Los Alamos, New Mexico, November 5.

LANL (Los Alamos National Laboratory), 2004a, *Statement of Mission Need and Project Description for Refurbishment of the Los Alamos Neutron Science Center (LANSCE-R)*, LA-UR-04-1350, May 21.

LANL (Los Alamos National Laboratory), 2004b, "Section G10 Site Preparation," *Engineering Standards Manual*, OST220-03-01-ESM, Revision 1, Los Alamos, New Mexico, August 16.

LANL (Los Alamos National Laboratory), 2004c, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004d, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *2004 LANL Radionuclide Air Emissions*, LA-14233, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *LANSCE Refurbishment Project: Mission Need Statement, Non-Major System Acquisition Project*, LA-UR-05-4040, Los Alamos, New Mexico, June 1.

LANL (Los Alamos National Laboratory), 2005c, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Environmental Stewardship Division, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005d, *Los Alamos National Laboratory Wildland Fire Management Plan, Management Review Draft*, LA-UR-05-0286, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005e, *Pollution Prevention Project, Radioactive Liquid Waste Treatment Facility (RLWTF), Influent Boundary Condition Assessment*, Revision 2.0, LA-UR-05-9001, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2005f, Conceptual Design Report for the TA-50 Radioactive Liquid Waste Treatment Facility Upgrade Project (90%), *Final Waste Management Plan*, Prepared by DJMJ Holmes and Narver.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006c, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, Ecology Group, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006d, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006e, *Emissions Inventory Report Summary for Los Alamos National Laboratory for Calendar Year 2005*, LA-14309-SR, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory) 2006f, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2007, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Design Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

LSC (LSC Transportation Consultants, Inc.), 2005a, *LANL Distribution Center Traffic Impact and Access Analysis*, Colorado Springs, Colorado, November 15.

LSC (LSC Transportation Consultants Inc.), 2005b, *LANL Science Center Traffic Impact and Access Analysis*, Colorado Springs, Colorado, November 15.

NMED (New Mexico Environment Department), 2005, Compliance Order on Consent Proceeding Under the New Mexico Hazardous Waste Act Section 74-4-10 and the New Mexico Solid Waste Act Section 74-9-36(D), March 1.

NNSA (National Nuclear Security Administration), 2001, *Environmental Assessment for Construction and Operation of a New Office Building and Related Structures within TA-3 at Los Alamos National Laboratory, Los Alamos, New Mexico*, NNSA/EA-1375, Los Alamos Area Office, Los Alamos, New Mexico, July 26.

USGBC (U.S. Green Building Council), 2006, "LEED for New Construction," Available at http://www.usgbc.org/LEED, Accessed April 10.

APPENDIX H
IMPACTS ANALYSES OF CLOSURE AND REMEDIATION ACTIONS

APPENDIX H
IMPACTS ANALYSES OF CLOSURE AND REMEDIATION ACTIONS

Appendix H presents project-specific analyses for three proposed projects related to closure and remediation that would be initiated within the timeframe under consideration in the *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS):

- Technical Area (TA) 18 Closure, including remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition (DD&D);
- TA-21 Structure Decontamination, Decommissioning, and Demolition; and
- Waste Management Facilities Transition.

Each of these proposed projects would either: (1) generate potentially large volumes of wastes from exhumations or DD&D activities; or (2) require the installation of closure covers and subsequent long-term monitoring of areas at Los Alamos National Laboratory (LANL) where it is proposed that waste be left in place. Additionally, one project would also provide facilities necessary for the safe management of newly generated waste. The proposed timeframes associated with construction, DD&D, and closure activities for these projects are depicted in **Figure H–1**. Analyses in this appendix consider projects proposed for the period 2007 through 2011, but would equally apply to actions beyond 2011 as long as the actions are bounded by the analyses in the appendix.

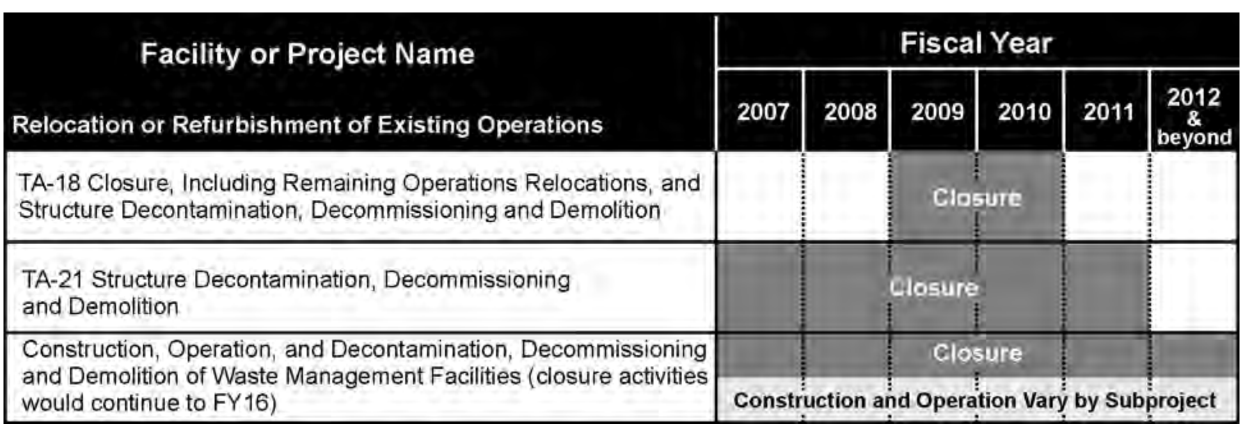


Figure H–1 Proposed Timeframes for Construction and Operation of Closure and Remediation Actions

DD&D activities are governed by a series of guidelines and procedures specified in U.S. Department of Energy (DOE) implementation guides DOE G-430.1-2, -3, -4, and -5, and by DOE-STD-1120-2005, that addresses integration of safety and health into disposition of facilities. LANL staff carefully plan all work to ensure compliance with established state and Federal laws and regulations (such as National Emissions Standards for Hazardous Air Pollutants [NESHAP]), DOE Orders, and Compliance Agreements, and in accordance with LANL procedures and best management practices. Depending on the project, LANL staff may choose to perform the DD&D work with site personnel or subcontract all or portions of the project. For the purpose of this description, both LANL and subcontractor personnel are considered DD&D workers. The National Nuclear Security Administration (NNSA) develops detailed project-specific work plans for the DD&D of structures before any actual work can begin.

Management and support activities associated with DD&D projects that parallel these elements include overall project management, DD&D work planning and engineering, characterization, authorization basis, radiological and safety technical support, waste and traffic management, cost and schedule management, program waste management planning, utilities and infrastructure management, and building surveillance and maintenance prior to and during DD&D. In particular, planning activities include preparation of implementation plans, safety documents, waste management plans, and procedures; engineering reviews and evaluations; readiness reviews and verification; and closure surveys and reports. LANL staff implement activity planning to support work control and worker safety using the Integrated Safety Management process, and limits exposure to workers based on an administrative control level of 500 millirem per year and as low as reasonably achievable (ALARA) principles.

Every DD&D project shares several common stages described in the following text box. The project-specific DD&D information related to each of the three proposed projects are detailed in subsequent sections of this appendix.

The ultimate disposition of the facilities constructed by the projects in this appendix would be considered at the end of their operations, usually several decades after their construction. The designs for the facilities that would support missions involving radioactive and hazardous materials are required to consider life-cycle features including eventual facility DD&D. It is anticipated that the impacts from the eventual disposition of the newly-constructed facilities would be similar or less than the impacts resulting from the disposition of the facilities that they replace.

Waste Management and Pollution Prevention Techniques. Waste management and pollution prevention techniques that could be implemented during the DD&D of the buildings and structures would include:

- Conducting routine briefings of workers.
- Segregating wastes at the point of generation to avoid mixing and cross-contamination.
- Decontaminating and reusing equipment and supplies.
- Removing surface contamination from items before discarding.
- Avoiding use of organic solvents during decontamination.
- Using drip, spray, squirt bottles or portable tanks for decontamination rinses.
- Using impermeable materials such as plastic liners or mats and drip pallets to prevent the spread of contamination.

Decommission, Decontamination and Demolition Work Elements

Deactivation (a preliminary step to DD&D): Materials and equipment to be reused would be relocated, and accountable materials would be collected and transferred to other locations for storage. Additional actions could be draining liquids from tanks and removing high levels of contamination. The structure may be placed in a surveillance and maintenance status. After deactivation, the structure may undergo DD&D or be reused.

Removal of Process Equipment (a preliminary step to DD&D): Equipment would be cut up or removed. This may include ventilation systems and process lines. The process equipment would either be reused or packaged for disposal.

Characterization, Segregation of Work Areas, and Structural Evaluation: Walls, floors, ceilings, roof, equipment, ductwork, plumbing and other components within each building and site element would be tested to determine the type and extent of contamination present. The buildings and structures would then be segregated into areas of contamination and no contamination. Contaminated areas would be further subdivided by the type of contamination: radioactive materials, hazardous materials, toxic materials including asbestos, and any other Resource Conservation and Recovery Act listed or characteristic contamination. As part of the characterization and segregation of work areas, consideration would also be given to the structural integrity. Some areas could require demolition work prior to decontamination.

Removal of Contamination: Workers would remove or stabilize contamination according to the type and condition of materials. If the surface of a floor or wall were found to be contaminated, it might be physically stripped off. If contamination were found within a wall, a surface coating might be applied to keep the wall from releasing contaminated dust during dismantlement and to keep the surface intact.

Demolition of the Structures, Foundation, and Parking Lot: After contaminated materials have been removed, wherever possible and practical, the demolition of all or portions of the structure would begin. Demolition could involve simply knocking down the structure and breaking up any large pieces. Knocking down portions of the building, foundation, and parking lot could require the use of backhoes, front-end loaders, bulldozers, wrecking balls, shears, sledge and mechanized jack hammers, cutting torches, saws, and drills. If not contaminated, demolition material could be reused onsite at LANL or disposed of as construction waste onsite or offsite. Asphalt would be placed in containers and trucked to established storage sites within LANL, at TA-59 on Sigma Mesa.

Segregating, Packaging, and Transport of Debris: Demolition debris from the structures would be segregated and characterized by size, type of contamination, and ultimate disposition. Debris that is still radiologically contaminated would be segregated as low-level radioactive waste if no hazardous[1] contamination were present. Other types of debris that would be segregated include mixed low-level radioactive waste,[2] noncontaminated construction debris, and debris requiring special handling. Segregation activities could be conducted on a gross scale using heavy machinery or could be performed on a smaller scale using hand-held tools. Segregated waste would be packaged as appropriate and stored temporarily pending transport to an appropriate onsite or offsite disposal facility.

Debris would be packaged for transport and disposal according to waste type, characterization, ultimate disposition, and U.S. Department of Transportation (DOT) or DOE transportation requirements. Uncontaminated construction debris could be sent unpackaged to the local landfill by truck. Demolition debris would also be recycled or reused to the extent practicable. Debris would be disposed of either on or offsite depending on the available capacity of existing disposal facilities. Offsite disposal would involve greater transportation requirements depending on the type of waste, packaging, acceptance criteria, and location of the receiving facility.

Testing and Cleanup of Soil and Contouring and Seeding: The soils beneath the buildings would be sampled and tested for contamination. Any contaminated soil would undergo cleanup per applicable environmental regulations and permit requirements and would be packaged and transported to the appropriate disposal facility depending on the type and concentration of contamination. After clean fill and soil were brought to the site as needed, the site would be contoured. Contouring would be designed to minimize erosion and replicate or blend in with the surrounding environment. Subsequent seeding activities would use native plant seeds and the seeds of non-native cereal grains selected to hold the soil in place until native vegetation becomes stabilized.

[1] *Hazardous waste is a category of waste regulated under the Resource Conservation and Recovery Act (RCRA). Hazardous RCRA waste must be solid and exhibit at least one of four characteristics described in 40 Code of Federal Regulations (CFR) 261.20 through 40 CFR 261.24 (ignitability, corrosivity, reactivity, or toxicity) or be specifically listed by the U.S. Environmental Protection Agency in 40 CFR 261.31 through 40 CFR 261.33.*

[2] *Mixed low-level radioactive waste contains both hazardous RCRA waste and source, special nuclear, or byproduct material subject to the Atomic Energy Act.*

- Avoiding areas of contamination until they are due for decontamination.
- Reducing waste volumes (by such methods as compaction).
- Engaging in the use of recycling actions (materials such as lead, scrap metals, and stainless steel could be recycled to the extent practical).

Some of the wastes generated from the DD&D of the buildings would be considered residual radioactive material. DOE Order 5400.5 establishes guidelines, procedures, and requirements to enable the reuse, recycling, or release of materials that are below established limits. Materials that are below these limits are acceptable for use without restrictions. The residual radioactive material that would be generated by DD&D would include uncontaminated concrete, soil, steel, lead, roofing material, wood, and fiberglass. The concrete material could be crushed and used as backfill at LANL. Soil could also be used as backfill or as topsoil cover, depending on its characteristics. Steel and lead could be stored and reused or recycled at LANL. Wood, fiberglass, and roofing materials would be disposed of at the Los Alamos County Landfill or other available landfills.

H.1 Technical Area 18 Closure, Including Remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition Impacts Assessment

This section provides an impacts assessment for the closure of TA-18, including the disposition of the remaining TA-18 Security Category III and IV capabilities and materials[1], a decision that was deferred in the Record of Decision (ROD) (67 *Federal Register* [FR] 79906) for the *Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory* (DOE/EIS-0319) (*TA-18 Relocation EIS*), and the DD&D of the buildings and structures at TA-18. Section H.1.1 provides background information and the purpose and need for the relocation of TA-18 Security Category III and IV capabilities and materials, the proposed actions for the disposition of the remaining Security Category III and IV operations and materials, and DD&D activities. Section H.1.2 provides a brief description of the proposed options for the disposition of the remaining Security Category III and IV capabilities and materials. Section H.1.3 describes the affected environment and presents an impacts assessment for both the disposition of the remaining Security Category III and IV capabilities and materials and for the DD&D of buildings at TA-18. Chapter 4 of this SWEIS presents a description of the affected environment at LANL and TA-18. Any unique characteristics of LANL and TA-18 not covered in Chapter 4 that would be affected by the proposed TA-18 closure, relocation of remaining TA-18 operations and subsequent DD&D of TA-18 buildings, are presented here.

Descriptions and impact analyses in this section are based on the status of TA-18 facilities and activities as of approximately the end of 2005. Facility status continues to change at TA-18 as NNSA implements the decisions made in the ROD for the *TA-18 Relocation EIS* (DOE/EIS-0319). Activities that could affect the descriptions included in this section include the following:

---

[1] *This Security Category description refers to the required level of safeguards and security as established in DOE Order 470.4 and its manual, DOE M 470.4-6.*

- transitioning of radiation sources to TA-55,
- removing special nuclear fuel from criticality machines and undertaking activities to prepare the machines for transfer to the Nevada Test Site Device Assembly Facility,
- removing and relocating materials from TA-18 storage areas, and
- removing accelerators and related sources and support equipment.

Performance of these activities does not affect the environmental impacts analysis presented in Section H.1.3.

H.1.1 Introduction and Purpose and Need for Agency Action

This section provides background information on the relocation of TA-18 Security Category I, II, III, and IV capabilities and materials, the proposed actions for the disposition of the remaining Security Category III and IV operations and materials, and DD&D activities.

Background

NNSA is responsible for providing the Nation with nuclear weapons, ensuring the safety and reliability of those nuclear weapons, and supporting programs that reduce global nuclear proliferation (LANL 2005f). One of the major training facilities supporting these missions is located at TA-18. The principal TA-18 operation has been research in the design, development, construction, and application of nuclear criticality experiments. The operations at TA-18 enable DOE personnel to gain knowledge and expertise in advanced nuclear technologies that support the following: (1) nuclear materials management and criticality safety; (2) emergency response in support of counterterrorism activities; (3) safeguards and arms control in support of domestic and international programs to control excess nuclear materials; and (4) criticality experiments in support of Stockpile Stewardship and other programs.

TA-18 is located at the Pajarito Site and contains about 60 structures totaling about 80,000 square feet (7,432 square meters) (see **Figure H–2**). The TA-18 buildings and infrastructure, some of which have been operational since 1946, range from 30 to more than 50 years of age and are increasingly expensive to maintain and operate. NNSA prepared an environmental impact statement (EIS) for relocating the TA-18 capabilities and materials in 2002. In its December 31, 2002 ROD (67 FR 79906) for the *TA-18 Relocation EIS*, NNSA decided to relocate Security Category I and II capabilities and related materials to the Device Assembly Facility at the Nevada Test Site (DOE 2002b). This alternative included transportation of special nuclear materials and equipment required to support Security Category I and II capabilities. NNSA did not issue a decision regarding the future location of TA-18 Security Category III and IV capabilities and materials within the LANL site, or the disposition of the TA-18 facilities.

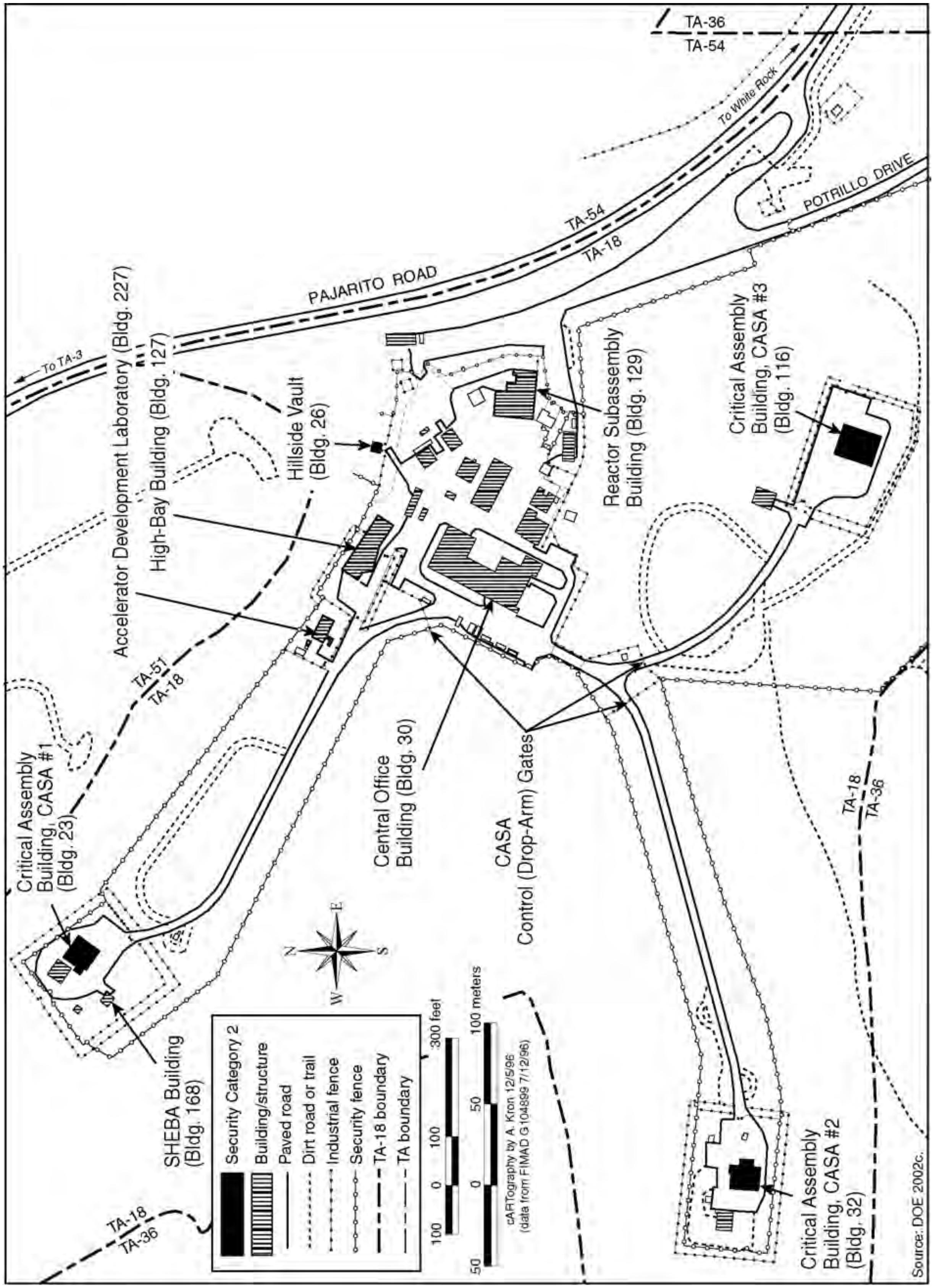


Figure H–2 Technical Area 18 Pajarito Site

SPECIAL NUCLEAR MATERIALS SAFEGUARDS AND SECURITY

(DOE Manual 470.4-6)

Special nuclear materials are defined in the Atomic Energy Act of 1954 as (1) plutonium, uranium enriched in the isotope 233 or 235, or any other material designated as special nuclear material; or (2) any material artificially enriched by any of the above.

DOE's policy is to protect national security and the health and safety of DOE and contractor employees, the public, and the environment by protecting and controlling special nuclear material. This is accomplished by designing specific safeguards and security strategies to prevent or minimize both unauthorized access to special nuclear material and unauthorized disclosure, loss, destruction, modification, theft, compromise, or misuse of special nuclear material as a result of terrorism, sabotage, or events such as disasters and civil disorders.

DOE uses a cost-effective, graded approach to providing special nuclear material safeguards and security. Quantities of special nuclear material stored at each DOE site are categorized into Security Categories I, II, III, and IV, with the greatest quantities included under Security Category I and lesser quantities included in descending order under Security Categories II through IV. Types and compositions of special nuclear material are further categorized by their "attractiveness," that is, the relative ease of the processing and handling activities required to convert such materials into a nuclear explosive device. For example, assembled weapons and test devices fall under Attractiveness Level A. Pure products (metal items that can be used for weapons production in their existing form or after simple mechanical processing) are categorized under Attractiveness Level B. High-grade special nuclear material (high-grade chemical compounds, mixtures, or metal alloys that require relatively little processing to convert them for weapons use) and low-grade special nuclear material (bulk and low-purity materials that require extensive or complex processing efforts to convert them to metal or high-grade form) are categorized as Levels C and D, respectively. All other special nuclear material (highly radioactive special nuclear material not included under another attractiveness level, solutions containing very small amounts of special nuclear material, uranium enriched to less than 20 percent uranium-235, etc.) fall under Level E. This alphanumeric system results in overall categories ranging from Security Category IA (weapons and test devices in any quantities) to Security Category IV (reportable quantities of special nuclear material not included in other categories).

Implementation of the ROD to relocate Security Category I and II capabilities and materials was initiated in 2004. In October 2005, TA-18 was de-inventoried below Security Category I and II levels. More than half of the programmatic special nuclear material was transported to the Device Assembly Facility at the Nevada Test Site. The remaining portion was transferred to TA-55 for temporary storage and excess special nuclear material was sent to Y-12 for disposition. The planning assumptions for this SWEIS are:

- TA-18 would continue to support limited Security Category III and IV capabilities through September 2008.
- TA-18 operations would cease by the end of September 2008, and the facility would be turned over for disposition.

Until closed, the major programs using TA-18 facilities would be the Defense Nuclear Nonproliferation and the Nuclear Criticality Safety Programs. Defense Nuclear Nonproliferation Program elements include International Atomic Energy Agency and second line of defense training support. After 2006, the International Atomic Energy Agency training program would be performed at other LANL facilities. The Defense Nuclear Nonproliferation Program would continue to conduct experiments to support second line of defense and nuclear nonproliferation research and development testing at TA-18 until other locations within LANL become available.

After the removal of Security Category I and II equipment and material, the only critical assembly that remains operational at TA-18 would be the Solution High-Energy Burst Assembly (SHEBA) in its Security Category III configuration. The Nuclear Criticality Safety Program would continue to operate SHEBA at TA-18 to maintain the capabilities for training and criticality experiments. NNSA will analyze, through separate National Environmental Policy Act (NEPA) action, the relocation of SHEBA from TA-18 to another site.

TA-18 has also been used to store sealed radiation sources returned to the NNSA under the Global Threat Reduction Initiative until they can be disposed of at the Waste Isolation Pilot Plant (WIPP) in New Mexico. LANL would continue to store radiation sources at TA-18, but over time would transition the staging to an area at TA-55 or other LANL locations (for example, at TA-54) for temporary storage pending disposition at WIPP.

NNSA plans to relocate some capabilities and materials from TA-18 to the Nonproliferation and International Security Center in TA-3, which currently houses personnel that support Defense Nuclear Nonproliferation Program activities. This facility can accept Security Category IV material.

The main facilities consist of three remote-controlled Critical Assembly Storage Areas, or CASAs, (Buildings 23, 32, and 116) and a separate weatherproof shelter near Building 23 that houses SHEBA (Building 168). These buildings are located some distance from the main laboratory (Building 30) that houses individual control rooms for the remote-controlled critical assemblies. A security fence surrounds each CASA. The following text describes the primary buildings addressed in this project-specific analysis (DOE 2002b).

Building 23 (CASA 1)

CASA 1 was built in 1947. The CASA 1 experimental operations area is best described as cuboid. The interior dimensions are 30 feet (9.1 meters) wide by 48 feet (14.6 meters) long by 26 feet (7.9 meters) high. The walls of CASA 1 are constructed with standard hollow 8-inch (20.3-centimeter) by 8-inch (20.3-centimeter) by 46-inch (116.8-centimeter) concrete masonry blocks. The concrete masonry block walls are reinforced with 0.375-inch- (0.95-centimeter-) diameter reinforcing steel placed at 24 inches (61 centimeters) on center in both the vertical and horizontal directions. At a height of 16 feet (4.9 meters), the concrete blocks are replaced with glass block panels. These panels are constructed from regular 7.75-inch (19.7-centimeter) by 7.75-inch (19.7-centimeter) by 3.875-inch (9.84-centimeter) glass blocks. The west and east walls have one centrally located panel approximately 8 by 22 feet (2.4 by 6.7 meters), while the north and south wall each have three panels approximately 7.42 feet by 15.33 feet (2.3 meters by 4.7 meters). The roof is a 4-inch- (10.2-centimeter-) thick concrete slab. The floor is an 8-inch- (20.3-centimeter-) thick concrete slab with a 6-inch- (15.2-centimeter-) square reinforcing mesh of number 6 wires. The eastern wall has a 12 by 14 foot (3.7 by 4.3 meter) electrically operated ballistic-steel door.

In addition, four 3 foot (0.9 meter) by 7 foot (2.1 meter) personnel doors penetrate the CASA 1 experimental area walls (two in the south wall and one each in the east and west wall). CASA 1 houses a general-purpose criticality experiment remote critical assembly machine. This machine does not contain permanently mounted nuclear fuel, and will remain in this building until relocation to the Device Assembly Facility at the Nevada Test Site.

Building 32 (CASA 2)

CASA 2 was built in 1952. It is a single-bay laboratory constructed of reinforced concrete walls and reinforced concrete slab and beam construction at the roof. The walls are 9 inches (22.9 centimeters) thick with a single mat of reinforcing, and 15 to 39 inches (38.1 to

99.1 centimeters) thick around the bay with double mat reinforcing. CASA 2 walls are like CASA 1 walls and afford only nominal shielding. The critical assemblies housed in CASA 2 are Flattop and Comet. These machines do not contain permanently mounted nuclear fuel, and will remain in this building until their relocation to the Device Assembly Facility at the Nevada Test Site.

Building 116 (CASA 3)

CASA 3 was built in 1962. It is a single-story structure with a high-bay laboratory. It has no windows, and no glass blocks were used in its construction. The main structure is constructed of reinforcing concrete shear walls and reinforced concrete slab and beam construction at the roof. Reinforced concrete masonry block walls surround the entrance, machine section, and equipment areas. CASA 3, with its 18-inch- (45.7-centimeter-) thick concrete walls and ceiling, is the only CASA that has significant shielding.

CASA 3 construction provides reasonable confinement in case of a relatively severe criticality accident. The one entrance to the main room is designed like a tunnel to minimize radiation scattering outside of the building, and it is oriented so that the entrance does not open toward the areas most frequently occupied by personnel or members of the public.

CASA 3 houses the Godiva critical assembly. This machine does not contain permanently mounted nuclear fuel, and will remain in this building until its relocation to the Device Assembly Facility at the Nevada Test Site.

Building 168 (SHEBA Building)

Located approximately 60 feet (18.3 meters) southwest of CASA 1 is the SHEBA Experiments Building 168. The building is an all metal double-wall construction with rigid frames anchored to a concrete pad. All walls and the ceiling are fiberglass insulated. For high-radiation experiments, SHEBA is lowered into a pit in the floor of the building which provides shielding during the experiments and provides containment of any liquid release from SHEBA. The current planning basis includes removal of SHEBA in 2009 and reconstituting it at another DOE Site, pending a NEPA review.

The SHEBA Building provides only a weatherproof shelter for the SHEBA critical assembly. No radiation shielding is provided by the structure. This is intentional, as radiation dose measurements and radiation instrumentation can be fielded around critical assemblies in the SHEBA Building without the presence of shielding or building scatter.

Building 30 (Central Office Building)

The main offices of the operating group are located in Building 30. These include the offices of the group management, staff, and several counting laboratories and electronic assembly areas. In addition, Building 30 houses the main TA-18 machine shop. The CASA 1, 2, and 3 control rooms are located on the south side of the building. Building 30 is a single-story building constructed of reinforced concrete with a basement.

Building 26 (Hillside Vault)

The Hillside Vault is located in the canyon wall at the northeast side of the TA-18 site. Materials and components are stored in sealed storage containers at designated locations. Containers are transported to other locations at TA-18 for use in experiments or radiation measurements. The vault is normally maintained to be free of detectable contamination and is subject to a very low occupancy factor.

Building 127 (High Bay)

Building 127, also known as the High Bay, is located next to the canyon wall at the north side of the site. It consists of a large room and a basement with an office complex. The experimental bay features a false floor and light walls to provide low scatter. This feature led to the use of the facility for measurements that require a "clean" radiation environment. A two-story-high shield wall separates the experimental bay from the rest of the site.

Activities on the main floor include portable radiography and detector development for passive and active surveillance of fissile material. There is currently a linear accelerator as well as a Kaman neutron generator in the basement. Both the linear accelerator and the neutron generator are connected to a scram system and a series of interlocks that allow their operation from the main-floor control room.

Building 129 (Reactor Subassembly Building)

Building 129 is located at the northeast end of the site. It is a concrete structure in which portal monitors and detection systems are developed and tested. It consists of one large room and several compartmentalized office and laboratory spaces. Both neutron and gamma-ray sources are used for detector development and calibration procedures. Fissionable material in Building 129 is limited to Security Category III special nuclear material.

Building 227 (Accelerator Development Laboratory)

Radiography operations are conducted in Building 227. Building 227, the Accelerator Development Laboratory, is a concrete structure housing a radiofrequency quadruple accelerator in the main level and a tomographic gamma scanner and a radioactive waste drum counter in the basement. Both of these devices use small sources (the tomographic gamma scanner uses cesium and barium sources and the drum counter uses a shielded pulsed neutron generator), or up to Security Category III special nuclear material inserted in matrices inside the drums to be used. A shielded control room is situated in the basement adjoining the laboratory space. The shielding is provided by a combination of both concrete and earth.

Purpose and Need

The purpose of this project is to remove all operations from TA-18 for security and safety reasons, primarily because it is located at the bottom of a canyon. The NNSA must make a decision regarding the future location of TA-18 Security Category III and IV capabilities and materials.

Consistent with its decision to relocate the Security Category I and II materials and operations to the Nevada Test Site or another site, NNSA plans to close TA-18 and relocate associated Security Category III and IV mission operations elsewhere at LANL. Therefore, NNSA needs to identify a suitable location, or locations, for relocating the remaining TA-18 capabilities and materials. In conjunction with that action, NNSA also needs to DD&D TA-18 facilities and disposition surplus Category III and IV materials.

H.1.2 Options Description

This section provides a description of the options for the disposition of the remaining Security Category III and IV capabilities and materials. It also identifies potential disposition options for TA-18 facilities.

H.1.2.1 Disposition of Remaining Security Category III and IV Capabilities and Materials

The following summarizes the options considered for the disposition of the remaining Security Category III and IV capabilities and materials:

Option 1. Relocate the capabilities and materials within LANL. This option would have three approaches to accommodate the capabilities and materials: Option 1a) construct a new facility at TA-55; Option 1b) construct a new facility elsewhere at LANL (for example at TA-48); or Option 1c) distribute the activities among selected facilities.

Option 2. Relocate, or reconstitute, the capabilities and materials at a site other than LANL. This option would have two approaches: Option 2a) relocate the capabilities and materials to a facility near the Device Assembly Facility at the Nevada Test Site; or Option 2b) relocate to other facilities at another DOE site.

Option 3. Keep the capabilities and materials at TA-18. This option is encompassed by the No Action Alternative, and would continue to use some TA-18 buildings and structures.

The *TA-18 Relocation EIS* considered and evaluated the consequences of constructing new facilities and relocating Security Category III and IV capabilities and materials to other locations within LANL. The consequences, as presented in the *TA-18 Relocation EIS*, would envelop those associated with the activities for Options 1a and 1c, and for Option 3. Option 1b is being considered as part of an integrated Radiological Sciences Institute Project and is evaluated in Appendix G, Section G.3, of this SWEIS. Options 2a and 2b would reconstitute the operation at the Nevada Test Site or at facilities at another DOE site and therefore are not evaluated in this SWEIS.

The SHEBA critical experiment machine would not be relocated with other Security Category III and IV capabilities and materials from TA-18 to another location at LANL. The SHEBA criticality experiment machine, because of its minimal shielding, has to be located in an isolated area away from population centers. NNSA will analyze, through a separate NEPA action, the relocation and reconstitution of SHEBA from TA-18 to the Nevada Test Site.

NNSA is routinely exchanging and transferring equipment and materials between the various TAs. Therefore, transferring some of the Security Category IV materials to the Nonproliferation and International Security Center or TA-35 is considered to be part of the requirements for the normal operation and would not require any project-specific NEPA documentation. Both of these facilities are authorized to accept, store, and handle special nuclear material Security Category IV materials. Movements of Security Category III and IV materials between TA-18 and TA-55 are also considered routine operations activities at LANL.

The impacts of keeping the capabilities and materials at TA-18 within LANL would be similar to, or smaller than, those evaluated in Chapter 5 of this SWEIS under the No Action Alternative.

H.1.2.2 Disposition of Technical Area 18 Facilities

Disposition options considered for the TA-18 building and structures include:

Option 1. DD&D all building and structures;

Option 2. Continue to use some buildings and structures for continued operation of Security Category III and IV activities; and

Option 3. No Action, (no DD&D), keep the buildings and structures for other uses.

Over the past 60 years of operations, certain areas within some of the buildings and structures at TA-18 have become contaminated with radioactive material. At this time, the existing structures have not been completely characterized with regard to types and locations of contamination. In addition, project-specific work plans have not been prepared that would define the actual methods, timing, or workforce to be used for the DD&D of the structures.

The general processes that would be used to DD&D the structures at TA-18 would be the same as those described in the introduction of Appendix H. The contaminated areas within the TA-18 buildings comprise about 500 square feet (46 square meters) (DOE 2002b). There are also small amounts of activation products in the concrete and metals within the walls of the critical assembly structures. Some of the disposition work could involve technologies and equipment that have been used in similar operations, and some could use newly developed technologies and equipment.

All demolition debris would be sent to disposal locations onsite or offsite. Demolition of the uncontaminated structures would be performed using standard industry practices. The TA-18 structures are not expected to be technically difficult to demolish and waste debris would be handled, transported, and disposed of in accordance with standard LANL procedures. A post-demolition site survey would be performed in accordance with the requirements of the MARSSIM (MARSSIM 2000).

H.1.3 Affected Environment and Environmental Consequences

The following discussions present the potential environmental consequences from: (1) disposition of the remaining Security Category III and IV and capabilities and materials; and (2) disposition of TA-18 buildings and structures. Detailed information about the LANL affected environment is presented in the main body of the SWEIS. An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for environmental justice, a determination was made that no further analysis was necessary because no disproportionate impacts to low-income or minority populations would be expected.

H.1.3.1 Disposition of Remaining Security Category III and IV Capabilities and Materials

The environmental consequences of Security Category III and IV activities under Option 3 (No Action) are similar to, or bounded by, those associated with the current activities at TA-18. Option 3 is incorporated into the No Action Alternative described in Chapter 3. Both this SWEIS and the *TA-18 Relocation EIS* provide the bounding consequences associated with the No Action Alternative. Relocation of the Security Category III and IV capabilities and materials to a facility near the Device Assembly Facility at the Nevada Test Site under Option 2 could provide a synergy between these capabilities and the Security Category I and II missions being relocated to the Nevada Test Site. NNSA is also considering relocating, or reconstituting, the SHEBA critical assembly to another DOE site. These actions, as well as the option of relocating Security Category III and IV capabilities and materials to another DOE site, would result in environmental consequences outside the LANL site and are therefore not evaluated in this SWEIS.

The environmental consequences of actions under Options 1a or 1c, would be similar to, or bounded by, the consequences of relocating Security Category III and IV capabilities and materials evaluated in the *TA-18 Relocation EIS*. That EIS evaluated the consequences of relocating Security Category III and IV capabilities and materials, except for the SHEBA, to a new facility south of TA-55. Under Option 1a, a similar building would need to be constructed in a comparable location, leading to similar environmental consequences. Under Option 1c, capabilities and materials would be distributed among selected facilities, including the Nonproliferation and International Security Center and TA-35 laboratories for Security Category IV missions and materials, and the Chemistry and Metallurgy Research and TA-55 facilities for Security Category III and IV capabilities. Acceptance of Security Category III and IV materials would require capabilities and materials with minimal or no modification to these facilities. The movement of materials between the building and technical areas is considered to be part of the routine, day-to-day, operations at LANL. Therefore, the environmental consequences of actions under Option 1c would be nil, or bounded by those of Option 1a. The environmental consequences of actions under Option 1b are analyzed as part of the Radiological Sciences Institute at TA-48 (see Appendix G). Option 1 is incorporated into the Expanded Operations Alternative described in Chapter 3.

H.1.3.2 Disposition of Technical Area 18 Buildings and Structures

This section describes the potential environmental consequences of the disposition of TA-18 facilities. This evaluation is based on the use of general industry DD&D methods and known practices that could be used for TA-18 buildings and structures.

Under Option 1, all TA-18 structures and buildings would undergo DD&D. Under Option 2, the excess buildings and structures would undergo DD&D. Option 3 is the No Action Option for the

DD&D process. For Option 3, the buildings and structures would either remain under surveillance and maintenance or would be occupied by other users. For the purposes of this analysis, only the potential impacts of Option 1 are discussed, because the activities associated with this option would have the greatest potential impacts, including generating the largest volume of waste materials, and therefore bound Options 2 and 3.

The environmental impacts from demolition of buildings and structures are discussed qualitatively for land resources, air quality and noise, ecological resources, cultural resources, and human health. Quantitative impacts are presented for waste generation and its transport to local and offsite disposal sites. For purposes of analysis, it was assumed that low-level radioactive waste could be disposed of onsite, or transported to offsite disposal facilities, such as a commercial facility in Utah. Disposition of industrial waste and uncontaminated materials could be performed onsite or sent to local landfills.

Land Resources

Land resources include land use and visual resources.

Land Use

Facilities at TA-18 are located on a 131-acre (53-hectare) site that is situated 3 miles (4.8 kilometers) from the nearest residential area, White Rock. Approximately 20 percent of the site has been developed. Site facilities are located at the bottom of a canyon near the confluence of Pajarito Canyon and Threemile Canyon. TA-18 structures include a main building, three outlying remote-controlled critical assembly buildings known as CASAs, and several smaller laboratory, nuclear material storage, and support buildings. A security fence to aid in physical safeguarding of special nuclear material bounds the entire site. The Cerro Grande Fire threatened structures at TA-18; however, no permanent buildings were damaged or destroyed (DOE 2002b).

The generalized land use categories within which TA-18 is located are depicted in Chapter 4, Figure 4–4 and include the Nuclear Materials Research and Development and Reserve (LANL 2003d). According to the *Comprehensive Site Plan* for 2001, TA-18 falls within the Pajarito Corridor East Development Area (LANL 2001a). The Plan indicates that much of TA-18 (including all developed portions) is designated as a No Development Zone (Hazard).

DD&D Impacts—DD&D of TA-18 buildings and structures could result in an overall change in the land use designation of the area. Although not shown on future land use maps of the site (LANL 2003d), the Nuclear Materials Research and Development designation could be changed such that the entire area would be designated as Reserve. Since the area would not be redeveloped following DD&D, there would be no conflict with the Pajarito Corridor East Development Area designation of much of the site.

Visual Environment

Since surrounding canyon walls rise approximately 200 feet (61 meters) above the site, TA-18 is not visible from any offsite location (DOE 2002b).

DD&D Impacts—DD&D activities could have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Since TA-18 is located on the bottom of the Pajarito Canyon and the surrounding canyon walls essentially mask the buildings, no offsite visual impacts are expected. Once buildings and structures are removed and the site restored, including grading and planting of native species, the canyon bottom would present a natural appearance and, given time, would blend with previously undisturbed portions of the TA.

Geology and Soils

DD&D of the TA-18 facilities would result in disturbance of approximately 6.7 acres (2.7 hectares) and excavation of approximately 223,000 cubic yards (170,000 cubic meters) of soil. Because the soil was previously disturbed for facility construction, there would be no impact to native LANL soils. If uncontaminated, the excavated soils would be stockpiled for use as backfill either at TA-18 or elsewhere at LANL. If the soil is to be stockpiled for longer than a few weeks, the stockpiles should be seeded or managed as appropriate to prevent erosion and loss of the resource. In addition, care would be taken to employ all necessary erosion control best management practices during and following DD&D to limit impact on soil resources adjacent to the building sites. If contaminated, the soil would be disposed of as appropriate.

Water Resources

TA-18 facilities use domestic and industrial water, but the effluent from these sources has been pumped to the TA-46 Sanitary Wastewater Systems Plant and the TA-50 Radioactive Liquid Waste Treatment Facility, as appropriate. There has been no effluent discharged from TA-18 directly to the environment. Water usage at TA-18 has not been metered, but is expected to be average for laboratory and office facilities. Stormwater from the TA-18 buildings, roads, and parking lots drains into or falls within Pajarito Canyon. There are no underground or above-ground fuel storage tanks at the facility (DOE 2002b).

Parts of TA-18 lie within the 100-year floodplain for Pajarito Canyon. The building that houses SHEBA is partially within the floodplain boundary, although that assembly is only located at the facility during experiments. After the Cerro Grande Fire, high volumes of stormwater flow were expected through Pajarito Canyon, so a flood retention structure and a steel diversion wall were constructed upstream of TA-18 to minimize the possibility of flooding. When the watershed that drains into Pajarito Canyon returns to more stable conditions, these structures may be removed (DOE 2002c).

DD&D Impacts—DD&D activities would have little or no effect on water use or resources. Water use would be transferred to the other locations at LANL where TA-18 operations would be relocated. Most structures at TA-18 would be removed, which would remove potential contamination sources from an area where they could possibly be flooded. This would include removal of the steel diversion wall installed after the Cerro Grande Fire. Although the possibility of floodwater mobilizing contaminants from the buildings is remote, complete removal of this potential contaminant source would enhance protection of surface water quality.

DD&D activities would not result in the disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. A Stormwater Pollution

Prevention Plan using best management practices, such as silt fences and hay bales, would be used during the DD&D project to ensure that fine particulates would not be transported by stormwater into surface water channels in the Pajarito Canyon. Potable water use at the site would be limited to that necessary for equipment washdown, dust control, and sanitary facilities for workers. Impacts of DD&D activities on groundwater should be minimal, because surface water would be collected and properly disposed of.

Air Quality and Noise

Air Quality

Nonradiological air pollutant emissions from TA-18 include criteria pollutants from various small fuel-burning sources and toxic chemicals. Use of toxic pollutants has been reduced in recent years and, in 2003, chemical use was limited to propane (LANL 2004c). Actual emissions vary by year with the amounts of chemicals used. The use of toxic chemicals at TA-18 has not been shown to have an adverse impact on air quality.

The primary radiological emissions from TA-18 Security Category III and IV activities would be the radioactive noble gas activation (argon-41) generated during SHEBA operations. After removal of the SHEBA critical assembly (in 2009), no gaseous radionuclide would be present or generated at TA-18.

DD&D Impacts—DD&D of the buildings and structures would result in emissions associated with vehicle and equipment exhausts, as well as radiological and particulate (dust) emissions from demolition activities. These air pollutant emissions would not be expected to result in exceedances of ambient air quality standards, although they could result in elevated concentrations of particulate matter near the demolition site for short periods.

No releases of gaseous radionuclides are anticipated from DD&D. DD&D would generate very small amounts of particulate air emissions (dust) from size reduction of metal and concrete within the buildings. The dust could include lead, asbestos, and a small amount of radionuclides, primarily radioactive cobalt-60 isotopes from activation. Any emissions of contaminated particulates would be reduced by the use of plastic draping and contaminant containment coupled with high-efficiency particulate air filters. The location of TA-18 in the canyon bottom limits the transport of, and promotes the deposition of, airborne particulates, thus reducing the concentration of airborne particulates at the site boundary.

Noise

Noise sources from TA-18 operations include heat ventilation and air conditioning equipment, and vehicles. Noise impacts on the public from the operations in this area are limited to employee and other traffic.

DD&D Impacts—Construction noise at LANL is common, and noise levels during demolition activities would be consistent with those typical of construction activities. As appropriate, workers would be required to wear hearing protection to avoid adverse effects on hearing. Noninvolved workers at the edges of the mesas above TA-18 could hear the activities below; however, the level of noise would not be distracting. Some wildlife species may avoid the immediate vicinity of TA-18 as demolition proceeds due to noise; however, any effects on wildlife resulting from noise associated with demolition activities would be temporary. Upon completion of DD&D, there would be a minor reduction in noise.

Ecological Resources

This section addresses the ecological setting (terrestrial resources, wetlands, aquatic resources, and protected and sensitive species) of TA-18. Ecological resources of LANL as a whole are described in Section 4.5 in this SWEIS, and the vegetation zones are depicted in Figure 4–25.

TA-18 is located in the Pinyon (*Pinus edulis* Engelm.)-Juniper (*Juniperus monosperma* [Engelm.] Sarg.) Woodland vegetation zone, although Ponderosa Pine (*Pinus ponderosa* P. & C. Lawson) forest is present along north-facing canyon walls. Approximately 20 percent of the TA is developed. Due to the presence of security fencing, no large animals would be found within developed portions of TA-18 (DOE 2002b); however, elk (*Cerus elaphus*) have been seen within other parts of the TA. The more northwesterly portions of TA-18 were burned at a low or unburned severity level as a result of the Cerro Grande Fire. At this level, seed sources should remain viable (DOE 2000).

There are no wetlands located within TA-18; however, nine wetlands have been delineated within Pajarito Canyon (TA-36) just to the east (ACE 2005). These wetlands total 15.2 acres (6.2 hectares). Plants found within these wetlands include coyote willow (*Salix exigua* Nutt.), Baltic rush (*Juncus balticus* Wildl.), sedges (*Carex* spp.), common spike rush (*Eleocharis palustris* (L.) Roemer & Schultes), American speedwell (*Veronica americana* Schwein. ex Benth), and cattail (*Typha* spp,). There are no aquatic resources located within TA-18 (DOE 2002b).

TA-18 falls within portions of the Threemile Canyon and Pajarito Canyon Mexican spotted owl (*Strix occidentalis lucida*) Areas of Environmental Interest. However, none of the TA-18 structures are in core habitat, and only CASAs 1 and 2 are in buffer habitat for the Threemile Canyon Area of Environmental Interest. TA-18 does not fall within Areas of Environmental Interest for the bald eagle (*Haliaeetus leucocephalus*) or southwestern willow flycatcher (*Empidonax traillii extimus*) (LANL 2000b). However, the project is located 890 feet (267 meters) upstream from the southwestern willow flycatcher Area of Environmental Interest (LANL 2006b).

DD&D Impacts—All DD&D activities would take place within the previously fenced and developed area of TA-18 that contains little wildlife habitat. Wildlife in canyon lands adjacent to TA-18 could be intermittently disturbed by construction activity and noise during the demolition period when heavy equipment would be used to raze structures, remove building foundations and buried utilities, excavate contaminated soil, and transport wastes to disposal sites. Species most likely to be affected are those commonly associated with the Pinyon-Juniper Woodland community within which TA-18 is located. Due to the presence of wetlands downstream from TA-18, a Floodplain-Wetlands Assessment would need to be performed prior to DD&D activities taking place. Implementation of best management practices during the demolition phase would prevent potentially sediment-laden runoff from reaching the wetlands. Ultimately, the canyon habitat could be restored using native species (which would have a beneficial effect on area wildlife) if the site were not used for other LANL-related purposes.

Potential impacts to the Mexican spotted owl were evaluated in a biological assessment prepared by DOE. This assessment noted that although CASA 1 and 2 are 980 feet (294 meters) and 680 feet (204 meters), respectively, from the nearest core boundary, noise levels in the core habitat would be elevated somewhat more than 6 decibels (A-weighted) [dB(A)] above background levels. However the report concluded that DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl provided reasonable and prudent alternatives are implemented. Reasonable and prudent alternatives include muting all trucks and heavy equipment, reseeding and erosion protection, and not removing trees with a diameter at breast height greater than 8 inches (20 centimeters) without approval (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

With respect to the bald eagle, the DOE biological assessment noted that DD&D of TA-18 facilities would have no effect since the project would not remove any bald eagle foraging habitat. As noted above, the project would take place upstream from the southwestern willow flycatcher Area of Environmental Interest. Provided that reasonable and prudent alternatives are implemented, the biological assessment concluded that the proposed project may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Reasonable and prudent alternatives would include the use of appropriate soil erosion best management practices to ensure that sedimentation of downstream wetlands does not occur (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with the biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Human Health

DD&D Impacts—The primary source of potential consequences to workers and members of the public would be associated with the release of radiological contaminants during the demolition process. The only radiological effect on noninvolved workers or members of the public would be from radiological particulate air emissions. Any emissions of contaminated particulates would be reduced by the use of plastic draping and contaminant containment coupled with high-efficiency particulate air filters. Contaminant releases of radioactive particulates from disposition activities are expected to be lower than releases from past TA-18 operations.

Because of their age, it is anticipated that the demolition of the TA-18 buildings and structures would involve removal of some asbestos-contaminated material. Removal of asbestos-contaminated material would be conducted according to existing asbestos management programs at LANL in compliance with strict asbestos abatement guidelines. Workers would be protected by personal protective equipment and other engineered and administrative controls, and no asbestos would likely be released that could be inhaled by members of the public.

DD&D is estimated to require 43,330 person-hours. The DOE and LANL limit for the annual worker exposure is 5 rem (Title 10 *Code of Federal Regulations* [CFR] Part 835), with an administrative control level of 2 rem (DOE 1999c). The worker dose during DD&D would be less than that of normal operations, or less than 100 millirem per person, annually.

For nonradiological impacts, based on the expected labor hours and DOE and national construction safety statistics, the DD&D of the TA-18 structures could result in an estimated two recordable injuries. No construction fatalities would be expected. Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment.

Cultural Resources

Archeological Resources and Historic Buildings and Structures. TA-18 contains three types of archaeological cultural resource sites that have been determined to be eligible for the National Register of Historic Places. These include approximately 40 cavates, a rock shelter, and a historic structure of the Homestead Period (the Ashley Pond cabin). All of these sites have been determined to be eligible for listing on the National Register of Historic Places. Extensive erosion and stormwater control efforts initiated after the Cerro Grande Fire have had beneficial effects on the historic Ashley Pond cabin. This structure was surrounded by concrete barriers and sandbags to prevent damage from debris carried by stormwater runoff. Construction of a flood retention structure upstream also provides the Ashley Pond cabin additional protection from flooding (DOE 2002b).

TA-18 contains 60 buildings and structures dating to the Manhattan Project through the early Cold War period. Three of these buildings have been identified as eligible for listing on the National Register of Historic Places, including the Slotin Building (TA-18-1) and two other buildings (TA-18-2 and TA-18-5).

DD&D Impacts—Three archaeological resources sites found at TA-18 (a rock shelter, a cavate complex, and the Ashley Pond cabin) have been determined to be eligible for listing on the National Register of Historic Places. These resources are currently protected from disturbance and would continue to be protected during DD&D; thus, there would be no impact to archaeological resources. Only three LANL-associated buildings within TA-18 have been identified as National Register of Historic Places-eligible. However, there are other potentially significant historic buildings within TA-18 that have yet to be assessed for National Register of Historic Places eligibility status. A formal eligibility assessment of these buildings must be conducted prior to any demolition activities. Additionally, prior to any demolition activities, DOE, in conjunction with the New Mexico State Historic Preservation Office, would implement documentation measures such as preparing a detailed report containing the history and description of the affected properties. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division in order to resolve adverse effects to eligible properties. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Traditional Cultural Properties. Consultations to identify Traditional Cultural Properties were conducted with 19 American Indian tribes and two Hispanic communities in connection with the preparation of the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a). As noted in Section 4.8.3 of the *1999 SWEIS*, Traditional Cultural Properties are present throughout LANL and adjacent lands. While specific features or locations are not identified in order to protect such sites, no Traditional Cultural Properties would be expected within developed areas of TA-18.

DD&D Impacts—Impacts on Traditional Cultural Properties would not be expected since such resources do not occur within developed portions of TA-18. However, the removal of structures at the TA could have a positive impact on any such resources located nearby since the area would present a less disturbed appearance than is presently the case.

Socioeconomics and Infrastructure

Major utility infrastructure (electric power, natural gas, and water) is available at TA-18 to provide service to existing facilities. The cessation of activities within TA-18 and the DD&D of TA-18 buildings and structures would include the removal or abandonment of existing utility corridors that serve the affected facilities. TA-18 operations have historically required about 2,840 megawatt-hours of electricity, 7 decatherms (equivalent to about 7,000 cubic feet [200 cubic meters]) of natural gas, and 3.9 million gallons (15 million liters) of water annually (DOE 2002b).

DD&D Impacts—Activities associated with DD&D of TA-18 facilities are expected to require 273,000 gallons (1.03 million liters) of liquid fuels and 8.4 million gallons (32 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities are shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities.

Waste Management

The total amount of waste generated from the disposition of the buildings and structures is estimated to be 21,900 cubic yards (16,700 cubic meters). This estimate does not include the amount of waste generated by the demolition of the parking lot or by soil removal. Waste types and quantities generated by removal of the structures would be within the capacity of existing waste management systems, and would not result in substantial impact to existing waste management disposal operations. **Table H–1** summarizes the waste types and volumes expected to be generated during demolition activities. About 21 percent of the waste produced during DD&D activities would be bulk low-level radioactive wastes, all of which could be transported offsite for disposal. For the purpose of analysis, this SWEIS evaluates both the onsite and offsite disposal options for low-level radioactive waste to ensure that the potential environmental consequences of potential waste management options have been bounded.

Table H–1 Estimated Waste Volumes (cubic yards)

Low Specific Activity Waste	*Mixed Low-Level Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
4,700	5	17,100	20	55

[a] Includes construction, demolition, and sanitary waste.
Note: To convert waste volumes to cubic meters, multiply by 0.76456.

- **Option 1**. Under this option, NNSA would pursue offsite disposal of low-level radioactive waste resulting from DD&D of the buildings and structures including concrete, soil, steel, and personal protective equipment. Both the Nevada Test Site facilities for waste disposal and an existing commercial facility at Clive, Utah, have the capacity to accept the anticipated amount of these types of waste. Under this option, there would be little reduction of LANL's remaining low-level radioactive waste disposal capacity at TA-54 Area G.

- **Option 2**. Under this option for waste disposal, low-level radioactive waste would be disposed of onsite at LANL at TA-54 Area G. The current footprint is expected to be adequate for the amount of low-level radioactive waste that would be generated by these DD&D activities, but implementing this option would reduce the remaining capacity at Area G.

All other wastes generated by DD&D activities would be handled, managed, packaged, and disposed of in the same manner as the same wastes generated by other activities at LANL. Most mixed low-level radioactive waste generated at LANL is sent offsite to other DOE or commercial facilities for treatment and disposal.

Small amounts of hazardous waste would also be generated during DD&D activities. These wastes would be handled, packaged, and disposed of according to LANL's hazardous waste management program. This amount of waste is within the capacity of LANL's hazardous waste management program.

TA-18 uses lead shielding and beryllium metal in their experiments. These metals are expected to move with the experiments to new locations. It is expected that some of the materials would be categorized as excess inventory requiring disposal. If that is the case, the volume of this excess and potentially contaminated metal would be within the storage capacity at LANL, and would be managed and disposed of consistent with LANL's hazardous waste management program.

The generated solid waste could also be managed at the Los Alamos County landfill or could be transported to an offsite landfill. For the purposes of analysis, it was assumed that these wastes would be disposed of at an offsite location.

DD&D would generate about 55 cubic yards (41 cubic meters) of nonradiological asbestos waste. This waste would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment offsite to a permitted asbestos disposal facility along with other asbestos waste generated at LANL. It is not expected that the anticipated amount of waste would be beyond the disposal capacity of existing disposal facilities.

The *TA-18 Relocation EIS* (DOE 2002b) identified about 9 tons (8.5 metric tons) of natural uranium, depleted uranium and thorium that would not be relocated with the critical experiment machines to the Nevada Test Site. During DD&D of TA-18, LANL staff would relocate those materials that are required to support LANL operational capabilities to another part of LANL, or re-classify the materials as waste and dispose of them accordingly. No materials (depleted or natural uranium, thorium, or other bulk materials) would remain at TA-18.

Transportation

DD&D wastes would need to be transported to storage or disposal sites. These sites could be at LANL or an offsite location. Based upon this analysis, no excess fatal cancers are likely to result from this activity. Transportation has potential risks to workers and the public from incident-free transport, such as radiation exposure, because the waste packages are transported along the highways. There is also increased risk from traffic accidents (without release of radioactive material) and radiological accidents (in which radioactive material is released).

The effects from incident-free transportation of demolition wastes under both waste options for the worker population and the general public are presented as collective dose in person-rem resulting in excess latent cancer fatalities (LCFs) in **Table H–2**. Based on this table, the risk for development of excess LCFs is highest for workers and the public under the offsite disposition option. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. This would lead to a highest dose and risk from disposal at the Nevada Test Site, which is the farthest from TA-18.

Table H–2 Incident-Free Transportation Impacts – Technical Area 18 Decontamination, Decommissioning, and Demolition

Disposal Option	*Low-level Radioactive Waste Disposal Location*	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCFs)*	*Collective Dose (person-rem)*	*Risk (LCFs)*
Onsite disposal	LANL TA-54	0.001	6×10^{-7}	0.0002	1×10^{-7}
Offsite disposal	Nevada Test Site	0.40	2×10^{-4}	0.08	5×10^{-5}
	Commercial Facility	0.35	2×10^{-4}	0.07	4×10^{-5}

LCF = latent cancer fatality, TA = technical area.

Accidents could occur in all phases of activities during DD&D, including onsite and offsite transportation, deactivation, disassembly, characterization, and packaging of waste for disposal. Once materials and equipment were removed, there would be no potential for any radiological accident release. Any potential for a radiological accident during equipment removal would be bounded by those of operational accidents analyzed in this SWEIS (see Chapter 5) and the *TA-18 Relocation EIS* (DOE 2002b). Two sets of accidents were analyzed: industrial and transportation accidents.

Two types of transportation accidents were evaluated: traffic-related accidents without release of radioactive wastes, and cargo-related accidents in which radioactive wastes would be released. Traffic accident risks were evaluated in terms of traffic fatalities, and the cargo or radiological accident risks were presented in terms of excess LCF from exposure to radioactive materials. The analysis assumed that all generated nonradiological wastes would be transported to offsite disposal facilities.

Table H–3 presents the impacts from traffic and radiological accidents. The results indicate that no traffic fatalities and no excess LCFs would likely occur from the activities during DD&D of TA-18.

Table H–3 Transportation Accident Impacts – Technical Area 18 Decontamination, Decommissioning, and Demolition

Low-level Radioactive Waste Disposal Location [a]	*Number of Shipments* [b]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL TA-54	1,234	0.41	Not applicable [c]	0.0049
Nevada Test Site	1,234	1.1	5.0×10^{-8}	0.012
Commercial Facility	1,234	1.0	3.7×10^{-8}	0.011

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported offsite.
[b] Only 22 percent of shipments are radioactive wastes, others include 77.5 percent for industrial and sanitary waste, and about 0.05 percent for asbestos and hazardous wastes.
[c] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.
Note: To convert kilometers to miles, multiply by 0.621.

H.2 Technical Area 21 Structure Decontamination, Decommissioning, and Demolition Project Impact Assessment

This section provides information on the environmental effects of the proposed DD&D of TA-21 buildings at LANL. Section H.2.1 provides background information on TA-21 and its buildings, and describes the purpose and need for TA-21 DD&D, an action that would reduce ongoing surveillance and maintenance costs and allow investigation of potential release sites[2] located beneath the buildings. Section H.2.2 provides a description of the options to address the TA-21 buildings. Section H.2.3 describes the affected environment at TA-21 and presents an impacts assessment for the options to DD&D, as well as the No Action Option. Chapter 4 of this SWEIS

[2] *For this SWEIS, a potential release site means a site suspected of releasing or having the potential to release contaminants (radioactive, chemical, or both). Potential release site is a general term that includes solid waste management units and areas of concern that are cited and defined in the Compliance Order on Consent (Consent Order) that was entered into on March 1, 2005, by DOE, the management and operating contractor for LANL, and the State of New Mexico.*

presents an overall description of the affected environment at LANL and TA-21. Any unique characteristics of LANL and TA-21 not covered in Chapter 4 that would be affected by the proposed DD&D of TA-21 buildings are presented here.

As DD&D and remediation of potential release sites progresses in TA-21, the status of buildings, utilities, and contaminated sites will evolve. The analysis of impacts in this section is based on the status as of approximately the end of 2005. As of the issuance of this SWEIS, conditions may have changed with respect to building occupancy, building status, and availability of utilities. For example, operating facilities may have been placed in surveillance and maintenance status, personnel may have been moved out of buildings to another location at LANL, and utilities may have been terminated to certain buildings.

H.2.1 Introduction and Purpose and Need for Agency Action

The purpose of this project-specific analysis is to provide an assessment of impacts from the DD&D of TA-21 buildings and structures. This section provides background information on the DD&D activities, the purpose and need of the action, and a summary of related NEPA actions.

Background

TA-21 covers about 312 acres (126 hectares) at the northern portion of LANL adjacent to the Los Alamos Airport, principally on the DP Mesa. It contains a total of about 65 buildings and structures with a cumulative area of 239,000 square feet (22,200 square meters) (LANL 1999). The central area of TA-21 consists of groups of buildings and support facilities divided into two areas known as the DP West and DP East sites (sometimes collectively referred to as the "DP Site"). **Figure H–3** and **Figure H–4** show the locations of buildings and potential release sites in DP West and DP East, respectively.

The DP Site was built late in the Manhattan Project, in 1945, as the principal location for the LANL Plutonium Processing Facility. Buildings at DP West were used for plutonium recovery, precipitation, conversion, purification, reduction, metal casting and machining, and liquid radioactive waste treatment. Later, the buildings were converted for research on uranium hydride, enriched uranium fuel elements, and plutonium fuels service and development. During the 1970s, LANL transferred the process activities from DP West to facilities at TA-55, and removed the remaining process equipment. In 1996, large portions of two of the buildings, 21-0003 and 21-0004, were demolished.

The DP West buildings center on a core group of buildings running west to east: Buildings 21-0210, 21-0002, 21-0003, 21-0004, 21-0005, and 21-0150. Planning for DD&D is in process for Building 21-0210. The remainder of these structures were process buildings designed for work with uranium and transuranic materials. The buildings have below-grade unlined concrete "troughs" that contain waste and process piping. The older buildings are pre-engineered steel frame metal lath and plaster buildings with metal exterior sidings and roofs. Building 21-0150 is concrete column construction with exterior walls of concrete masonry unit construction (LANL 1999).

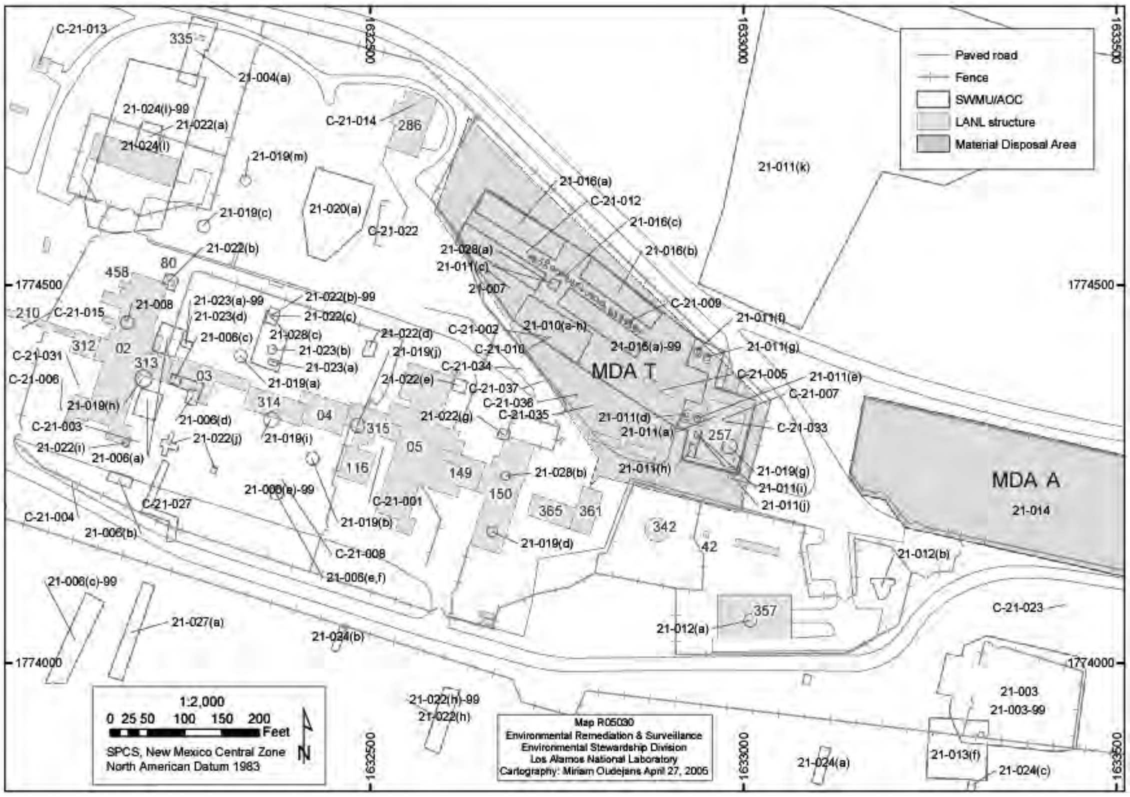


Figure H–3 Technical Area 21 Map of DP West Buildings and Potential Release Sites

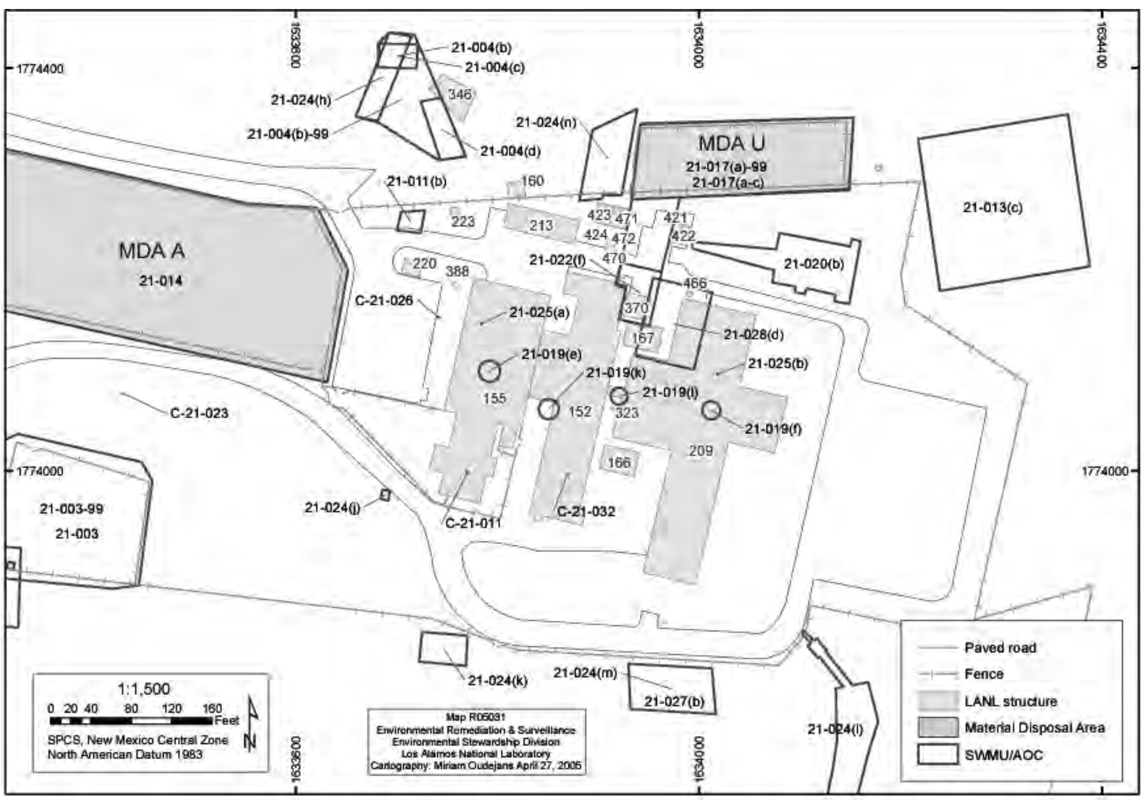


Figure H–4 Technical Area 21 Map of DP East Buildings and Potential Release Sites

Although most of the highly contaminated process equipment such as gloveboxes, glovebox ducts and filter plenums, and process tanks have been removed, small amounts of equipment such as fume hoods, waste tanks, sections of duct, and air filtration equipment remain. A small quantity of highly contaminated process piping remains, particularly in the troughs. This piping is likely contaminated with transuranic nuclides. The buildings are being operated at a minimum surveillance and maintenance level, involving only those actions that are necessary to prevent environmental releases or hazards to surveillance workers. In practice this means that the heat and ventilation services are shutdown and the lights, electrical power, and fire suppression systems remain active. Maintenance is insufficient to prevent slow deterioration of the structure and deterioration of protective coatings (paint) applied to contaminated building surfaces. NNSA maintains radiological and access controls for the buildings consistent with the presence of high levels of fixed contamination.[3] Previous DD&D projects demolished most of Buildings 21-0003 and 21-0004 in the 1990s, with the only portions remaining being the central corridor areas. A number of lesser structures directly supported the larger buildings, mostly by providing utility services and corridor access between buildings (LANL 1999).

Two other DP West buildings, 21-0257 and the 21-0286 slab, are located within or adjacent to Material Disposal Area (MDA) T, and the DD&D approach for those structures would be closely coordinated with the remediation approach for that MDA. Building 21-0286 was a former storage vault and warehouse, and the slab is minimally contaminated. Building 21-0257, the TA-21 Liquid Radioactive Waste Treatment Facility, provided pretreatment of liquid radioactive wastes prior to their transfer to the TA-50 Liquid Radioactive Waste Treatment Facility for final treatment. During 2001, the two-mile long, single-walled transfer line, dedicated to the transfer of radioactive liquid wastes from the TA-21 tritium facilities to the TA-50 Liquid Radioactive Waste Treatment Facility, was taken out of service, flushed, drained, and capped. The small volumes of liquid waste pretreated at the TA-21 Liquid Radioactive Waste Treatment Facility were transported from TA-21 to TA-50 or TA-53 by truck for final treatment and disposal (LANL 2004c). The disposition of any contaminated effluent piping would be addressed as an environmental remediation activity.

DP East buildings historically supported polonium and actinium initiator work and research on coatings of reactor fuels for the Rover Program. Since 1977, the buildings have been used for tritium handling, processing, and storage to support the Tritium Key Facility tritium research and technology mission. The remainder of TA-21 surrounds the DP East and DP West sites and includes various infrastructure and support buildings and structures.

Figure H–5 provides an aerial view of DP East and DP West and their relationship to the western portion of TA-21 and the Los Alamos townsite.

The DP East process buildings are 21-0155, 21-0152, and 21-0209. Buildings 21-0155 and 21-0152, the Tritium Systems Test Assembly Buildings, were originally used for polonium-210 initiator research, and were converted for use in the tritium program in 1977. They are primarily production facilities with presses, furnaces, and tritium trapping equipment (LANL 1999). Beryllium was used in Building 21-0152 in conjunction with polonium for the Initiator Research

[3] *"Fixed contamination" refers to residual radioactive materials that are not easily removed from a surface. In many cases, the contamination may be "fixed" in place with paint.*

Development Project. Building 21-209, the Tritium Science and Fabrication Facility, holds some process equipment, but also contains gloveboxes, laboratory equipment, change rooms, and administrative areas; it was never used for processing transuranic materials (LANL 1999). A number of support structures, the largest being Buildings 21-0166, 21-0167, 21-0213, and 21-0370, provide mechanical equipment, exhaust filtration, and warehouse support.

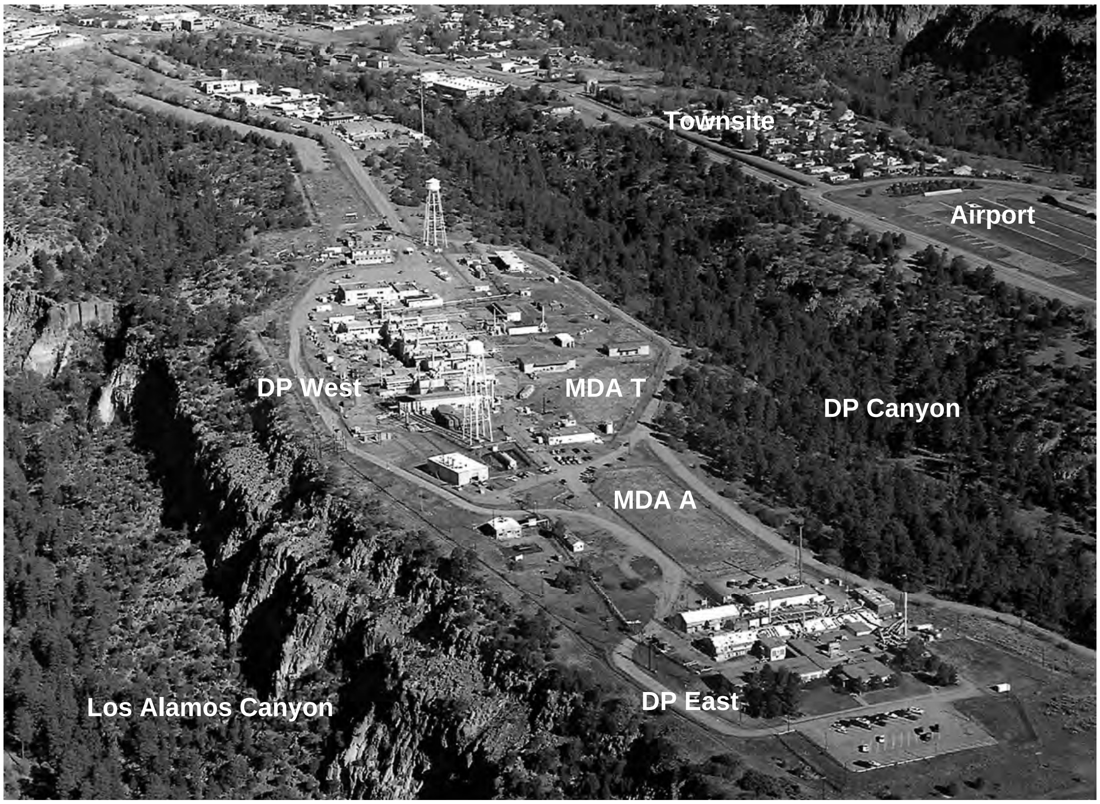


Figure H–5 Aerial Photograph of the DP East and DP West Sites, Looking West (1995)

Building 21-0152 and portions of Building 21-0155 are 1945-era pre-engineered steel frame, metal lath and plaster buildings with metal exterior siding and roofs. Buildings 21-0155 and 21-0209 contain concrete columns with concrete masonry units and brick exterior walls, and built-up roofing (LANL 1999). The equipment in these two buildings contained accountable quantities of radioactive material that is assumed to be removed in the deactivation operations prior to DD&D.

LANL staff has essentially completed the transfer of the tritium handling and storage mission from the DP East process buildings. Many of the remaining TA-21 buildings have been used for administrative or logistics support (such as general offices, warehouses and maintenance shops). There are numerous inactive buildings and structures that are largely unused and awaiting DD&D. Particularly prominent items include two water towers and water supply pumps and equipment that support the domestic water system. There are a number of warehouse facilities, sludge drying beds adjacent to the now unused sewage treatment plant, a steam plant that supplies heat to process and office facilities within the TA-21 area, electrical substations, chemical tanks and piping, security buildings, and additional miscellaneous utilities. There are also other nonbuilding “structures” such as roads and parking lots, various types of fences and security systems, utility poles, light poles, steam lines, and other miscellaneous features (LANL 1999). A natural gas pipeline currently supplies the steam plant and furnace facilities of DP East and serves as a secondary supply of natural gas to TA-53.

Access to the TA-21 facilities is via DP Road, which connects with New Mexico (NM) 502 at the edge of the Los Alamos business district. Access from TA-21 to the remainder of the LANL facility is either west along NM 502 (Trinity Drive) and Diamond Drive to TA-3, or east on NM 502 to NM 4. The route east on NM 502 is steep and curved and not recommended for truck traffic.

The Consent Order issued on March 1, 2005, establishes requirements for the investigation and cleanup of environmental contamination at LANL (NMED 2005a). TA-21 contains five MDAs, and over 60 potential release sites, many related to TA-21 buildings. For example, the Liquid Radioactive Waste Treatment Facility in 21-0257 contains many treatment and holding tanks that are designated as solid waste management units under the Consent Order and is included in the area specified for MDA T corrective action. The process buildings were originally constructed with below-grade waste piping contained in concrete troughs; these troughs are being investigated as potential release sites. There are additional known or suspected contaminant release sites next to or underneath the process buildings that are subject to investigation and corrective actions as part of the NNSA response to the Consent Order.

To allow a thorough and complete investigation of existing TA-21 potential release sites, NNSA would remove a number of the larger remaining TA-21 structures to allow reasonable access to nearby potential release sites and areas that are currently obstructed. Utility infrastructure also would need to be removed to allow access to additional areas. Schedules and activities for investigating each impacted potential release site would need to be integrated with the DD&D schedules of the obstructing buildings. The current schedule for the Consent Order requires that DOE complete all corrective actions within the Los Alamos and Pueblo watershed by August 2011. Building 21-0257 is collocated with MDA T, where a remedy completion report is required by February 19, 2010 (LANL 2006a, NMED 2005a).

Areas in TA-21 are also designated for potential reutilization under Public Law 105-119. Section 632 of that law directed DOE to convey land at or in the vicinity of LANL to the County of Los Alamos or transfer land to the U.S. Department of the Interior in trust for the Pueblo of San Ildefonso. DOE identified a number of tracts and subtracts of land for potential conveyance or transfer, including three subtracts within TA-21 as shown in **Figure H–6**. Section 4.1.1 includes additional information about the conveyance and transfer of TA-21 and other LANL tracts (DOE 1999d). TA-21 "subtracts" include DP Road-1 (A-8), TA-21-1 (A-15-1 and A-15-2), and TA-21-2 (A-16). The DP Road-1 subtract (25 acres [10.1 hectares]) and 8.7 acres (3.5 hectares) of the TA-21 tract have been, or are expected to be, conveyed to Los Alamos County. The remaining portion of the TA-21 tract (referred to as subtract A-16), about 252 acres (102 hectares), contains the majority of the areas within TA-21 that would need to be remediated under the Consent Order. This area has been withdrawn from the conveyance process.

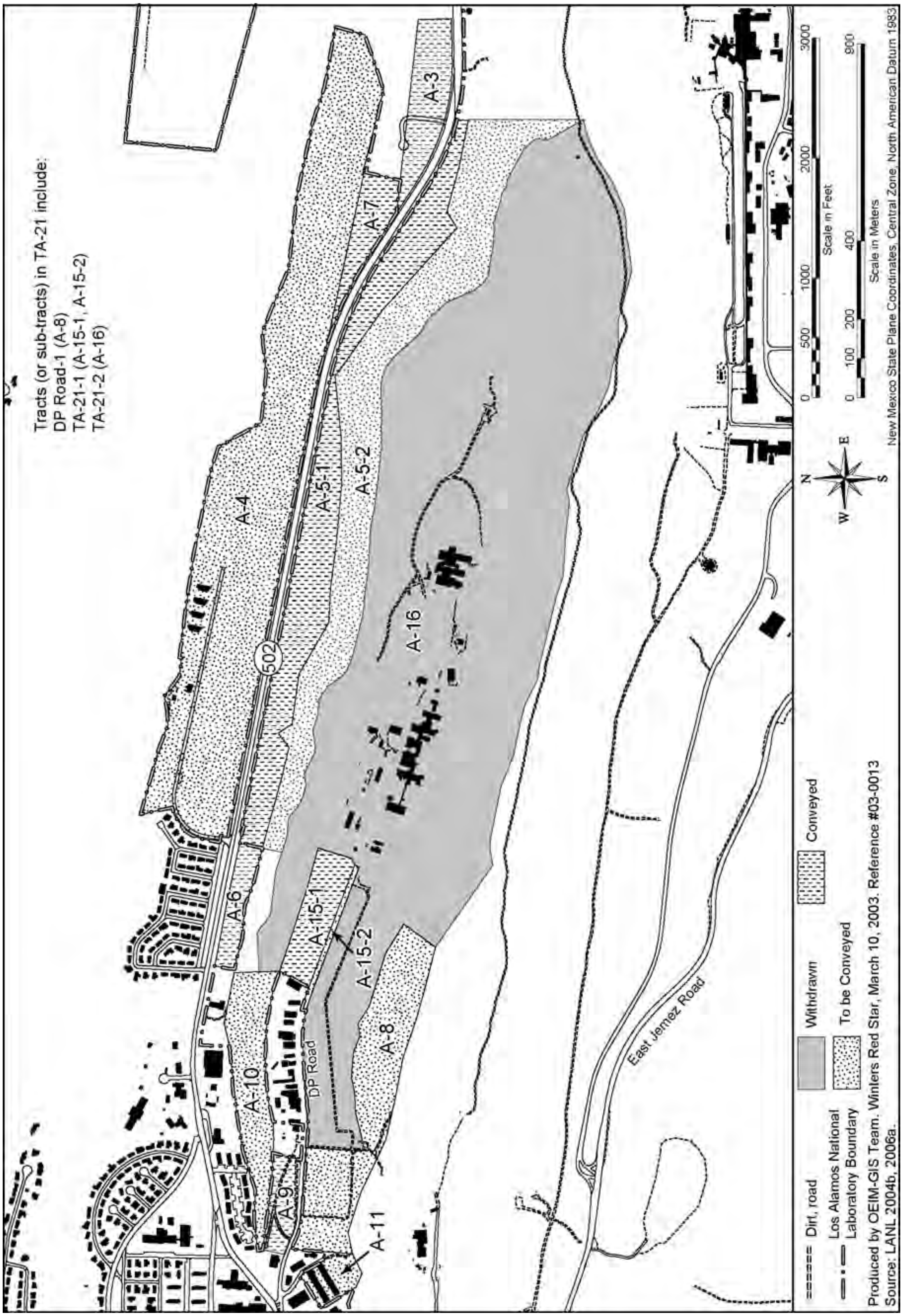


Figure H–6 Land Transfer Activities in Technical Area 21

In the midst of the DP Road and TA-21 tracts there is a land parcel of approximately 10 acres (4 hectares) of private land that is currently occupied by private commercial and light industrial businesses not directly associated with LANL contracts. This land is surrounded on the west and north by portions of the DP Road tract, and bounded on the south and east by portions of the TA-21 tract. MDA B is located directly across DP Road from these businesses.

Three buildings are in the DP Road-4 subtract which has yet to be conveyed. These consist of two National Register of Historic Places-eligible buildings (the LANL archives and warehouse), and a portable guardhouse that has been determined not eligible for listing on the National Register of Historic Places. Final characterization for radioactivity and hazardous materials contamination is incomplete and a determination of whether the structures need to be demolished prior to conveyance has yet to be made (LANL 2005a).

Although the TA-21-2 subtract is currently "withdrawn" from conveyance to Los Alamos County because of legacy contamination and as a buffer zone for TA-53 operations, portions of it may still be considered for conveyance after the remediation process is complete. The subtract is potentially attractive to businesses due to its proximity to the Los Alamos townsite, which suffers from a lack of land available for commercial development. Conversely, the remediation option selected for TA-21 might include significant quantities of radioactive materials remaining in place in a capped disposal site. This would result in significant areas being maintained under perpetual institutional control, making the remaining adjacent portions less desirable for development.

One possibility is removal of all buildings within subtract TA-21-2, and the subsequent evaluation of the resultant brownfield sites for potential reuse. Other possibilities include allowing the building foundations to remain, with or without application of a cap. Geophysical and radiological surveys have been conducted, potential release sites and boundaries identified, buried waste lines and structures located, and the nature and extent of geophysical and radiological anomalies determined (LANL 2005a). Based on this information, LANL staff can continue evaluating the reuse of portions of subtract TA-21-2 for industrial development and potential conveyance to Los Alamos County.

A number of previous NEPA determinations have been made that affect the proposed DD&D of TA-21. In 1995, DOE prepared the *Environmental Assessment of the Relocation of Neutron Tube Target Loading Operations*, DOE/EA-1131 (DOE 1995). The Proposed Action considered in that environmental assessment was the relocation of Neutron Tube Target Loading operations from TA-21 Building 21-0209 to Weapons Engineering Tritium Facility at TA-16 and associated upgrading of the building. Neutron Tube Target Loading involves the transfer of radioactive tritium gas onto metal target disks that are then assembled into neutron tubes. These neutron tubes are ultimately assembled into neutron generators that are used as nuclear weapons components. This environmental assessment specifically excludes consideration of the DD&D of Building 21-0209, but in addressing the relocation of these tritium activities, includes the subsequent deactivation of Building 21-0209. This Proposed Action was overtaken by the decision to relocate Neutron Tube Target Loading operations to Sandia National Laboratories (DOE 2005a).

DOE prepared the *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the DOE and Located at LANL, Los Alamos and Santa Fe Counties, New Mexico (Conveyance and Transfer ElS)*, DOE/EIS-0293 (DOE 1999d) to examine potential environmental impacts associated with the conveyance or transfer of each of the land tracts tentatively identified in the DOE's Land Transfer Report to the Congress under Public Law 105-119. The transfer of TA-21 areas is considered under the *Conveyance and Transfer EIS,* including the DP Road tract and TA-21-1 subtract identified for transfer and development for commercial and industrial uses, and the TA-21-2 subtract that has been withdrawn from the conveyance process. This development would bring additional members of the public into the vicinity of the DP West and DP East Sites.

The Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico, DOE/EA-1409 (DOE 2002a) analyzes the construction of a gas line to provide natural gas to TA-53 and other LANL areas. The new line provides a more reliable source of natural gas for the areas currently supplied by the line that crosses TA-21 near DP East, in the necessary quantity, reliability, and redundancy necessary to allow the TA-21 line to be used as a secondary or emergency source of natural gas to these areas. Although the TA-21 natural gas requirements would end if the TA-21 steam plant is shut down, maintenance of the cross-mesa line as a secondary feeder to TA-53 would require modifications to allow remediation activities at MDA A and MDA T.

In 2005, DOE completed the *Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production*, DOE/EA-1532 (DOE 2005a). This environmental assessment evaluates the potential impacts of relocating certain tritium handling operations from TA-21 and TA-16 to Sandia National Laboratories. This document and the associated finding of no significant impact provide NEPA analysis of installation of the neutron tube target loading process equipment in Building 870 at Sandia National Laboratories and subsequent target loading operations, but do not address the disposition of LANL tritium facilities.

Purpose and Need

There are numerous aging process and support buildings in TA-21 that are surplus to future LANL needs. Since the *1999 SWEIS* ROD, all activities associated with the NNSA missions have been relocated to other buildings at LANL, offsite locations, or have been discontinued. With their missions consolidated elsewhere, these buildings have been prioritized within the queue of buildings awaiting DD&D as part of LANL's program to reduce the surveillance and maintenance cost necessary to protect workers, the public, and the environment. The *1999 SWEIS* section on decommissioning includes a discussion but no formal consideration of the impacts of the DD&D of the DP West buildings (DOE 1999a). The movement among tritium facilities was discussed in general in the *1999 SWEIS,* and addressed specifically in the *Environmental Assessment of the Relocation of Neutron Tube Target Loading Operations* (DOE 1995). Thus, although the deactivation of all TA-21 process facilities has been the subject of NEPA analysis and is included in the No Action Alternative, NNSA has yet to formally consider the DD&D of the DP West and East Sites and of the remainder of TA-21 structures.

In addition to the general need to eliminate inactive legacy buildings and their associated overhead and maintenance costs, NNSA must remove many of these buildings to support the investigations of solid waste management units identified under the Consent Order. Some of these solid waste management units lie underneath buildings and slabs or are associated with past activities at the buildings. In addition, the TA-21 Liquid Radioactive Waste Treatment Facility is within the boundary of MDA T, and NNSA must remediate and manage the land associated with the building as part of that corrective action. The current schedule for the Consent Order requires that all corrective actions within the Los Alamos and Pueblo watershed be completed by August 2011 (LANL 2006a).

Finally, TA-21 is an area with potential for reuse under Public Law 105-119, and 54 acres (21.9 hectares) have been designated for conveyance to Los Alamos County. However, a large portion of the area (see Figure H–6) has been withdrawn from the conveyance process. Portions of this area could be considered as brownfield sites in the future.

H.2.2 Options Description

This section provides descriptions of the three options – the No Action Option; the Compliance Support Option, which removes structures only as necessary to support the environmental restoration activities; and TA-21 Complete DD&D Option of all structures within TA-21. The TA-21 Complete DD&D Option and the Compliance Support Option support the Expanded Operations Alternative within the overall SWEIS (Chapter 3 of this SWEIS). The TA-21 Complete DD&D Option is the preferred option.

As it continues to match missions to buildings, LANL staff identify buildings that are excess to its needs based on age, building condition, and current mission requirements. For decades, the DP West and DP East sites, which include buildings from the 1940s and 1950s that have hosted several radiological missions, have been identified for eventual DD&D. The *1999 SWEIS* projected that the DD&D of DP West would be completed by 2004, and identified the potential for (but did not analyze) the consolidation of TA-21 tritium operations to TA-16 (DOE 1999a). As part of a long-term plan to eventually DD&D these sites and allow for their environmental remediation and possible reuse, NNSA has not located any new missions at TA-21, and has relocated all TA-21 mission activities to buildings at other locations that are more structurally sound or operationally efficient. With the completion of the tritium mission in DP East, the NNSA planning process considers all of the TA-21 process buildings excess, with some in DP West already demolished.

The options identified for DD&D of the TA-21 buildings are generally consistent with the plan to DD&D the DP East and DP West Sites, and differ only in schedule and scope. All options begin with the DP East tritium buildings having completed deactivation.

H.2.2.1 No Action Option

The No Action Option assumes that the DP Site facilities would remain in their current status through 2011, the period analyzed by this SWEIS, and that there would be no additional DD&D during that period. All process facilities would be maintained under a surveillance and maintenance status, all administrative and logistics facilities would remain occupied or in their current service, and Building 21-0257 would maintain its capability to process liquid radioactive waste. Certain portions of the investigations and corrective actions for the DP Site under the Consent Order could be undertaken, but those that would be obstructed by existing buildings, and particularly Building 21-0257, would be postponed indefinitely. There would be continued surveillance and maintenance costs, minor emissions, and failure to achieve Consent Order milestones. All of the radioactively contaminated facilities in TA-21 must eventually undergo some level of decontamination and decommissioning; the No Action Option defers the actions and extends the public health liabilities for TA-21 radioactive facilities to an indeterminate future time.

H.2.2.2 Technical Area 21 Complete Decontamination, Decommissioning, and Demolition Option

Under this option all structures located within the boundaries of TA-21, including process buildings, administrative and logistics buildings, and support facilities would undergo DD&D. This would include the DD&D of infrastructure such as gas, water, and waste piping, electrical and communication lines, fences, and similar materials and equipment. NNSA would schedule DD&D activities to support the investigation and corrective actions required under the Consent Order. However, below-grade remediation activity not directly associated with structural foundations is not part of this scope and would be addressed separately as part of the Consent Order actions. The DD&D of buildings and structures with a possible interim use, such as the steam plant and piping and administrative and logistics facilities, could be deferred.

The TA-21 Complete DD&D Option would remove approximately 126 buildings and structures totaling approximately 271,000 square feet (25,177 square meters) (LANL 2006a). It would generate approximately 34,000 cubic yards (26,000 cubic meters) of radioactive waste and 48,000 cubic yards (37,000 cubic meters) of nonradioactive waste, and would require on the order of 256,000 person-hours of DD&D effort. Combined with the associated remediation activities, this option would directly affect the entire mesa top from the end of the mesa on the east to MDA B on the west, plus canyon areas for the access road. Contractor facilities would be required, including a waste management area to load and ship waste and a clean soil stockpile area to accept incoming and excavated clean soils.

The current status of TA-21, as described in the beginning of Section H.2.2, would be the starting point for the initiation of activities under this option. Activities under this option would include the characterization of the DP West process facilities, removal of any remaining process piping and interior process and nonprocess equipment, surface decontamination and facility demolition. The TA-21 Liquid Radioactive Waste Treatment Facility (Building 21-0257) would be deactivated, and all process equipment would be removed from it and from the tritium facilities in DP East. These facilities would also proceed through the remaining elements of DD&D discussed in the beginning of Appendix H. The remaining TA-21 nonprocess buildings and structures would then be characterized and demolished, with waste disposal dependent on facility characterization information. The DD&D projects under this option would be coordinated with Consent Order remediation activities to support timely completion of Consent Order milestones. Activity scope would be coordinated to avoid duplication of efforts such as soil and below-grade pipe removal, area excavation, and revegetation. Detailed DD&D plans are currently being prepared for the contaminated facilities. Since initial planning and characterization is not complete, specific work plans, methods, schedules, and resources are not available. Therefore, the impact analysis has used the general methods identified above to provide a bounding case.

H.2.2.3 Compliance Support Option – Partial Decontamination, Decommissioning, and Demolition to Allow Consent Order Compliance

Under the Compliance Support Option, LANL workers would DD&D only those structures that cover or would interfere with activities to investigate and remediate MDAs and other potential release sites where releases of contamination to the environment are suspected. The DD&D of TA-21 would be initiated based on the DP Site Decontamination and Decommission Project as currently defined, because the scope of that project is to DD&D those facilities that inhibit or preclude the cleanup of potential release sites. Under this option, there would be no further DD&D scope for TA-21 subsequent to this work, including any removal of buildings or structures to reduce surveillance and maintenance costs or support reutilization or conveyance under Public Law 105-119.

The Compliance Support Option would remove approximately 25 buildings and structures totaling approximately 200,000 square feet (18,580 square meters). It would generate approximately 34,000 cubic yards (26,000 cubic meters) of radioactive waste, 19,000 cubic yards (14,000 cubic meters) of nonradioactive waste, and would require on the order of 230,000 person-hours of DD&D effort (LANL 2006a). It would directly affect an area of approximately 14 acres (5.7 hectares) in TA-21, including grading and revegetation, although this would overlap with areas remediated as part of the Consent Order. **Table H–4** shows the TA-21 structures that would undergo DD&D in conjunction with the Compliance Support Option.

In practice, the initial actions of this option would be the same as the TA-21 Complete DD&D Option. LANL workers would characterize the DP West process facilities, remove any remaining process piping and interior nonprocess equipment, decontaminate surfaces, and demolish the facilities. Similarly, the TA-21 Liquid Radioactive Waste Treatment Facility (Building 21-0257) would be deactivated, and all process equipment removed from it and from the tritium facilities in DP East. These facilities would also proceed through the elements of characterization, decontamination, and demolition, which would result in removing most of the contaminated facilities from TA-21. The Compliance Support Option would also remove approximately seven additional buildings and structures that are largely uncontaminated but would obstruct remediation actions necessary to comply with the Consent Order. Various portions of the utilities infrastructure including gas, steam, water, sewage, and electrical lines and water towers would need to be removed to facilitate the investigation and remediation of MDAs and other potential release sites in both this and the TA-21 Complete DD&D Option. After removal of this infrastructure, an additional effort would be required to reroute or compensate for these interrupted services to the buildings that remain occupied after completion of Compliance Support Option DD&D activities.

Table H–4 Technical Area 21 Buildings to Undergo Decontamination, Decommissioning, and Demolition for the Compliance Support Option

Property Identification	***Description***
21-0002	Wet laboratory north + south
21-0002	Wet laboratory north + south mezzanine
21-0003	Remaining structure + adjacent asphalt
21-0004	Remaining structure + adjacent asphalt
21-0005	Laboratory north + south
21-0005	Laboratory north + south - mezzanine and attic
21-0005	Laboratory basement
21-0021	Building slab only
21-0046	Warehouse
21-0089	Pressure relief valve
21-0116	Hot tool room, including basement
21-0144	Utility/passageway
21-0149	Corridor
21-0150	Basement
21-0150	Mezzanine
21-0150	Molecular chemistry
21-0152	Laboratory building
21-0155	1st floor
21-0155	External mezzanine
21-0209	1st floor
21-0209	Basement
21-0228	Warehouse-slab only
21-0230	Sludge drying bed
21-0257	Liquid Radioactive Waste Treatment Plant
21-0257	Underground piping
21-0258	West water tower
21-0286	Warehouse - radioactive
21-0312	Corridor
21-0313	Corridor
21-0314	Corridor
21-0315	Corridor
21-0342	East water tower
RW Lines	Radioactive waste lines at Technical Area 21

Source: LANL 2006a.

H.2.3 Affected Environment and Environmental Consequences

This section describes the natural and human environment that could be impacted during the DD&D of TA-21 buildings and structures and provides the context for understanding any associated environmental consequences. The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to TA-21 is available and adds to the understanding of the affected environment, it is included here. The affected environment descriptions in this section serve as a baseline from which any environmental changes brought about by implementing one of the options can be evaluated; the baseline conditions are the existing conditions.

The definition of existing conditions is complicated by the evolution of TA-21 activities. Over the past several years, TA-21 tritium operations have been discontinued and there have been limited DD&D activities – equipment has been removed from several buildings and other buildings have been demolished. As a result, TA-21 characteristics may show variations independent of any action considered in this document. This is discussed in more detail in the individual resource sections.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for environmental justice, a determination was made that no further analysis was necessary because no disproportionate impacts to low-income or minority populations would be expected.

H.2.3.1 No Action Option

The No Action Option assumes that the administrative, logistics, and office activities currently occurring at TA-21 would continue. As there would be no additional DD&D at TA-21, the western portion of the area (that is, the 8.7-acre [3.5-hectare] TA-21-1 [West] Parcel) would be conveyed to Los Alamos County in the condition planned, with structures and infrastructure intact. The remainder of the TA would remain a part of LANL in an ongoing state of surveillance and maintenance. The No Action Option would have little or no additional effect on water resources except for the elimination of the National Pollutant Discharge Elimination System (NPDES) outfall associated with the deactivation of the Tritium Science and Fabrication Facility. Similarly, no changes to current radiological and nonradiological emissions or air pollutant concentrations are expected under the No Action Option, except those resulting from the deactivation of the TA-21 tritium facilities. Tritium emissions should diminish through 2011 even without DD&D, especially if ventilation at DP East could be terminated. (Emissions from stacks at TA-21 were stopped in September 2006 as one of TA-21 shutdown activities.) Ecological and cultural characteristics of TA-21 would remain largely unchanged from existing conditions, whereas public and worker dose resulting from radiological emissions from TA-21 would be expected to be consistent with, and less than, historical values. The No Action Option would eliminate the generation of waste that would otherwise be generated from DD&D and environmental restoration projects under the TA-21 Complete DD&D Option and Compliance Support Option.

H.2.3.2 Technical Area 21 Complete Decontamination, Decommissioning, and Demolition Option

Land Resources

Land Use

TA-21 consists of about 312 acres (126 hectares) at the eastern end of DP Mesa, near the central business district of the Los Alamos Townsite. The airport is located immediately north of TA-21, across DP Canyon. About 20 percent of the TA has been developed with the west-central portion of the tract containing the majority of development; remaining portions of the TA consist of sloped areas, some of which would likely not accommodate development. Access to the site is via DP Road (LANL 1999). As noted in Section H.2.1, facilities at TA-21 have until recently supported tritium research.

TA-21 is one of a number of TAs identified for conveyance to Los Alamos County under Section 632 of Public Law 105-119 (see SWEIS Chapter 4, Section 4.1.1). This TA has been divided into four subtracts for purposes of the land conveyance: DP Road-1, TA-21-1 (West) that consists of two units, and TA-21-2 (East). These subtracts have also been designated as A-8, A-15-1, A-15-2, and A-16, respectively (see Figure H–6). Subtracts A-8, A-15-1, and A-15-2 total 33.7 acres (13.6 hectares) in size and either have been or are slated to be conveyed to the county. Parcel TA-21-2 (East) is 252.1 acres (102 hectares); however, its conveyance has been deferred.

Land use within TA-21 has, until recently, included Waste Management; Administration, Service, and Support; Nuclear Materials Research and Development; and Reserve (see Chapter 4, Figure 4–4). According to the *Comprehensive Site Plan* for 2001, TA-21 falls within the Omega West Planning Area. The *Comprehensive Site Plan* indicates that all TAs within the planning area would eventually be decommissioned (LANL 2001a). Two areas within TA-21 are noted as No Development Zones (Hazard). TA-21 also includes five MDAs and numerous other potential release sites that will have to be addressed and potentially remediated in support of the Consent Order.

DD&D Impacts—Following DD&D of the buildings and structures within that part of TA-21 that has been withdrawn from conveyance to Los Alamos County (the 252-acre [102-hectare] TA-21-2 [East] Parcel), portions of the area could be considered as brownfield sites for potential reuse. Pending a decision relating to reuse, the redesignation of portions of the TA-21 from Waste Management, Service and Support, and Nuclear Materials Research and Development to Reserve is in keeping with the present designation of the remaining land within TA-21, as well as adjacent TAs (LANL 2003d).

Visual Environment

Facilities at TA-21 are situated on DP Mesa, which is located between Los Alamos Canyon to the south and DP Canyon to the north. Developed portions of the TA present an industrial appearance. Undeveloped portions of the mesa remain moderately vegetated with native grasses, shrubs, and small trees. The canyons are wooded. The site, particularly the water tower, can be seen from locations along NM 502. Developed portions of TA-21 are visible from higher elevations to the west. An analysis of the visual quality of the site determined that both developed and undeveloped areas of the site had low public value for visual resources (DOE 1999d).

DD&D Impacts—DD&D activities would have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Following removal of buildings and structures within TA-21, the area would be contoured and revegetated, as appropriate, resulting in an improved visual environment. Since the area could be developed in the future, these efforts would be aimed primarily at soil stabilization and not at recreating a more natural environment. With future redevelopment possible, the view of the TA from NM 502 and from higher elevations to the west could remain commercial and industrial in nature. Nevertheless, with proper planning, the view would be of modern architecturally compatible buildings rather than the current mix of 50-year-old structures.

Geology and Soils

The TA-21 buildings and structures are subject to the same general geology and seismic conditions as the entire LANL site. As discussed in this SWEIS, Chapter 4, Section 4.2.2, geologic mapping and related field and laboratory investigations that included TA-21 revealed only small faults that have little potential for seismic rupture.

The LANL soil-monitoring program conducts annual sampling of soils for contaminants in and around the LANL facility. The program has identified TA-21 soils and soil samples from an adjacent area near the airport as the only LANL areas routinely exceeding Regional Statistical Reference Levels for plutonium, although the levels remain below levels that would require active remediation. The elevated contaminant levels are the result of actinide processing activity conducted at the DP West facility prior to its transfer to the TA-55 facility in the 1970s. There was no impact on the TA-21 soils from the Cerro Grande Fire.

DD&D Impacts—Under all options, the impact of a seismic event has been reduced by the deactivation of the DP East facilities and removal of a majority of the source material present. Since no new facilities would be constructed under the TA-21 Complete DD&D Option, there would be no new potential seismic impact. The TA-21 Complete DD&D Option would have a minor impact on the geologic and soils resources at LANL as the affected facility areas are already developed and adjacent soils are already disturbed. The DD&D activities would introduce some additional ground disturbance in excavating foundations and establishing laydown yards and waste management areas near the facilities to be demolished. However, the impacts would be temporary and available paved surfaces, such as adjacent parking lots, would be used to mitigate any impact. The degree of soil disturbance from this option is expected to be much smaller than that resulting from major remediation activities under the Consent Order. The primary indirect impact would be associated with the need to excavate any contaminated tuff and soil not addressed by the Consent Order from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade. Such resources are available from onsite borrow areas (see Chapter 5 of this SWEIS, Section 5.2) and in the vicinity of LANL.

Water Resources

Since the DP West and DP East buildings were constructed in 1945, they have used domestic and industrial water and have discharged cooling water to the DP Canyon. Building 21-0227 originally treated TA-21 sewage and industrial wastewater effluents prior to discharge to the DP Canyon. In 1999, this waste stream was rerouted to the TA-46 Sanitary Wastewater Systems Plant. Past soil contamination could impact surface water contamination levels in runoff, contamination migration through the soil, and contamination levels that may be present in the groundwater.

TA-21 water usage has historically averaged about 25 million gallons (95 million liters) per year representing about 5 percent of LANL usage (LANL 2006a). As the tritium mission at DP East is completed, the need for process and cooling water is expected to continue to decrease, leaving domestic usage and building ventilation (steam heat and cooling water) as the only major continuing uses.

There are two NPDES outfalls into the DP Canyon, which is considered part of the Los Alamos Canyon watershed. **Table H–5** provides the actual annual flows of these outfalls for the TA-21 facilities, the Steam Plant and the Tritium Science and Fabrication Facility (LANL 2006f).

Table H–5 Volume of Technical Area 21 National Pollutant Discharge Elimination System Outfalls (millions of gallons per year)

Facility Mission	*NPDES Outfall Designation*	*Source Building*	*Building/Process Description*	*2005 SWEIS Yearbook Actual Flow*
Tritium	02A-129	155N, 357	Steam Plant	32.6 [a]
Tritium	03A-158	209	Tritium Science and Fabrication Facility	0.39

NPDES = National Pollutant Discharge Elimination System.
[a] Discharge is estimated from flow measurements made at the time of sampling assuming a constant discharge rate. Contributing flows such as boiler blowdown are not metered. Thus, the reported discharge is overestimated based on metered water use at the steam plant.
Note: To convert gallons to liters, multiply by 3.785.
Source: LANL 2006f.

Most of the TA-21 site is sloped so that stormwater from the buildings and parking lots drain into either the DP or Los Alamos Canyons. TA-21 is located on a mesa top and not within the 100-year or 500-year floodplain boundaries. TA-21 currently contains four active aboveground fuel storage tanks and one active underground fuel storage tank, some of which are empty in anticipation of closure or DD&D.

DD&D Impacts—The TA-21 Complete DD&D Option would result in little or no effect on overall LANL water use or resources. Water use and discharges associated with the use of TA-21 office and logistics facilities would be reduced. The outfalls from the Tritium Science and Fabrication Facility and the Steam Plant would be eliminated, which would have a minor effect on surface water quality in Los Alamos Canyon. These industrial effluents comprise less than 40 percent of the discharges into that canyon. Removal of these discharges would have little effect on surface water quality, as the majority of the effluent is boiler blowdown and cooling water, which contains fewer contaminants than wastewater. However, as organizational functions are transferred to other LANL buildings, there would be compensating increases in the water and steam uses by those buildings. If TA-21 actions are limited to those required by the Federal Facility Compliance Agreement, then there would be little impact on surface water quantity and quality in Los Alamos Canyon, as only the Tritium Science and Fabrication Facility outfall would be eliminated.

This option would not result in the disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. Silt fences, hay bales, or other appropriate best management practices would be employed (as described in stormwater pollution prevention plans) to ensure that fine particulates are not transported by stormwater or water used in dust suppression into surface water features in the DP or Los Alamos Canyons. Potable water use at the site would be limited to that necessary for equipment washdown, dust control, and sanitary facilities for workers. Impacts of DD&D activities on groundwater should be minimal because of surface water collection practices, especially in comparison to the impact from environmental restoration activities being conducted to comply with the Consent Order. Any final contouring of industrial areas and subsequent soil stabilization would be in conjunction with remediation activities necessary for compliance with the Consent Order. Groundwater profiling and any actions required to remediate past spills would be undertaken as part of the TA-21 remediation activities.

Air Quality and Noise

This section discusses radioactive and nonradioactive air emissions specific to TA-21. Radiological doses are discussed under Human Health.

Air Quality

Emissions from TA-21 activities include pollutants that have the potential to impact co-located LANL workers and the surrounding community, including radiological emissions from operating facilities and facilities in a state of surveillance and maintenance, as well as radioactive and nonradiological emissions from buildings and DD&D projects. The proximity of TA-21 to the Los Alamos townsite and to the recently transferred "DP Road" tract places all TA-21 emission sources close to the LANL site boundary and the public. NNSA plans, executes, controls, and monitors new and established TA-21 building and activity emissions to ensure worker and public safety, and to verify pollutant levels are within established regulatory limits.

Nonradioactive Emissions. Activities generating nonradioactive air pollutants at TA-21 include the Steam Plant, vehicle exhaust, and minor emissions from activities in the maintenance facilities operated by the LANL maintenance contractor. Emissions from the TA-21 Steam Plant are shown in **Table H–6**. DD&D activities have produced small amounts of fugitive dust consistent with dust generation that would result from normal construction activities (LANL 2004d).

Table H–6 Calculated Actual Emissions for Regulated Pollutants Reported to the New Mexico Environment Department for 2005

Source	*Nitrogen Oxides*	*Sulfur Oxides*	*Particulate Matter (less than or equal to 10 micron)*	*Carbon Monoxide*	*Volatile Organic Compounds*	*Hazardous Air Pollutants*
TA-21 Steam Plant	1.6	0.016	0.12	1.33	0.09	0.03
All Other LANL	48.9	1.9	4.9	33.8	14.5	6.5
Total	50.5	1.9	5.0	35.1	14.6	6.5
Percent TA-21 Steam Plant	3.1	0.8	2.4	3.8	0.6	0.5

TA = technical area.
Note: Air emissions in tons per year (LANL 2006e).

As part of the Title V operating permit application, the New Mexico Environment Department requested that LANL provide a facility-wide air quality impacts analysis. The analysis included emissions from the TA-21 boilers and demonstrated that simultaneous operation of all regulated air emission units described in the Title V permit application, being operated at their maximum requested permit limits, would not result in any ambient air quality standards being exceeded (LANL 2003c).

The limited amount of ambient air sampling that has been performed for nonradioactive air pollutants within the LANL region is discussed in Chapter 4 of this SWEIS. Although past activities at TA-21 facilities have involved handling of beryllium materials none of the TA-21 buildings is on the NESHAP permit for beryllium emissions, and TA-21 has no current operations that would result in beryllium emissions (LANL 2005e).

The NESHAP for asbestos requires that NNSA provide advance notice to the New Mexico Environment Department for large renovation jobs that involve asbestos and for all demolition projects such as at TA-21. The asbestos NESHAP further requires that all activities involving asbestos be conducted in a manner that mitigates visible airborne emissions and that all asbestos-containing wastes be packaged and disposed of properly. To ensure compliance, the LANL contractor has established an Asbestos Report Project with internal requirements defined in its Quality Assurance Project Plan, and conducts internal inspections of job sites and asbestos packaging on approximately a monthly basis (LANL 2003a, 2005e).

DD&D Impacts—Under the TA-21 Complete DD&D Option, the operational emission sources would be relocated or cease as the activities are relocated and the buildings demolished. There would be temporary increases in vehicle exhaust and fugitive dust during the demolition. Initial air emissions from TA-21 would be similar to current emissions. The nonradioactive air pollutant emissions from the three natural gas fired boilers in Building 21-0357 would be eliminated. Vehicle exhaust and emissions from activities in the maintenance and support facilities would be expected to follow these functions to their new location within LANL. The emissions produced from the use of toxic chemicals in the laboratory and the Liquid Radioactive Waste Treatment Facility, already reduced during deactivation, would be eliminated, as the process buildings are placed into surveillance and maintenance status and subsequently demolished.

Demolition and removal of radiological and nonradiological buildings and structures would result in temporary air quality impacts from construction equipment, truck, and employee vehicle exhaust. Criteria pollutant concentrations were not modeled for demolition of buildings at TA-21, but would be less than for construction of new facilities occurring concurrently at LANL. Concentrations offsite and along the perimeter road to which the public has regular access would be below the ambient air quality standards. Building demolition would also result in particulate (fugitive dust) emissions. The dust could include small amounts of lead, asbestos, and other nonradioactive hazardous constituents despite methods and controls used to mitigate such contaminants and ensure DD&D worker and co-located employee safety during demolition. Although the DP Canyon separates the DP Mesa from the site boundary, the proximity to the public would require active measures to ensure dust suppression and control. This option would result in the DD&D of a greater number of buildings than the Compliance Support Option. If the dust generated by demolition is assumed to be roughly proportional to the demolition waste volume, then the dust generated by the TA-21 Complete DD&D Option would be approximately 40 percent greater than that generated by the Compliance Support Option.

Radioactive Emissions. Radiological emissions from the TA-21 facilities are shown in **Table H–7**, and the ambient air sampling data at the center of TA-21 and at the East Gate (at the LANL perimeter across the DP Canyon north of TA-21) are shown in **Table H–8**.

Table H–7 Technical Area 21 Radiological Point Source Emissions

Location	Emissions Point	7-Year Average (1999-2005) Radionuclide Emissions (curies per year) [a]
21-155 (TSTA Stack)	21015505	264 (tritium) [b]
21-209 (TSFF Stack)	21020901	470 (tritium) [b]
Total		734 (tritium) [b]

TSTA = tritium systems test assembly, TSFF = Tritium Science and Fabrication Facility.
[a] Sources: LANL 2000c, 2001b, 2002c, 2003b, 2004a, 2005b, 2006d.
[b] Tritium gas and tritium oxide combined.

Table H–8 Technical Area 21 Ambient Air Monitoring

Radionuclide	2005 Average Concentrations (curies per cubic feet) [a]	
	Concentration at East Gate Location (north of LANL east of the airport)	Concentration at TA-21 (central between DP East and DP West)
Tritium	1.0×10^{-13}	1.2×10^{-13}
Americium-241	-1.2×10^{-20}	1.3×10^{-19}
Plutonium-238 [b]	-1.2×10^{-20}	6.7×10^{-21}
Plutonium-239 [b]	1.4×10^{-20}	1.3×10^{-18}
Uranium-234	2.2×10^{-19}	1.7×10^{-18}
Uranium-235 [b]	1.3×10^{-20}	1.3×10^{-19}
Uranium-238	2.6×10^{-19}	8.2×10^{-19}

TA = technical area.
[a] Source: LANL 2006e.
[b] Negative values are the result of analytical uncertainties due to the small quantity of material present in the sample, and from the adjustment to account for background radionuclide concentrations.
Note: To convert curies per cubic feet to curies per cubic meters, multiply by 0.028.

Tritium emissions from the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility exhaust ventilation stacks has decreased since 2003, in part due to the completion of active source removal activities at TA-21-155 and initiation of surveillance and maintenance status. Continued emissions from this facility, the result of off-gassing from contaminated equipment that remains in the building, requires continued monitoring until the potential emission levels from TA-21-155 are fully characterized. As TA-21-209 tritium-contaminated systems are dismantled and prepared for removal and disposal, increased emissions of tritium are expected. However, overall long-term emissions from these facilities would decrease following deactivation (LANL 2004d). There may be a short-term increase in tritium emissions from the Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility during removal and relocation of tritium processing equipment, with emissions in the range of 1 to 7 curies per week from each facility. Since these increases should only be for limited periods, annual emissions would remain well below the facility 5-year averages.

Information on past building DD&D emissions at DP West was developed during the Building 3 and Building 4 South DD&D project. Stack monitors remained operational until the main ventilation systems were bypassed and capped in 1994 and 1995. For the first 3 years of the project (1991 through 1993) stack emissions were 9.2×10^{-5}, 5.1×10^{-5}, and 5.3×10^{-5} curies combined uranium and plutonium, respectively. This is comparable to routine emissions data for other LANL operating facilities as shown in Chapter 4, Section 4.4.3.1 of this SWEIS. Additionally, during the demolition of decontaminated buildings with areas of stabilized residual contamination, numerous air monitors placed at the perimeter of the controlled area detected no activity above background (LANL 1995).

Ambient air samples were analyzed for 10 radionuclides, and concentrations of the radionuclides that are relevant to activities at TA-21 are shown in Table H–8. The elevated tritium concentrations at TA-21 and the East Gate locations are likely to be at least partially the result of Tritium Systems Test Assembly and the Tritium Science and Fabrication Facility emissions, although ambient air sampling cannot unambiguously determine the sources of the radionuclides detected. The source of the uranium and transuranic air concentrations are less apparent, although some of these concentrations are near regional background levels.

DD&D Impacts—Even during surveillance and maintenance, radiological facilities could produce radiological emissions, depending upon the operational status of the building exhaust systems. During initial DD&D, there would be emissions during the removal of equipment and decontamination of structural surfaces. While the building shell is intact, emissions would result from building or temporary ventilation systems used for dust and contamination control. These systems would use high-efficiency particulate air filtration to reduce entrained airborne radioactivity prior to exhausting air from interior contaminated spaces to areas outside the building. Ventilation and other controls would be used to minimize worker inhalation and exposure to radioactivity and avoid recontamination of previously decontaminated areas. The result of the initial activities would be structural surfaces either decontaminated to unconditional-release levels or with selected contaminated surfaces stabilized to permit segregation of radioactively contaminated and uncontaminated debris after demolition.

The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during building demolition. Release of radioactivity would be minimized by proper decontamination of buildings prior to demolition – if facilities are decontaminated to unconditional release levels as prescribed by the MARSSIM protocol, emissions would be similar to those from uncontaminated buildings. If residual levels of contamination remain after decontamination activities are complete, then small amounts of radioactivity would be emitted during demolition. The radionuclide concentrations resulting from demolition of contaminated facilities can be predicted based on the predemolition characterization of the building, and would be addressed in regulatory documents approved at that time. Such emissions typically would be of short duration, and would be minimized using dust suppression techniques and monitored along with the fugitive dust. This option would result in the DD&D of a greater number of buildings than the Compliance Support Option, but the number of radioactively contaminated buildings would be essentially the same.

Noise

The activities at TA-21 are similar to those of other office and laboratory areas at LANL. Operations noise sources include heating, ventilation, and cooling equipment, generators, and vehicles. DD&D and construction activities have also generated noise for limited periods. Minimal noise impacts are generated by current TA-21 activities.

DD&D Impacts—Noise levels during demolition activities would be consistent with those typical of construction activities. As appropriate, workers would be required to wear hearing protection to avoid adverse effects. Noninvolved workers at the edge of the demolition areas and members of the public on the perimeter road would be able to hear the activities; however, the level of noise would not be expected to result in increased annoyance. Construction noise at LANL is common. Some wildlife species might avoid the immediate vicinity of the TA-21 demolition sites as demolition proceeds due to noise; however, any effects on wildlife resulting from noise associated with the demolition activities would be expected to be temporary.

Ecological Resources

This section addresses the ecological setting (terrestrial resources, wetlands, aquatic resources, and protected and sensitive species) of TA-21. Ecological resources of LANL as a whole are described in Chapter 4, Section 4.5 of this SWEIS, and the vegetation zones are depicted in Figure 4–25.

While most of TA-21 is located within the Ponderosa Pine Forest vegetation zone, the more easterly portions of Los Alamos Canyon are within the Pinyon-Juniper Woodland vegetation zone. Also, mixed conifer forest occurs along north facing canyon walls (see Figure 4–25). About 20 percent of the area is developed as roadways, parking lots, and facilities with associated landscaping (DOE 1999d). Wildlife within undisturbed portions of the TA would be expected to be typical of those two communities. The Cerro Grande Fire (DOE 2000) did not directly affect TA-21. Wildlife use of developed portions of the site would be expected to be minimal, with large mammals being excluded from the area due to the presence of security fencing.

There are no wetlands within TA-21 (ACE 2005). Los Alamos Canyon contains a perennial water source flowing a few cubic feet per second during most of the year (DOE 1999d). Aquatic resources within the Los Alamos Canyon stream would be limited since no fish have been found in any LANL streams.

TA-21 falls within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest with the southern and eastern portions included within the core zone. TA-21 does not include any portion of the Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000b).

DD&D Impacts—All DD&D activities analyzed in this SWEIS would take place within the industrial area of TA-21, which contains little wildlife habitat. Wildlife in canyons adjacent to TA-21 could be intermittently disturbed by construction activity and noise over the demolition period when heavy equipment would be used to raze structures, remove building foundations and buried utilities, excavate contaminated soil, and transport wastes to disposal sites. Demolition related disturbances to wildlife are expected to be intermittent and localized. Upon DD&D of the buildings and structures within TA-21, the site would be contoured and revegetated. However, revegetation would have only relatively short-term benefits to wildlife since it is likely that the area could be developed in the future.

There are no wetlands located within TA-21. Thus, neither the elimination of two NPDES-permitted outfalls nor DD&D activities would affect this resource.

As noted above, TA-21 falls within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. Since the TA-21 is highly disturbed no suitable foraging or nesting habitat would be lost as a result of DD&D activities and owls have not been identified in Los Alamos Canyon for the past 11 years. Noise levels may exceed background levels by more than 6 dB(A) as a result of demolition activities. The DOE biological assessment concluded that provided reasonable and prudent alternatives are implemented, DD&D activities may affect, but are not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include muted back-up indicators on heavy equipment, keeping disturbance and noise to a minimum, avoidance of unnecessary disturbance to vegetation including not removing trees with a diameter at breast height larger than 8 inches (20 centimeters), reseeding and erosion protection, and ensuring that any new lighting meet the requirements of the New Mexico Night Sky Protection Act. Also, activities involving heavy equipment would not be permitted to take place between March 1 and May 15, or until the completion of surveys for spotted owls. If owls were determined to be present work restrictions would be extended until August 31 (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Since no bald eagle nesting or foraging habitat would be lost as a result of DD&D activities and the southwestern willow flycatcher Area of Environmental Interest is more than 2.6 miles (4.2 kilometers) from TA-21, the DOE biological assessment determined that the proposed project would have no effect on either species (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Human Health

Routine operations and activities at TA-21 facilities result in LANL workers and the public receiving a radiation dose above background radiation levels, either through direct radiation exposure or through the inhalation or ingestion of radioactivity in the air or elsewhere in the environment. Subsections discuss TA-21 radiological doses to certain receptors, followed by the impact of those doses on the public and LANL workers. The "Worker Health" section also discusses the impacts from DD&D industrial accidents. Nonradiological air emissions and their effects are discussed in the "Air Quality" section and the effects of traffic accidents are discussed in the "Transportation" section in the following pages. The risk of facility accidents during the DD&D of TA-21 facilities was evaluated based on the radioactive material-at-risk estimated to remain in each individual process building after its deactivation or during surveillance and maintenance. On the basis of this evaluation, the environmental impacts for releases that could result from a facility accident at TA-21 are bounded by the impacts of previously evaluated accidents at the same location, and are not further addressed in this analysis.

NNSA evaluates the public impact of radionuclide emissions by direct monitoring of emission point sources and ambient air monitoring. The radiation doses calculated from the radiological emissions from TA-21 facilities are shown in **Table H–9**. Radiological doses determined from the ambient air sampling at TA-21 and the adjacent East Gate locations are shown in **Table H–10**.

Table H–9 Maximally Exposed Individual Average Radiological Doses from Technical Area 21 Point Source Emissions

Location	*7-Year Average Dose (1999-2005) (millirem per year)*	
	Dose to LANL MEI at East Gate	***Dose to Facility-Specific MEI***
21-155 (TSTA Stack)	0.0103	0.0103
21-209 (TSFF Stack)	0.00891	0.0200
Total	0.0192	0.0303

MEI = maximally exposed individual, TSTA = Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility.
Sources: LANL 2000c, 2001b, 2002c, 2003b, 2004a, 2005b, 2006d.

Table H–10 Radiological Doses (above background) Measured at Technical Area 21 and the East Gate Locations, Based on Ambient Air Monitoring

Radionuclides	*7-Year Average Dose (1999-2005) (millirem per year)*	
	Annual Dose at the East Gate Location (north of LANL east of the airport)	***Annual Dose at TA-21 (central between DP East and DP West)***
Tritium	0.0401	0.0439
Americium-241	0.00157	0.00643
Plutonium-238	0.0	0.000429
Plutonium-239	0.000571	0.0424
Uranium-234	0.00629	0.0186
Uranium-235	0.00129	0.00257
Uranium-238	0.00786	0.0147
Total	0.0586	0.129

TA = technical area.
Sources: LANL 2000c, 2001b, 2002c, 2003b, 2004a, 2005b, 2006d.

Table H–9 provides the basis for assessing impact to the public from existing TA-21 operations. Radioactive material processing facilities in TA-21 collect, filter, and exhaust air from contaminated portions of the facility through ventilation exhaust stacks under normal operating conditions. Dispersion modeling techniques use the calculated radionuclide emissions data shown in Table H–7, along with other inputs to predict the radiological doses for hypothetical individuals at selected locations and for the collective population dose received by the surrounding community. The information in Table H–9 indicates the average annual radiological impact that the facilities within TA-21 have had on the surrounding community for the last 7 years. As deactivation activities are completed, the radiological dose attributable to tritium emissions should decrease independent of the options.

The radiological dose shown in Table H–10 is the average annual dose that a hypothetical individual would receive if they breathed air with the net airborne radionuclide concentration (sampled minus background) collected from the designated location. Although both radiological doses are low, the dose at the TA-21 location is higher, as might be expected closer to the tritium facility stacks and the DD&D of the moderately contaminated buildings removed during the sampling period. The radiological dose is derived in approximately equal parts from tritium, transuranic (plutonium and americium), and uranium isotopes. The East Gate location is common to both Table H–9 (emissions sampling and dose calculated by dispersion modeling) and Table H–10 (dose calculated using ambient air sampling data). The values given for tritium dose, the only radionuclide present in substantially elevated levels, shows reasonable agreement between the two tables for that location, given the difference in methods and the presence of other LANL emissions that could contribute to the hypothetical ambient dose.

Public Health

The LANL maximally exposed individual (MEI) is a hypothetical member of the public who, while not on LANL property, would receive the greatest dose from LANL operations (see Chapter 4 of this SWEIS, Section 4.6). The location of this MEI during most years of the analysis has been at the East Gate along NM 502, entering the east side of Los Alamos County. The 7-year (1999 through 2005) average dose the LANL MEI would have received is 1.9 millirem per year (based on emission sampling and dispersion modeling, not the ambient air monitoring value shown in Table H–10; see Chapter 5 of this SWEIS, Section 5.6), less than one percent of the naturally occurring background radiation dose (estimated to range from 300 to 500 millirem per year based on where the individual lives). Of the dose to the LANL MEI at the East Gate, the average portion attributed to the TA-21 facilities was minimal (0.0192 millirem per year).

In addition to the LANL MEI, each Key Facility has a facility-specific MEI, a hypothetical member of the public who, while at a location near that facility but not on LANL property, would receive the greatest dose from all Key Facilities. As shown in Table H–9, the average TA-21 facility-specific MEI is 0.0303 millirem per year.

The 7-year (1999 through 2005) average collective population dose attributable from all LANL operations to persons living within 50 miles (80 kilometers) of LANL was 1.22 person-rem. Tritium, from DP East as well as other Key Facilities, contributed to this population dose; however, most of this population dose resulted from the short-lived air activation products from the Los Alamos Neutron Science Center (LANSCE) (LANL 2006e).

DD&D Impacts—The DD&D process could cause temporary increases in radiological emissions that could be controlled within acceptable limits, but would result in the elimination of residual emissions from legacy structures. Removal of legacy structures also would permanently preclude any uncontrolled releases that would result from the failure of deteriorating structures or external factors such as wildfires. Environmental remediation activities that would follow DD&D perform a similar function for contaminated soil or environmental media, trading minimal temporary emissions for long-term risk reduction. There would be no direct radiation exposure to members of the public during this project due to the prohibition of public access to DD&D areas and the low levels of radiation present after deactivation.

Radiological emissions from TA-21 facilities under the TA-21 Complete DD&D Option would be divided into two phases. In the first phase, DD&D activities occurring within the building would take advantage of building integrity and certain building systems for contamination and emissions control. The second phase would be the short period during structural demolition for each building after decontamination is complete. A small fraction of any remaining radioactive contamination (and other hazards) could become airborne as the structure is demolished.

Estimating the dose received by the public from the in-building DD&D activities is difficult since there is little facility characterization or planning data available, including levels of radioactivity in equipment and how building and other contamination control systems would be used. Given the limited data, one approach to developing a bounding estimate radiation dose to the public is to assume that the emissions from in-building DD&D would be similar to the emissions from the building during operations. The types of radioactivity and controls would be similar, the building structure would be intact, and tritium trapping and filtration systems would be in place for ventilation exhaust during decontamination. The estimate would be conservative because, with the removal of accountable quantities of radioactive materials and cessation of process activities, levels of radioactivity present in the building would be orders of magnitude less than levels present during operation. Additionally, radioactivity would be continually reduced as equipment and materials are packaged as waste and removed. The 7-year average dose received by East Gate MEI from current emissions from the DP East tritium facilities is 0.0192 millirem per year (see Table H–9)

A second approach to estimating the dose received by the public is to compare it to emissions from similar previous DD&D projects. The Building 3 and Building 4 South DD&D project at DP West had stack emissions during in-building DD&D activities ranging from an initial high of 92 microcuries of uranium and plutonium the first year of the project to a low of 27 microcuries the final year of the project. A conservative calculation of the dose received from this emission suggests the East Gate MEI would receive less than 0.02 millirem per year. While it is difficult to accurately quantify the impact of in-building DD&D activities on the public, it is clear that the dose that would be received would be significantly less than one millirem per year.

Based on conservative estimates of residual levels of surface contamination and no mitigation on emissions during demolition from surface sealants or water spray, the dose that would be received by the East Gate MEI over the course of the whole TA-21 building demolition was estimated at 0.0002 millirem. Since many of the process buildings would be decontaminated to unconditional release levels, and dust suppression using water sprays also would be required to reduce fugitive dust, this dose is considered bounding. In examining previous projects, air sampling conducted during the Building 3 and Building 4 South demolitions detected no radioactivity above background that was attributable to decommissioning.

All of the options would have some ongoing emissions during the period considered under this SWEIS, with the impacts being bounded by those present during past DP East and DP West process operations. Tritium outgassing from deactivated equipment in DP East and some additional emissions from the DP West facilities in surveillance and maintenance status would continue under all options. The TA-21 Complete DD&D Option and the Compliance Support Option would remove radioactive materials from buildings; while that process might temporarily increase emissions, it would actively reduce emissions over time.

Worker Health

The 7-year average collective total effective dose equivalent for the LANL worker population is 161 person-rem (LANL 2003d, 2004c, 2005d, 2006f). In general, determining collective total effective dose equivalents for each TA is difficult because worker exposure data are collected at the group level, and members of many groups and organizations receive doses at several locations. The fraction of a group's collective total effective dose equivalent coming from a specific Key Facility or TA can only be estimated. For example, health physics personnel and maintenance workers are distributed over the entire site, and these two occupational groups account for a significant fraction of the LANL total effective dose equivalent. This would also be applicable to workers previously conducting work at DP West who also worked on other environmental restoration and DD&D activities. Thus, relevant historical worker exposure is not readily available from LANL data on an activity-by-activity basis.

Although data to support quantitative values of worker dose by facility are not readily available, the relative dose workers receive can be predicted based on the specific considerations at TA-21. Office workers receive only ambient radiation doses. The radiological dose received by workers engaged in surveillance and maintenance activities at DP East and DP West radioactive facilities is relatively low because the radiation source terms have been largely removed and the time spent in the contaminated areas has shortened. Doses received by workers associated with tritium activities, including the deactivation of these facilities, would not be applicable as a baseline for comparison of options. Thus non-DD&D workers receive low exposures.

Workers conducting DD&D activities in production facilities that are contaminated with uranium, tritium, and transuranic isotopes receive both external and internal dose. The external dose, in the form of gamma or beta exposure, is modest during the deactivation element and continues to decrease as the higher levels of radioactivity and more contaminated equipment is removed from the buildings. The internal dose, which is received when radioactive contamination is inhaled or ingested, can be reduced through ventilation controls, stabilization of loose contamination, and the use of personal protective equipment. DD&D projects in DP West reported worker internal radiation doses averaging 2 millirem over the project (LANL 1995).

DD&D activities involve work with tools, cutting equipment, and often large hydraulic and construction equipment, and workers are exposed to potential accident conditions similar to those found on construction sites. These include cutting and pinching, work at elevated locations and in trenches or enclosed spaces, rigging, and working near large construction equipment. Additionally, there are industrial hygiene hazards, particularly those associated with old buildings, such as exposure to asbestos and transite, lead and other heavy metals, polychlorinated biphenyls, solvents and hazardous constituents, and biological hazards (such as hantavirus from mouse droppings). National safety statistics are used in this analysis because they provide a more conservative estimate than would DOE safety statistics.

DD&D Impacts—The principal impacts on worker health would result from the radiation dose workers receive during the execution of DD&D, industrial hygiene impacts due to exposure to asbestos and hazardous materials, and industrial accidents similar to those associated with routine construction.

Potential worker dose during the decontamination of the buildings can only be estimated, as each facility would have to be characterized before work planning could begin. Planning would support maintaining worker doses at an ALARA level. The collective worker dose would be greater than that received at present because DD&D workers would receive a greater dose than workers performing surveillance and maintenance activities, and a greater number of workers would be required. However, under the No Action Option, the liability of the contaminated building remains, and addressing that liability would eventually require workers to incur similar radiological doses. Based on these projects, worker exposures from the DD&D of TA-21 should be less than the LANL radiation worker 7-year average of 161 person-rem per year.

The demolition of the TA-21 buildings might also involve the removal of asbestos contaminated materials. Removal of asbestos-contaminated materials would be conducted according to LANL asbestos management programs, in compliance with strict asbestos abatement guidelines, and is regulated by New Mexico Environment Department under the provisions of NESHAPS. Workers would use personal protective equipment and other engineered and administrative controls. Reviews of historical documentation and characterization of facilities would also provide information on areas in buildings where hazardous material spills have occurred, and conditions that present additional industrial hygiene hazards to workers. Industrial hygiene hazards may be present in facilities in which there is no radioactive contamination; however, nonradiological facilities may allow greater use of large construction equipment, resulting in less direct worker contact with hazardous locations.

Construction accidents are a substantial worker risk in DD&D activities, which require the use of cutting and shearing electrical, pneumatic, and hydraulic tooling. Workers must address issues of working at elevated locations, on scaffolding, below grade, and in confined or atmospherically suspect areas, and address issues of rigging large equipment and electrical safety. These issues are addressed at LANL through the Integrated Safety Management process, including job characterization, work planning, and worker training. Special care is also necessary in work around large pieces of construction equipment. Since there is no DD&D activity associated with the No Action Option, the risk of construction accidents resulting in worker injury or death is greater in the TA-21 Complete DD&D Option and the Compliance Support Option. Based on an expected 256,000 DD&D labor hours and DOE and national construction accident statistics, the DD&D of the TA-21 buildings could cause 3 to 11 recordable injuries. No construction fatalities would be expected using either of the statistical bases. Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment.

Cultural Resources

The three general categories of cultural resources addressed in this section are archaeological, historic buildings and structures, and traditional cultural properties.

Archaeological and Historic Buildings and Structures. A cultural resource survey of TA-21 has identified 5 archaeological sites. These include a cavate, a rockshelter, trails and stairs, and a rock or wooden enclosure. The five sites are formally declared eligible or potentially eligible for listing on the National Register of Historic Places through consultation with the State Historic

Preservation Office. Additionally, surveys of buildings and structures at TA-21 have determined that 15 buildings are National Register of Historic Places-eligible.

Traditional Cultural Properties. Traditional cultural properties are properties that are eligible for the National Register of Historic Places because of their association with cultural practices or beliefs of a living community that are rooted in that community's history and are important in maintaining its cultural identity. There are no known traditional cultural properties located within TA-21; however, consultations with American Indian and Hispanic groups have not been conducted. Traditional cultural properties would not be anticipated in developed portions of the TA (DOE 1999d).

DD&D Impacts—DD&D of buildings and structures at TA-21 would not directly impact the five National Register of Historic Places-eligible or potentially eligible archaeological sites present within the area. DD&D of buildings and structures would have direct effects on 15 National Register of Historic Places-eligible historic buildings and structures that are associated with the Manhattan Project and Cold War years at LANL.

Prior to any demolition activities taking place, DOE in conjunction with the State Historic Preservation Office, would implement documentation measures such as preparing a detailed report containing the history and description of the affected properties. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division to resolve adverse effects to eligible properties. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Socioeconomics and Infrastructure

Socioeconomics

As of the end of 2005, approximately 130 personnel were located in TA-21 facilities, along with additional seasonal employees or summer students. These personnel supported environmental and other LANL programs and maintenance and warehousing functions for the LANL maintenance contractor.

DD&D Impacts—Socioeconomic impacts could result from the TA-21 DD&D action, including impacts on:

- LANL contractor and subcontractor employment;
- Potential employment from business using additional conveyed land (previously discussed in the *TA-21 Conveyance and Transfer EIS* [DOE 1999d]); and
- Private enterprises located on and adjacent to the DP Mesa.

Both the TA-21 Complete DD&D Option and the Compliance Support Option would remove most of the office space that these organizations currently use. However, since the programs and functions would still be required after the DD&D of TA-21, the majority of the personnel would be relocated to other buildings owned or leased by LANL, with little resulting effect to overall

LANL employment. The 30 personnel who support TA-21 tritium operations would be relocated regardless of the TA-21 DD&D option.

Any employment from DD&D activities would be modest and temporary, with a maximum onsite DD&D workforce of fewer than 100 workers. Additionally, LANL has an ongoing program to remove excess facilities; the intermittent DD&D activity at the DP West Site over the last several years was funded and managed as part of this program. Although the DD&D of TA-21 would require DD&D workers at TA-21, this would not necessarily increase the overall number of DD&D workers. Any DD&D funding not used for TA-21 buildings would be available for DD&D projects in other TAs. The impacts of TA-21 DD&D would not directly translate into increases or decreases in overall DD&D employment.

Several of the tracts at the western end of TA-21 adjacent to the land on DP Road currently in commercial use have been (or are anticipated to be) conveyed to Los Alamos County. These tracts provide undeveloped areas close to the Los Alamos townsite available for future development unencumbered by the issues associated with "brownfield" areas. Current plans allow for the possibility that portions of the largest tract (TA-21-2/A-16), which contains the DP East and DP West and most of the TA-21 areas, may be made available for industrial use after remediation. Given the current level of planning detail for both the DD&D and remediation approach and the remediation schedule showing completion of corrective actions within the Los Alamos and Pueblo watershed by August 2011, the socioeconomic impacts from associated future development cannot be accurately predicted and would likely occur after 2011.

Private businesses located on the DP Mesa and adjacent to DP Road could incur modest but not irreparable impacts from the TA-21 DD&D. Waste disposal DD&D activities would result in an average of fewer than 10 one-way trips (and 10 empty return trips) per day between 2006 and 2011 on DP Road and onto NM 502. This would not be a significant increase in traffic compared to current operations on either of these roads. The DD&D of contaminated facilities would take place at least 500 yards (457 meters) from the businesses, sufficient distance to mitigate any fugitive dust or project infrastructure impacts.

Infrastructure

Major utility infrastructure (electric power, natural gas, and water) is available at TA-21 to provide service to existing facilities. The TA-21 steam plant (TA-21-0357) is the central utility plant for DP Mesa facilities and a major consumer of utility resources, particularly natural gas to fire its three boilers as well as water for makeup and cooling. As such, it is the only TA-21 facility for which utility demands are specifically monitored (LANL 2003c, 2006a). The cessation of activities within TA-21 and the DD&D of TA-21 buildings and structures would include the removal or abandonment of existing utility corridors that serve the affected facilities. TA-21 steam plant operations have most recently required approximately 200 megawatt-hours of electricity, 27,000 decatherms (equivalent to about 27 million cubic feet [0.76 million cubic meters]) of natural gas, and 1.6 million gallons (6.1 million liters) of water annually (LANL 2006a).

DD&D Impacts—Activities associated with DD&D of all TA-21 facilities are expected to require 43,000 gallons (163,000 liters) of liquid fuels and 1.3 million gallons (4.9 million liters) of water. DD&D activities would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure are expected to be minor on an annualized basis. Standard practice dictates that utility systems serving individual facilities are shut down as they are no longer needed. As DD&D activities progress, interior spaces, including associated equipment, piping, and wiring, would be removed prior to final demolition. Thus, existing utility infrastructure would be used to the extent possible and would then be supplemented or replaced by portable equipment and facilities as DD&D activities proceed, as previously discussed for construction activities.

Waste Management

LANL tracks its waste generation by "Key Facility" in the following categories: transuranic (including mixed transuranic), low-level radioactive waste, mixed low-level radioactive waste, and a category of chemical waste that includes hazardous and toxic waste and construction and demolition debris. Historical chemical and radioactive waste generation information is provided in **Table H–11** for TA-21.

Table H–11 Waste Generation Ranges and Annual Average Generation Rates from Technical Area 21 Facilities

		Tritium Facilities (annual rates)	*TA-21 Building 3 and Building 4 South Project, (1992-1995)*
Low-level Radioactive Waste (cubic yards)	Range	0 to 143	Not applicable
	Average	69	3,360
Mixed Low-level Radioactive Waste (cubic yards)	Range	0 to 2	Not applicable
	Average	0.9	Not applicable
Chemical Waste (pounds)	Range	20 to 11,390	Not applicable
	Average	2,483	1,790
Liquid Waste from TA-21-0257 (gallons)	Range	6,600 to 121,000	Not applicable
	Average	32,000	Not applicable

TA = technical area.
Notes: To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.78533.
Sources: LANL 1995, 2003d, 2004c, 2005d, 2006f.

Due to its limited activity, TA-21 has generated relatively little operational waste over the past 5 years. The DP East buildings are considered part of the Tritium Key Facilities, as are the Weapons Engineering Tritium Facility and other facilities in TA-16. While the quantity of waste shown for the Tritium Facilities in Table H–11 is conservative because it includes contributions from both TA-16 and TA-21, it provides an indication of the waste types and a bounding limit on waste quantities. Sanitary (solid) waste, and uncontaminated construction and demolition debris generated at TA-21 was disposed of at the Los Alamos County Landfill. Recent environmental restoration activities in TA-21 have included investigation and source removal actions. For example, a corrective action at MDA V in 2006 resulted in removal of a large volume of waste. The only reported waste was 10.5 cubic yards (8 cubic meters) resulting from a removal action and site restoration conducted at Solid Waste Management Unit 21-024(f) (LANL 2004c). The wastes generated by the DD&D project to remove the south portions of Building 21-3 and Building 21-4 in the 1990s is shown in Table H–11 as an example of quantities and types of waste generated during a previous small DD&D project. The area of the buildings removed as part of this project represents between 6 percent and 9 percent of the area of the facilities that currently remain at TA-21.

Liquid sanitary wastes generated from all TA-21 facilities are treated at the TA-46 Sanitary Wastewater Systems Plant. Building 21-257, which has historically treated all liquid radioactive wastes generated by the DP West and DP East process facilities, is currently being maintained in a standby condition to allow pretreatment of any liquid radioactive wastes that would be generated from the deactivated facilities. After deactivation is complete, such waste is expected to be minimal, and it is unlikely that any DD&D-generated liquids would require processing in Building 21-257. Table H–11 provides the range and average liquid radioactive waste volumes pretreated at Building 21-257.

DD&D Impacts—The DD&D of TA-21 buildings and structures would generate a substantial volume of waste, and a principal project effort would be characterizing, packaging, handling, and disposing of waste materials. Initial planning efforts for the DP Site DD&D project have developed preliminary waste estimates. Dimensions of existing building components along with projections of contamination levels and packaging efficiencies were used to estimate waste volumes by waste type. As additional characterization data and planning information becomes available these estimates would be updated to refine the waste types and quantities, determine container types and quantities, and estimate levels of waste radioactivity. The waste estimate values for both of the TA-21 DD&D action options are provided in **Table H–12**.

Table H–12 Waste Generation under the Proposed Action and Compliance Response Alternatives

	Tritium Facilities (nominal average yearly generation)	*TA-21 Complete DD&D Option*	*Compliance Support Option*
Low-level Radioactive Waste	69 cubic yards	34,000 cubic yards	34,000 cubic yards
Bulk Low-level Radioactive Waste [a]	Not available	26,000 cubic yards	26,000 cubic yards
Packaged Low-level Radioactive Waste [a]	Not available	8,600 cubic yards	8,600 cubic yards
Mixed Low-level Radioactive Waste (RCRA/TSCA constituents; not radioactive asbestos is considered low-level waste)	0.9 cubic yards	65 cubic yards	65 cubic yards
Transuranic Waste [b]	0.0	1.3 cubic yards	1.3 cubic yards
Solid Waste (nonradioactive construction debris and sanitary waste)	Not available	47,000 cubic yards	18,000 cubic yards
Chemical Waste (asbestos and hazardous)	1.2 cubic yards	420 cubic yards	420 cubic yards
Liquid Waste Pretreated at TA-21-0257	32,000 gallons	8,000 gallons	5,700 gallons

TA = technical area; DD&D = decontamination, decommissioning, and demolition; RCRA = Resource Conservation and Recovery Act; TSCA = Toxic Substances Control Act.

[a] The low-level radioactive waste total has been subdivided into "bulk" and "packaged" components. The bulk waste is typically lower-activity radioactive building debris transported in intermodal containers and lift liners. The packaged waste is typically the higher-activity (>10 nanocuries per gram) materials and equipment packaged in "Type A" containers.

[b] Includes transuranic and mixed transuranic waste; all of the TA-21 transuranic waste would be "contact-handled" with no generation of transuranic "remote handled" waste.

Notes: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.78533. All numbers rounded to two significant figures.

DOE has developed extensive liquid and solid waste management infrastructures at LANL with capabilities to characterize, process, package, store, and manage all of the waste types that would be generated during the DD&D of TA-21. NNSA has the capability to treat and dispose of some wastes onsite but in other cases uses permitted offsite facilities for treatment and disposal. The two largest-volume waste types expected to be generated by the DD&D of TA-21 are solid low-level radioactive waste and nonradioactive construction debris. NNSA plans on using a combination of onsite disposal and offsite disposal to disposition low-level radioactive waste to minimize the impact of the large volume of DD&D waste that this project, and other projects would generate.

The Los Alamos County Landfill is expected to cease operations in fall 2008. A new transfer station, operated by the County, will be used to sort and ship sanitary waste and uncontaminated debris to a landfill or recycling facilities outside the county. NNSA would also recycle as much of these materials as possible. Debris concrete may be crushed and used as fill material in lieu of importing clean fill soil and uncontaminated metal may be recycled as scrap. For the purposes of the analysis, Table H–12 conservatively assumes all of the debris is disposed of as waste.

All other wastes expected to be generated by the DD&D activities would be handled, managed, packaged, and disposed of in the same manner as the same wastes generated by other activities at LANL. Piping and other materials that are characterized as transuranic waste would be packaged in accordance with WIPP Waste Acceptance Criteria and the appropriate LANL procedures, transferred to Area G for storage, and ultimately shipped to the WIPP near Carlsbad, New Mexico. Any radioactive materials that are characterized as mixed low-level radioactive waste may be stored onsite at Area TA-54 pending identification of an offsite treatment and disposal facility. Most mixed low-level radioactive waste generated at LANL is sent offsite to other DOE or commercial facilities for treatment and disposal.

Asbestos contaminated with radioactive material could be disposed of in a disposal cell in Area G that is dedicated to the disposal of radioactively contaminated asbestos waste or alternatively packaged and disposed of offsite according to the receiving facility waste acceptance criteria. Asbestos waste that is not radioactively contaminated that is generated during the DD&D activities would be packaged according to applicable requirements and sent to the LANL asbestos transfer station for shipment offsite to a permitted asbestos disposal facility along with other asbestos waste generated at LANL.

Any hazardous waste generated during the TA-21 DD&D activities would be handled, packaged, and disposed of according to LANL's hazardous waste management program. These amounts are expected to be small and would be well within the capacity of LANL's hazardous waste management and disposal program.

Radioactive liquid waste would be transferred to the Radioactive Liquid Waste Treatment Facility in TA-50 at LANL for treatment. The liquid waste from the DD&D activities for TA-21 would be within the treatment and disposal capacity of the Radioactive Liquid Waste Treatment Facility. No effect on the Radioactive Liquid Waste Treatment Facility is anticipated.

The major difference between the TA-21 DD&D options is that the solid debris in the TA-21 Complete DD&D Option is about three times of the solid debris waste in the Compliance

Support Option due to the fewer buildings demolished. The asbestos waste would probably also be higher for complete DD&D; however, without characterization data on the buildings it is unclear which of the additional buildings would be expected to contain asbestos. The availability of asbestos removal contractors and asbestos disposal locations should not become a constraint.

Transportation

Several types of transportation impacts result from current TA-21 activities: automobile traffic on and off of the LANL facility, and truck traffic, particularly associated with maintenance and logistics activities. These vehicles need to pass through the Los Alamos townsite to reach other LANL TAs. This level of activity is consistent with an operating facility environment. There has historically been intermittent truck traffic associated with waste from DD&D of facilities at DP West.

DD&D Impacts—There are several types of temporary and permanent transportation impacts that could result from alternatives at TA-21. These include changes in automobile traffic patterns on and off of the LANL facility and changes in truck traffic patterns, particularly for transporting waste. While there might be minor changes in traffic patterns between options based on changes in number and locations of jobs and temporary increases in DD&D activities, the impact of a few hundred workers would be minor within the total LANL workforce.

Local traffic resulting from TA-21 DD&D activities, including worker commutes, equipment movement, and waste transportation, should not be appreciably greater than that which occurred during past operations. When combined with the traffic from concurrent remediation activities, the cumulative traffic would not result in local traffic exceeding normal volume for commercial areas, although there might be some intermittent periods of traffic congestion. The number of DD&D workers at TA-21 likely would be less than the current TA-21 staff. While the remediation option under the Consent Order for TA-21 has yet to be determined, even the most extensive remediation option would be less than 500 workers. The construction equipment may be staged at TA-21, so its movement along public roads would be mostly during project mobilization and demobilization. The traffic impacts from waste transportation would vary from about 1,000 to 1,500 trips per year from 2006 to 2010, an average of less than 20 one-way trips per day. Even remediation options that would result in several times greater truck traffic would still be consistent with acceptable commercial area traffic levels.

The effects from incident-free transportation of DD&D wastes under both the offsite disposal and onsite disposal options, for the worker population and the general public are presented in **Table H–13**. The effects are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that maybe attributable to the proposed project that are estimated to occur in the exposed population over the lifetime of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risk for development of excess LCFs is highest for workers under the offsite disposition option because of the duration of exposure during transport.

Table H–13 Incident-Free Transportation Impacts – Technical Area 21 Decontamination, Decommissioning, and Demolition

Disposal Option	*Low-level Radioactive Waste Disposal Location* [a]	*Crew*		*Public*	
		Collective Dose (person-rem)	*Risk (LCFs)*	*Collective Dose (person-rem)*	*Risk (LCFs)*
Onsite Disposal	LANL TA-54	0.30	0.0002	0.06	0.00004
Offsite Disposal	Nevada Test Site	9.27	0.006	2.69	0.002
	Commercial Facility	8.98	0.005	2.62	0.002

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes are disposed of at WIPP.

The traffic accident impacts from transportation of DD&D wastes for both offsite disposal and onsite disposal are presented in **Table H–14** as traffic accidents, population dose due to accidental release of radioactivity, and fatalities due to traffic accidents from both the collisions and excess LCFs. The analysis assumed that all generated nonradiological wastes would be transported to offsite disposal facilities.

Table H–13 and Table H–14 indicate that no excess fatal cancers or fatalities would likely occur from DD&D activities in TA-21.

Table H–14 Transportation Accident Impacts – Technical Area 21 Decontamination, Decommissioning, and Demolition

Low-level Radioactive Waste Disposal Location [a, b]	*Number of Shipments* [c]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL TA-54	4,742	1.19	1.7×10^{-11}	0.014
Nevada Test Site	4,742	6.33	2.8×10^{-7}	0.065
Commercial Facility	4,742	5.80	2.1×10^{-7}	0.060

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported offsite
[b] Transuranic wastes are disposed of at WIPP.
[c] Only 22 percent of shipments are radioactive wastes, others include 77.5 percent for industrial and sanitary waste, and about 0.05 percent asbestos and hazardous wastes.

H.2.3.3 Compliance Support Option – Decontamination, Decommissioning, and Demolition to Support the Consent Order Activities

Land Resources

Land Use

Following DD&D of selected buildings and structures within TA-21, the site (except parcel A-15-1 which has been transferred to Los Alamos County) would remain under the control of DOE. Any potential development would have to address structure reuse or DD&D. Land use designations would remain unchanged.

Visual Environment

The more limited DD&D activities of this option would have short-term adverse impacts on visual resources due to the presence of heavy equipment and an increase in dust. Since many buildings would remain within TA-21, only limited areas would be contoured and revegetated. Although some of the larger buildings would be removed, the view of the TA from NM 502 and from higher elevations to the west would still include portions of the current mix of 50-year old structures.

Geology and Soils

Under all options, the impact of a seismic event has been reduced by the deactivation of the DP East facilities and removal of a majority of the source material present. Since no new facilities would be constructed under the Compliance Support Option, there would be no new potential seismic impact.

The Compliance Support Option would have a minor impact on the geologic and soils resources at LANL as the affected facility areas are already developed and adjacent soils are already disturbed. The DD&D activities would introduce some additional ground disturbance in excavating foundations and establishing laydown yards and waste management areas near the facilities to be demolished. However, the impacts would be temporary and available paved surfaces, such as adjacent parking lots, would be used to mitigate any impact. The degree of soil disturbance from the Compliance Support Option is expected to be much smaller than that resulting from major remediation activities under the Consent Order. The primary indirect impact would be associated with the need to excavate any contaminated tuff and soil not addressed by the Consent Order from beneath and around facility foundations. Borrow material (such as crushed tuff and soil) would be required to fill the excavations to grade. Such resources are available from onsite borrow areas (see Section 5.2).

Water Resources

Similar to the No Action Option, the Compliance Support Option would have a negligible impact on water resources, due to the elimination of the Tritium Science and Fabrication Facility outfall, which discharges less than three percent of the effluent in Los Alamos Canyon. The impact on water resources for dust suppression and decontamination is similar but less extensive in this option than in the TA-21 Complete DD&D Option; no significant effect on water resources is anticipated. The option would not result in the disturbance of watercourses or generation of liquid effluents that would be released to the surrounding environment. Relocation of office personnel would be minimal in comparison to complete DD&D, and best management practices would be used to control stormwater runoff and water used for dust suppression.

Air Quality and Noise

Air Quality

Nonradioactive Emissions. In the Compliance Support Option, similar to the TA-21 Complete DD&D Option, the operational emission sources would be relocated or cease as the activities are relocated and the buildings demolished. There would be temporary increases in vehicle exhaust and fugitive dust during the actual building demolition. Initially, air emissions from TA-21 would be similar to the current emissions. The emissions from the laboratory use of various toxic chemicals should be eliminated as the process buildings are placed into surveillance and maintenance status and subsequently demolished. However, the nonradioactive air pollutant emissions from the three natural gas-fired boilers in Building 21-0357 and the vehicle exhaust and emissions from activities in the maintenance facilities operated by the LANL maintenance contractor would remain.

Similar to the TA-21 Complete DD&D Option, the DD&D of the buildings and structures would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. The relative quantities of the solid waste may be used to estimate the magnitude of demolition and hence the potential for dust generation. The Compliance Support Option would be expected to generate on the order of 78 percent as much dust as the TA-21 Complete DD&D Option.

Radioactive Emissions. The Compliance Support Option would have radiological emissions quantitatively similar to those of the TA-21 Complete DD&D Option, since all of the identified contaminated structures are within the scope of each option. Radiological emissions during surveillance and maintenance and initial DD&D would result from the exhaust of building or temporary ventilation systems used for dust and contamination control. Structural surfaces would be either decontaminated to unconditional release levels or with selected contaminated surfaces stabilized to permit segregation of radioactively contaminated and uncontaminated debris after demolition. Small quantities of radioactivity associated with the dust emissions would result from demolition activities. The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during demolition of facilities. Release of radioactivity would be minimized by proper decontamination of buildings prior to demolition. Such emissions are typically of short duration and are monitored and addressed in regulatory documents. Doses to the public and workers are discussed in the section on human health.

Noise

Noise levels during demolition activities for both the Compliance Support Option and the TA-21 Complete DD&D Option would be consistent with those typical of construction activities. Impacts on the public and wildlife would be similar as well.

Ecological Resources

As in the TA-21 Complete DD&D Option, wildlife in canyons adjacent to TA-21 would be intermittently disturbed by construction activity and noise over the demolition period; however the impacts would be smaller and confined to more localized areas. The revegetation following the DD&D of buildings and structures within TA-21 would be more localized as would the redevelopment impact on wildlife. However, the impact from environmental restoration activities would be similar between options, and possibly larger than that of facility DD&D. The determination made in the DOE biological assessment for the Complete DD&D Option as it relates to the Mexican spotted owl, bald eagle, and southwestern willow flycatcher, and concurred with by the U.S. Fish and Wildlife Service, would also be applicable to this option (see Section H.2.3.2).

Since there are no wetlands in TA-21, DD&D activities would not affect this resource. One of the two NPDES-permitted outfalls associated with TA-21 operations would be eliminated, and the quantity of surface water discharged to the adjacent canyons from the Steam Plant outfall should be reduced from the present levels as a result of the relocation of tritium operations.

Human Health

The Compliance Support Option includes the DD&D of the buildings and structures at TA-21 necessary to support the environmental remediation activities. The primary human health impacts from the Compliance Support Option are those to the public due to radiological emissions and worker health and safety. Precautions taken to assure the protection of workers from industrial hygiene hazards (for example, asbestos removal) would ensure there would be minimal chemical or asbestos emission that could impact the public.

Public Health. The radiological emissions from the TA-21 facilities under the Compliance Support Option, as in the TA-21 Complete DD&D Option, include continued emissions from surveillance and maintenance buildings until in-building DD&D activities are complete and the short-term emissions that result from residual contamination becoming airborne during structural demolition. Since the identities of the radiological facilities and the methods and schedule to DD&D those facilities is similar to complete DD&D, the dose to the public should be bounded.

Worker Health. The principal impacts on worker health under the Compliance Support Option are similar to those in the TA-21 Complete DD&D Option. The impacts result from the radiation dose workers receive during the execution of DD&D, industrial hygiene impacts due to exposure to asbestos and hazardous materials, and industrial accidents similar to those associated with routine construction. As discussed above in reference to the public dose, since the DD&D facilities and methods are similar between options, the radiological dose received by the DD&D workers should also be similar.

The demolition of the above buildings might also involve the removal of some asbestos contaminated material. Additional industrial hygiene hazards and hazards from routine construction accidents occur in facilities in which there is no radioactive contamination; however, nonradiological facilities may allow greater use of large construction equipment, resulting in less direct worker contact with hazardous locations. The smaller number of facilities subject to DD&D under the Compliance Support Option suggests that the worker exposure to industrial and construction hazards would be reduced from those expected in the TA-21 Complete DD&D Option. Construction accidents and fatalities would be bounded by the values identified in the TA-21 Complete DD&D Option.

Cultural Resources

The DD&D of buildings and structures under the Compliance Support Option would not affect the five National Register of Historic Places-eligible archaeological sites at TA-21 but would have direct effects on 15 National Register of Historic Places-eligible historic buildings and structures that are associated with the Manhattan Project and Cold War years at LANL. Documentation measures would be implemented to reduce adverse effects to National Register of Historic Places-eligible properties at LANL and Memorandum of Agreement terms negotiated.

This would also apply to the requirements for historic preservation defined in 36 CFR Part 800 during the transfer of land under Public Law 105-119.

Socioeconomics and Infrastructure

Implementation of the Compliance Support Option would result in a substantial reduction in utility demands in TA-21 as major operational and support activities, such as the Tritium Science and Fabrication Facility, would be eliminated as under the Complete DD&D Option. However, the TA-21 steam plant would not be demolished and may still operate at least on an interim basis, but at substantially reduced levels and with comparable reductions in electric power, natural gas, and water consumption.

Fewer buildings would be fully demolished under this option. Therefore, utility demands for DD&D activities would be less than for the Complete DD&D option.

Socioeconomics

The principle impacts of the Compliance Support Option would not change from the TA-21 Complete DD&D Option. This is largely due to the removal of office space that is currently used. These programs and their functions would be relocated to other available buildings that are owned or leased by DOE, with little effects to the overall LANL personnel, since the programs are still required.

Waste Management

For the Compliance Support Option, as for the TA-21 Complete DD&D Option, the waste types and quantities generated by removal of the structures would be within the capacity of existing waste management systems, and would not by themselves result in substantial impact to existing waste disposal operations. The waste types and volumes expected to be generated during the Compliance Support Option DD&D activities under the two disposal alternatives are summarized in Table H–12.

The Compliance Support Option would generate about 60 percent less solid debris than the TA-21 Complete DD&D Option because it demolishes fewer buildings. The asbestos waste would probably also be lower in the Compliance Support Option.

Transportation

As in the TA-21 Complete DD&D Option, the wastes generated during the DD&D activities would need to be transported to storage or disposal sites. These sites could be either at LANL or at an offsite location, although the impacts to the public are larger when wastes are shipped for offsite disposal. The largest categories of waste that would be generated from DD&D activities are low-level radioactive waste and solid sanitary waste or debris. Solid sanitary waste or debris may often be recycled as fill on the LANL site, reducing the actual waste quantity; solid waste that cannot be recycled can be disposed of at a New Mexico Subtitle D landfill. Possible offsite low-level radioactive waste disposal sites, in contrast, are located at the Nevada Test Site and a commercial facility in Utah.

Since the quantities of radioactive waste are similar between the Compliance Support Option and the TA-21 Complete DD&D Option, the risks to the public from both radiation dose and traffic accidents as shown in Table H–13 and Table H–14 are assumed to be the same. The tables address both the option for disposal of low-level radioactive and sanitary waste at onsite and offsite disposal facilities. The only difference in the impacts between the TA-21 Complete DD&D Option and the Compliance Support Option is a slightly reduced risk of accidents due to the reduced number of truck trips to the sanitary waste disposal facility. The radiological impacts would be identical.

H.3 Waste Management Facilities Transition Impacts Assessment

Section H.3 provides an assessment of environmental impacts for alternatives to the management of solid low-level radioactive waste, mixed low-level radioactive waste, hazardous and chemical waste, and transuranic waste that take into consideration the closure of TA-54 Area L and MDA L, and TA-54 Area G and MDA G. In this appendix, closure of Area G refers to closure of the existing 63-acre portion of Area G shown in Appendix I, Figure I–15. Disposal operations at Area G will be expanded to Zones 4 and 6 of Area G (64 FR 50797). Closure of these areas is required by DOE Order 435.1 with corrective actions for certain units specified by the Consent Order (NMED 2005a) that was entered into by DOE, the University of California as the management and operating contractor, and the State of New Mexico, in March 2005. More detailed information regarding the Consent Order is presented in Chapter 2, Section 2.2.6. Section H.3.1 provides background information for the actions needed to remove, replace and re-locate existing facilities that are used to store and process these solid waste streams, as well as the purpose and need. Section H.3.2 provides a brief description of the No Action Option and other proposed options. Section H.3.3 describes the affected environment and environmental impacts at the LANL technical areas associated with the options (TA-50, TA-54, and TA-63). Chapter 4 of this SWEIS presents a description of the overall affected environment at LANL. Any unique characteristics of these TAs and LANL not covered in Chapter 4 that would be affected by the proposed transition of waste management facilities are presented here.

H.3.1 Introduction and Purpose and Need for Agency Action

TA-54 provides storage, processing and disposal capabilities for mixed low-level radioactive waste (Area L), chemical and hazardous waste (Areas J and L), low-level radioactive waste (Area G), and transuranic waste (Area G) that are generated by LANL programs. Due to the schedule for pending corrective actions at MDA L and MDA G per the requirements of the Consent Order, the following would need to occur by the end of 2015 and require NEPA analysis:

- Low-level radioactive waste support facilities currently located in Area G would need to undergo DD&D and be moved or replaced so that low-level radioactive waste disposal operations can continue at LANL.

- Applicable mixed low-level radioactive waste storage structures and hazardous and chemical waste storage structures and operations in Area L that would otherwise prevent closure of subsurface units in Area L and MDA L would need to be closed and relocated.

- Transuranic waste[4] retrievably stored in Area G would need to be retrieved, processed, and shipped for final disposal at WIPP. This action would require the relocation and addition of processing capabilities for preparing transuranic waste for shipment, addition of retrieval capabilities for remote-handled transuranic waste, and the construction and operation of a TRU (Transuranic) Waste Facility (previously called the Transuranic Waste Consolidation Facility) in a location other than Area G to process newly-generated waste.

Background

This section provides an overview of how low-level radioactive waste, mixed low-level radioactive waste, hazardous and chemical waste, and transuranic waste are currently managed. Some of these actions have been analyzed for environmental impacts in prior NEPA documentation, while other options need to be analyzed in this SWEIS. The overview of waste management practices that impact closure activities is divided into a discussion of legacy wastes, newly-generated wastes, and stored sealed-sources.

Legacy Waste. Legacy waste is waste that has been generated by past operations and has been in storage for many years. Mixed low-level radioactive legacy waste and hazardous and chemical legacy wastes are only temporarily stored in Area L for processing and shipment to offsite disposal facilities; therefore, the discussion of legacy waste in this appendix is specific to transuranic waste in Area G.

Legacy transuranic waste[5] is stored in fabric domes, trenches, pits and shafts at MDA G. NNSA expects to characterize and prepare about 379,000 cubic feet (10,700 cubic meters) of legacy contact-handled transuranic waste for shipment. About 296,650 cubic feet (8,400 cubic meters) of this waste is stored in above-ground storage units and about 82,500 cubic feet (2,340 cubic meters) is stored in subsurface storage units. Contact-handled transuranic waste is currently stored in the fabric domes, Trenches A-D, Pit 9, corrugated metal pipes on top of Pit 29, and Shafts 262-266. About 4,600 cubic feet (130 cubic meters) of remote-handled transuranic waste is stored in 55 shafts at Area G (LANL 2005c).

Some of the contact-handled transuranic waste in the fabric domes is currently being prepared for shipment to WIPP through the "Quick-to-WIPP" Program. In this program, approximately 2,000 high-wattage drums have been prioritized for accelerated characterization, certification, and shipment as they contain almost 60 percent of the radioactive material-at-risk at Area G (LANL 2005c).

Facilities that currently support the processing and shipment of contact-handled transuranic waste to WIPP include the following:

[4] *The term transuranic waste as used in Section H.3 includes mixed transuranic waste.*

[5] *Waste identified as legacy transuranic waste was originally placed into storage under the assumption that it met the definition of transuranic waste applicable at the time. All of this waste will be re-characterized to determine whether it meets the current definition of transuranic waste. It will be disposed of as transuranic waste or low-level radioactive waste based on the new characterization.*

- The Decontamination and Volume Reduction System. This system is located in Building 412 at Area G and provides processing capabilities to decontaminate large-sized storage packages and reduce the size of transuranic waste.

- Waste Characterization, Reduction, and Repackaging Facility. Located in TA-50, this facility receives waste transported by truck from Area G to be characterized (including equilibration and headspace gas analysis) and repackaged in a form suitable for eventual packaging into TRUPACT II containers. The repackaged containers are then transported by truck back to Area G for storage until shipment to WIPP (NNSA 2003).

- Radioassay and Nondestructive Testing Facility. Located in the western part of TA-54 (TA-54 West), this facility receives transuranic waste containers sent from Area G for configuring into payloads and loading into TRUPACT II containers, and shipping to WIPP (NNSA 2003).

To accelerate the processing of contact-handled transuranic waste from the fabric domes, DOE plans to install and operate three modular units at Area G perform waste characterization, reduction, and repackaging. The net result is that 16 drums could be readied for shipment to WIPP in the same time that current operations at TA-50 can produce only one drum for shipment (DOE 2002d).

Transuranic waste in below-ground storage is found in the following locations (LANL 2005c):

- Trenches A-D. These trenches contain approximately 11,850 cubic feet (335 cubic meters) of contact-handled transuranic waste packaged within 30-gallon (114 liter) metal drums placed within concrete lined casks.

- Pit 9. This pit contains approximately 55,100 cubic feet (1,560 cubic meters) of contact-handled transuranic waste packaged within 30-, 55-, and 85-gallon (114-, 208-, 322-liter, respectively) drums and fiberglass-reinforced plywood boxes.

- Corrugated metal pipes on Pit 29. 158 corrugated metal pipes contain approximately 15,600 cubic feet (442 cubic meters) of contact-handled transuranic waste consisting of concreted wastewater treatment sludge.

- Shafts 262-266. These shafts contain approximately 247 cubic feet (7 cubic meters) of tritium-contaminated contact-handled transuranic waste. Each shaft contains a single stainless steel containment vessel designed for this waste.

- Shafts 302-306. These shafts contain approximately 1,800 cubic feet (51 cubic meters) of remote-handled transuranic waste consisting of hot cell liner boxes (decommissioned gloveboxes from LANL hot cells). The gloveboxes are packaged in steel boxes.

- Shafts 235-243 and 246-253. Each of these shafts contains a single 35 cubic foot (1 cubic meter) canister of remote-handled transuranic waste. Twelve of the canisters contain 1.5-gallon (6-liter) cans of waste packaged into 55-gallon (208-liter) drums, while the remaining five canisters contain large debris items and hardware in 55-gallon (208-liter) drums.

- Shafts 200-232. These shafts contain the highest activity remote-handled transuranic waste. There are approximately 950 cubic feet (27 cubic meters) of remote-handled transuranic waste consisting of hot cell debris packaged into one-gallon (4-liter) cans that were placed into the shafts. The waste in these shafts would be the most difficult to retrieve because of the high activity and the configuration of the cans.

Structures and processes for shipping contact-handled transuranic waste stored in the above-ground fabric domes to WIPP have been analyzed through the NEPA process in the *1999 SWEIS* (DOE 1999a) and related Supplement Analysis (DOE 2002d) and the Environmental Assessment prepared for the Decontamination and Volume Reduction System (DOE 1999b); the impacts of the retrieval and processing of transuranic waste in below-ground storage are addressed in this SWEIS.

Newly-Generated Waste. Newly-generated waste is waste that has been generated since October 1998. Newly generated waste considered in this appendix primarily addresses hazardous and chemical waste and mixed low-level radioactive waste operations currently in Area L, and low-level radioactive waste and transuranic waste operations currently in Area G.

- *Transuranic Waste*—Transuranic waste continues to be generated as LANL carries out its research and production missions. NNSA would continue to store and process newly-generated transuranic waste using the processes described for dispositioning legacy wastes.

- *Low-level Radioactive Waste*—The *1999 SWEIS* analyzed the expansion of low-level radioactive waste disposal operations from currently operational portions of Area G to Zones 4 and 6 of TA-54. Zone 4 is located adjacent to, and west of, the current operational portion of Area G. An access control and monitoring building, a characterization and verification building, and a compactor located in Area G currently support these operations.

- *Mixed Low-level Radioactive Waste and Hazardous and Chemical Waste*—Storage structures are currently located in Area L for storage of mixed low-level radioactive waste and hazardous and chemical waste until this waste is shipped offsite for treatment and disposal. NNSA would continue to generate mixed low-level radioactive waste and hazardous and chemical waste.

- *Stored Sealed Sources*—A number of excess and unwanted sealed sources that, for reasons of public safety, have been collected by NNSA's Off-Site Source Recovery Project (see Appendix J, Section J.3) are stored within Area G. The sealed sources contain actinides and other radionuclides. Some of the stored sources are eligible for disposal as transuranic waste at WIPP, some may be disposed of as low-level radioactive waste at DOE facilities, and some may be disposed of pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). Capability for continued storage of some sealed sources may be needed after 2015.

Purpose and Need

The mission of LANL is to help ensure the safety and reliability of the nuclear weapons in the United States stockpile, prevent the spread of weapons of mass destruction and to protect the Nation from terrorist attacks (LANL 2005f). Activities associated with accomplishing these missions generate solid wastes that include low-level radioactive waste, mixed low-level radioactive waste, hazardous and chemical wastes, and transuranic waste. Facilities that are necessary to manage these waste streams encompass transportation, storage, processing and disposal. Most of these waste management operations are located in TA-54 Area L and Area G, where operations have been conducted since 1959 and 1957, respectively (LANL 2005c).

Operations in Area L currently involve storage of mixed low-level radioactive waste and hazardous and chemical wastes in container storage units, which are subject to RCRA permit or interim status requirements. Past operations include the subsurface disposal of non-radioactive liquid chemical waste in pits, shafts and impoundments. Operations in Area G currently consist of processing and disposal of low-level radioactive waste, storage of transuranic waste in above-ground fabric domes and below-ground trenches, pits and shafts, processing of the transuranic waste stored in the fabric domes, and shipment of this waste to a disposal site.

Some of the burial areas in Area L and Area G are subject to corrective action under the Consent Order, and some are disposal units subject to Resource Conservation and Recovery Act closure and post-closure care requirements. The current schedule for the Consent Order requires DOE submit remedy completion reports to the New Mexico Environment Department by July 9, 2011, for MDA L and by December 6, 2015, for MDA G (NMED 2005a, LANL 2005c, 2006a). The New Mexico Environment Department intends to simultaneously issue two hazardous waste permits that will include closure and post-closure requirements; one for active storage and treatment units and the second for interim status disposal units that are no longer active (NMED 2005b).

In Area L, NNSA needs to remove several container storage units for storage of mixed low-level radioactive waste and chemical and hazardous waste so that closure activities can be completed. LANL needs to determine the impacts associated with removing these container storage units and consolidating storage operations in Area L or other locations at LANL.

In Area G, NNSA needs to complete or move all storage operations and processing of transuranic waste for shipment to WIPP for disposal so that closure activities can be completed in compliance with the Consent Order. Impacts from processing and shipping transuranic waste currently stored in the fabric domes are analyzed in the *1999 SWEIS* and the 2002 *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Transuranic Waste Characterization at Los Alamos National Laboratory* (DOE 2002d). The impacts of retrieval and processing of the transuranic waste stored below-ground in trenches, pits and shafts, are analyzed in this SWEIS so that a preferred option can be selected. In addition, inspection, characterization and verification, and repackaging facilities and equipment are needed to accelerate the processing and shipment of transuranic waste stored above-ground, and to address the management of newly-generated transuranic waste once operations in Area G cease. A new facility is needed to store, process and disposition newly-generated transuranic waste that would be created in support of LANL's mission after Area G and MDA G are closed. In addition, NNSA needs to remove and replace low-level radioactive waste processing facilities located in Area G to allow closure activities to be completed and to allow continuation of low-level radioactive waste disposal in support of LANL's mission. NNSA may need to transition storage of sealed sources collected under the Off-Site Source Recovery Project to another LANL location.[6]

H.3.2 Options Description

The No Action Option and two other options are considered. The No Action Option is incorporated into the No Action Alternative as presented in Chapter 3. Two other options are presented that are incorporated into the Expanded Operations Alternative – Option 1: Accelerated Actions for Meeting the Consent Order, and Option 2: Interim Actions Necessary for Meeting the Consent Order. One of the latter two options will be selected to facilitate implementation of Consent Order activities.

H.3.2.1 No Action Option

Under the No Action Option operation of existing radiological and nonradiological processes would continue in Areas L and G based on NEPA coverage provided prior to the issuance of this SWEIS[7]. Specifically, the following would occur:

- Contact-handled transuranic waste stored at Area G in fabric domes would be retrieved and processed using existing facilities (Decontamination and Volume Reduction System, Waste Characterization, Reduction, and Repackaging Facility, and Radioassay and Nondestructive Testing Facility), and modular units.

- Transuranic waste stored in below-ground facilities would not be retrieved for processing and eventual shipment to WIPP.

- Newly-generated transuranic waste would continue to be stored, processed and shipped using current facilities in Area G, the modular units, the Waste Characterization, Reduction, and Repackaging Facility, and the Radioassay and Nondestructive Testing Facility.

- Low-level radioactive waste processing facilities and operations (an access and control monitoring building and entrances, a characterization and verification building, a compactor facility and disposal areas) currently located in Area G (including Zone 4) would continue to be used as part of low-level radioactive waste disposal operations.

---

[6] Sealed sources in Area G are principally in Type B containers that are stored in domes. As needed, storage capacity could be transitioned to another LANL location, such as Zone 4 in TA-54 or the proposed TRU Waste Facility. Transition would be preceded by appropriate NEPA review. It is expected that the environmental impacts from storage of sealed sources in another LANL location would be similar to those for storage at Area G.

[7] The No Action Option is included in this appendix consistent with NEPA requirements; however, NNSA intends to comply with the Consent Order. NNSA plans to implement actions necessary to comply with the Consent Order regardless of decisions it makes on other actions analyzed in this SWEIS.

- All structures and processes currently located in Area L would remain with no changes to the footprint or operations.

H.3.2.2 Option 1: Accelerated Actions for Meeting the Consent Order

Under Option 1, NNSA would retrieve, process, and transport for disposal all wastes stored in facilities in Area L and MDA L, and Area G and MDA G, that need to be removed for closure activities; and remove, re-locate, and replace applicable facilities. Specific activities associated with Option 1 are described in Sections H.3.2.2.1 through H.3.2.2.5.

H.3.2.2.1 Remote-Handled Transuranic Waste Retrieval Facility

NNSA would construct and operate a remote-handled transuranic waste retrieval facility at Area G for the sole purpose of retrieving and processing remote-handled transuranic waste from Shafts 200-232, if a decision is made to retrieve some or all of this waste. This facility would provide remote capabilities to retrieve the remote-handled transuranic waste from the shafts.

A RCRA permit modification approval by the New Mexico Environment Department would be needed for the construction of this facility because mixed transuranic waste would be stored at the site. During the permit modification approval process, additional operating and safety procedures may be implemented based upon conditions added by the regulatory agency and from the public comment process.

NNSA would design this facility to Hazard Category 3 or Radiological Facility requirements and construct it in accordance with DOE and LANL standards, contingent upon nuclear safety analyses that would be performed. Construction of the facility would disturb about one-quarter acre (0.1 hectare) with the building taking up approximately 5,000 square feet (464 square meters), or about one-third of the floor space currently used for the Decontamination and Volume Reduction System (LANL 2006a).

The remote-handled transuranic waste retrieval facility would become operational by Fall 2011. It would be closed under the hazardous waste facility permit, and would undergo DD&D by 2015 upon completion of remote-handled transuranic waste removal from Area G. If permitted, the facility cannot undergo DD&D without completing closure by decontamination and removal of all wastes and waste residues. All empty shafts may be subsequently filled with low-level radioactive waste and incorporated into the Area G and MDA G closure.

H.3.2.2.2 TRU Waste Facility

Operations at LANL would continue to generate transuranic waste once Area G and MDA G are closed. LANL programs that currently generate transuranic waste include (Bachmeier 2005):

- Pit manufacturing and stockpile stewardship.
- Mixed oxide fuel research and development.
- Vault disposition programs.

- Plutonium-238 clean-up and stabilization.
- Actinide research and development.
- TA-18 inventory reduction.
- Off-Site Source Recovery Project.

A new TRU Waste Facility would therefore be needed to replace current capabilities at Area G for storing, processing, and shipping newly generated transuranic waste. Based on preconceptual design analysis, the TRU Waste Facility would be sized for a throughput of up to 1,500 drum equivalents per year. This capacity includes large items (such as size-reduced gloveboxes) and an additional contingency capacity of 500 drum equivalents per year to accommodate fluctuations throughout the waste management chain from LANL to WIPP. The facility would be composed of multiple buildings or a combination of buildings and domes, and would provide approximately 30,000 to 40,000 square feet (2,790 to 3,720 square meters) of space. A site of approximately 2.5 to 7 acres (1 to 2.8 hectares) would be required (LANL 2005h).

The facility would accommodate the following functions (LANL 2006a):

- Staging and Storage (10,000 to 15,000 square feet [930 to 1,390 square meters] for storage of up to 1,500 drums of transuranic waste).
- Characterization, certification, and repackaging consisting of approximately 3,000 square feet (280 square meters), either in new buildings or relocated mobile systems.
- Unpackaging, repackaging, decontamination and size reduction consisting of approximately 5,000 square feet (465 square meters), plus approximately 2,500 square feet (230 square meters) for change rooms.
- Utilities and support (including office and technical support space) consisting of approximately 5,000 square feet (465 square meters). The office space is considered optional, and may be satisfied by use of a nearby existing facility.
- Shipping (for example, TRUPACT II loading operations) consisting of approximately 5,000 square feet (465 square meters).

The nuclear portions of the facility (those areas or buildings where drum handling or waste processing occurs) would be designed and constructed to Hazard Category 2 and Performance Category 3 requirements. Other portions of the facility, such as office spaces, would be designed to more conventional standards and would be appropriately separated from nuclear functions. All facilities would be designed and constructed in accordance with applicable requirements and standards.

The TRU Waste Facility would use a Perma-Con® or similar confinement system (NFS 2005) to enclose facility functions. A comparable system for the new facility would include access ports, airlocks, the capability for supplying air to suited workers requiring access to the inner structure, and an overhead crane. Nuclear portions of the facility that require confinement ventilation systems would employ negative pressure and high-efficiency particulate air filtering systems for air treatment. Air would be discharged through a stack following high-efficiency particulate air filtration.

The floor would be constructed as a concrete pad covered with a material such as stainless steel or a sealant for contamination control. The pad would divert any liquids inadvertently introduced to the structure to a sump so that the liquids can be recovered, treated, and appropriately disposed.[8]

The facility would be connected to LANL site water, electricity, phone, and other utilities, and would be equipped with fire suppression, emergency communications, and other safety systems, including continuous air monitors, criticality monitors, fixed air samplers, a surrounding fence and controlled access.

A RCRA permit modification approval by the New Mexico Environment Department would be needed for the construction of this facility because mixed transuranic waste would be stored at the site. During the permit modification approval process, additional operating and safety procedures may be implemented based upon conditions added by the regulatory agency and from the public comment process.

A range of sites for constructing and operating the facility is being considered, with a preliminary site in TA-52 being identified. This site has a number of advantages including the fact that it is relatively close to TA-55, the primary waste generator for transuranic waste. Other sites will be reconsidered if there is reason to reject the location in TA-52 during the conceptual design phase. Because of the possibility that the location for this facility may change, this SWEIS evaluates locations where the facility would most likely be located that encompasses the following TAs in the Pajarito Road corridor: TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63 and TA-66. In addition, some of the functions to be conducted at the proposed TRU Waste Facility may be duplicated in a separate building co-located with the Radioactive Liquid Waste Treatment Facility in TA-50 to specifically treat any transuranic waste from this facility; however, the environmental analysis conducted for the TRU Waste Facility bounds this possibility.

Design of the TRU Waste Facility has begun. A RCRA permit modification request was submitted to the New Mexico Environment Department in 2007 and is pending (LANL 2006a). The facility would have a design life of 30 to 35 years. Facility operations are expected to occur after 2011.

H.3.2.2.3 Other Transuranic Waste Processing Needs

Additional equipment and facilities for accelerating the processing of contact-handled transuranic waste stored at Area G are needed. The additional equipment and facilities include the following (LANL 2005c):

[8] *It is assumed that waste acceptance criteria for the facility would include requirements to limit the quantities of free liquids that might be in received waste.*

- An IQ3 unit to replace the Fixed-Energy Response Function Analysis with Multiple Efficiency system and tomographic gamma scanner unit for performing quantitative assays to segregate low-level radioactive waste from the transuranic waste and determine plutonium isotopic characteristics and other transuranic isotope ratios.

- SuperHENC or multiple purpose crate counter to conduct standard waste box assays.

- An additional Perma-Con® containment system in Dome 224 for visual examinations, prohibited item disposition, and repackaging of drums.

- Mobile visual examination and repackaging for visual examinations, prohibited item disposition, and repackaging of drums.

- Modular repackaging unit for visual examinations, prohibited item disposition, and repackaging of drums.

- Decontamination and Volume Reduction System upgrades to a Hazard Category 2 facility to process oversize crates and fiberglass-reinforced plywood boxes, contingent on nuclear safety analyses to be performed.

- MART washers reinstallation in Dome 33.

- A diamond saw or similar type cutting system in the Decontamination and Volume Reduction System to cut corrugated metal pipe into lengths that can be packaged into standard waste boxes.

- A TRUPACT II loading and shipping area in Area G that would be used to load TRUPACT II containers for shipment to WIPP.

These additional equipment and facilities would allow the replacement of the Waste Characterization, Reduction, and Repackaging Facility and Radioassay and Nondestructive Testing Facility processing capabilities and eliminate shipments between Area G and these two facilities.

Different shafts store different forms of remote-handled transuranic waste, as described in Section H.3.1. NNSA would perform the following for the different transuranic waste forms by 2015 (LANL 2005c):[9]

- Shafts 302-306. NNSA would retrieve the steel boxes from each shaft using cranes or other available means and would place them in fabricated shielded containers. The containers would then be stored at Area G for future processing, repackaging, and characterization using currently available facilities. However, the Hazard Category and Performance Assessment would need to be upgraded to Hazard Category 2 and Performance Category 3 for the Decontamination and Volume Reduction System; Waste

[9] *After characterization, some of this transuranic waste could actually be determined to be low-level radioactive waste, which LANL staff would dispose of in onsite facilities in Area G.*

Characterization, Reduction, and Repackaging Facility; and modular units, contingent upon nuclear safety analyses to be performed.

- Shafts 235-243 and 246-253. Substantial and detailed historical information exists at LANL regarding the characterization and packaging of the transuranic waste contained in the canisters in these shafts. NNSA is in the process of preparing documentation that would meet acceptable knowledge requirements of the New Mexico Environment Department and complete the characterization process. Once the New Mexico Environment Department has approved a permit modification and determined that the documentation is sufficient for characterization of this remote-handled transuranic waste. This waste would be retrieved by readily-available means, placed into WIPP 72B casks, and sent to WIPP.

- Shafts 200-232. Approximately 950 cubic feet (27 cubic meters) of high-activity remote-handled transuranic waste in these shafts would be retrieved by the new, temporary remote-handled transuranic waste retrieval facility presented in Section H.3.2.2.1. The retrieved waste is assumed to be processed and repackaged at a LANL facility such as the Decontamination and Volume Reduction System in Area G.

H.3.2.2.4 Low-level Radioactive Waste Processing Facilities

To facilitate closure of Area G and MDA G, low-level radioactive waste processing facilities would need to undergo DD&D. DD&D of these buildings would be completed by 2011. These facilities include (LANL 2005c):

- An access control and monitoring building (Building 54-0156), called the Operations Center.

- A characterization and verification building (Building 54-0002).

- A compactor building (Building 54-0281).

NNSA would replace these buildings with similar buildings in Zone 4 to support continued low-level radioactive waste disposal operations. It is assumed that the size and functions of these structures and processes would be similar to the new structures and processes to be located in an expanded area of Zone 4.

Zone 4 is approximately 30 acres (12 hectares) located between, and adjacent to, the current operational areas in Area G and Area L. Access to Zone 4 and Area G is controlled by the gate at the western end of the waste management area. Mesita del Buey Road runs through Zone 4. The footprint of Zone 4 would need to expand westward into the current administrative area to accommodate the proposed low-level radioactive waste processing activities. The area south of Mesita del Buey Road would be the likely location of the processing activities. NNSA would also relocate the access gate, add a new access control structure, and remove or relocate several office trailers and storage sheds (LANL 2006a).

Access Control and Monitoring Building

The access control and monitoring building would provide a physical control point for access to Zone 4 and of Area G and a support area for radiological program needs. The building would consist of the following characteristics (LANL 2006a):

- A heating, ventilation and air conditioning system.
- An observation area with a large window to document entrance to and exit from Zone 4 and Area G.
- An administration area to support radiological control technicians and equipment.
- Separate entrances and exits for resident workers and non-resident workers (workers delivering waste packages).
- Restrooms and locker areas for donning and removing personal protective equipment and personnel radiological monitoring.
- A break area.
- Remote gate and portal and turnstile control.

The proposed access control and monitoring building would be approximately 1,200 to 1,500 square feet (110 to 140 square meters) in size and located near the entrance to Zone 4 and Area G. The building could be either a steel manufactured building or a portable or modular building. LANL would limit the radiological inventory for the building to check and calibration sources used for instrument maintenance and operational needs related to survey and smear sample analysis (LANL 2005c). The building would be operational by 2009.

Characterization and Verification Building

The characterization and verification building would house the assay equipment associated with identifying and verifying radiological characteristics of waste materials. Survey methods would consist of non-intrusive methods such as gamma spectroscopy, neutron counting, and handheld instrument techniques. The building would consist of the following (LANL 2006a):

- Central heating, ventilation, air conditioning, and dust control systems with a negative overpressure ventilation system.
- Processing areas for the characterization and verification equipment.
- A staging area for up to 15 55-gallon (210-liter) drums.
- Overhead rollup (coil) doors with ceiling clearance of at least 16 feet (5 meters) to provide for fork lift and lift truck access.
- A design floor load of 1,100 pounds per square foot (5,400 kilograms per square meter) to accommodate the concentrated floor loads of assay equipment that use lead shielding.

- Floors finished as smooth concrete with epoxy sealant for contamination control.
- Three-phase 480-volt power with a 200-amp panel with single-phase requirements being addressed with a step-down transformer, as appropriate.
- Building partitioning to address personnel monitoring and badge control, as well as a main restroom facility.

The proposed characterization and verification building would consist of a 2,500 to 3,000 square foot (230 to 300 square meter), single-story building. LANL staff would locate this facility in Zone 4 on the south side of Mesita del Buey Road. The building is anticipated to be designed to Hazard Category 3, Performance Category 2 standards (LANL 2006a). The building would be operational by 2010 (LANL 2005c).

Compactor Building

The compactor building would serve as a low-level radioactive waste volume reduction facility that would house a new hydraulic compactor with associated glove box train and a drum crusher. The compactor building would have the following characteristics (LANL 2006a):

- Sufficient space to operate both pieces of equipment. The compactor footprint is assumed to be 8 feet by 12 feet (2.4 meters by 3.7 meters), with access from at least two sides. The glove box dimensions would be 17 feet (5.2 meters) in length, 7 feet (2.1 meters) wide and 12 feet (3.7 meters) high with conveyor dimensions of 24 feet (7.3 meters) long, 8 feet (2.4 meters) wide and 20 feet (6.1 meters) high. The existing drum crusher footprint would be about 4 square feet (0.4 square meters) with access from at least one side.
- A waste package staging area of 300 to 500 square feet (28 to 46 square meters).
- A storage area of 300 square feet (28 square meters) for equipment, parts, and supplies.
- A ceiling clearance of about 28 feet (9 meters) for compactor maintenance access (a ceiling clearance for the drum crusher would be less than 16 feet, or 5 meters).
- Rollup (coil) doors to accommodate fork lift and lift truck access.
- A design floor load of 1,100 pounds per square foot (5,400 kilograms per square meter) to accommodate volume reduction equipment.
- Floors finished as smooth concrete with epoxy sealant for contamination control.
- Three-phase 480-volt power with a 200-amp panel with single-phase requirements being addressed with a step-down transformer, as appropriate.
- High-efficiency particulate air-filtered exhaust system for local contamination control.
- Centralized uninterruptible power supply backup for continuous air monitors and personal computers.

- Centralized vacuum system for air samplers.
- Negative overpressure air confinement (pending further safety analyses).

The compactor building would consist of a 3,000 to 5,000 square foot (280 to 460 square meter), single-story building near the administration building and characterization and verification building within the nuclear facility fenceline. The compactor building is anticipated to be designed to Hazard Category 3, Performance Category 2 standards (LANL 2006a). The compactor would be operational by 2011 (LANL 2005c).

In addition to the DD&D of the current low-level radioactive waste processing facilities in Area G, all other above-ground structures in Area G would undergo DD&D prior to the completion of closure activities.

H.3.2.2.5 Mixed Low-level Radioactive Waste and Hazardous and Chemical Waste Storage

The structures and container storage units to be removed for closure activities would depend on the results of ongoing investigations, the design of the final cover, and other regulatory and programmatic decisions. For the purpose of the analyses related to this option, NNSA assumes that a single closure cover would be used. The storage capacities of the container storage units in Area L are shown in **Table H–15**.

Table H–15 Area L Container Storage Units and Associated Storage Volumes

Facility Identification Number	*Container Storage Unit*	*Volume (cubic feet)*	*Drum Equivalent*
54-31	Waste storage shed	177	24
54-32	Hazardous waste storage with canopy	2,295	312
54-35 [a]	Waste storage pad	2,119	288
54-36 [a]	Perma-Con® waste storage pad	1,766	240
54-39	PCB waste storage facility	5,474	744
54-58 [a]	Waste storage pad	2,119	288
54-68	Waste/lab pack storage unit	237	32
54-69	Waste/lab pack storage unit	237	32
54-70	Waste/lab pack storage unit	237	32
54-215 [a]	Mixed low-level radioactive waste storage dome	34,926	4,752
54-216 [a]	Gas cylinder storage dome	4,944	672
	Total	54,526	7,416

PCB = polychlorinated biphenyls.
[a] Container storage units that would be removed under Option 1. All container storage units would be removed in Option 2.
Note: To convert cubic feet to cubic meters, multiply by 0.028317.
Source: LANL 2005c.

Using a single closure cover, NNSA would undertake the following actions (LANL 2005c):

- Remove container storage units 54-35, 54-58, 54-215 and 54-216 (and part of the Area L container storage unit, which is the paved area inside the Area L fenceline).
- Re-site container storage units 54-68 and 54-69.

- Close or re-locate container storage unit 54-36 (a Perma-con® unit used for sampling, repackaging, or consolidation).
- Decommission and remove Canopy 54-62.
- Re-site modular structures 54-50 and 54-1058.
- Modify the Area L fenceline.
- Remove office structures 54-37, 54-51, 54-60, 54-83, and 54-84.

Structures to be relocated to another location in Area L that is paved would be small enough to be moved with a fork lift or small crane. The mixed low-level radioactive waste storage dome would undergo DD&D. Other structures would undergo demolition using conventional means without the need for decontamination.

Mixed low-level radioactive waste storage operations would be consolidated at Area L using existing storage facilities that would not be impacted by closure activities. Only enough storage space for 530 to 5,830 cubic feet (15 to 165 cubic meters) of mixed low-level radioactive waste would be required, or approximately 72 to 793 drum-equivalents, which is as high as 17 percent of the current storage capacity in the mixed low-level radioactive waste dome (LANL 2005c). Future storage needs would therefore be approximately 2,600 square feet (242 square meters) (assuming the mixed low-level radioactive waste dome is 15,181 square feet [1,410 square meters] and the storage space required is proportional to the square footage).

LANL staff would manage hazardous and chemical wastes through other waste collection sites that may be established or removed based on need. These sites would be established and operated in compliance with all regulatory requirements. Container Storage Unit 54-32, which can store up to 312 drums, would remain in Area L and would continue to be used for the temporary storage of newly-generated hazardous and chemical wastes.

H.3.2.3 Option 2: Interim Actions Necessary for Meeting Consent Order and Other Options

Option 2 primarily considers variations of Option 1 if legacy and newly generated stored wastes cannot be removed from storage, processed, and shipped to disposal facilities on an accelerated schedule that would allow completion of closure activities in Area L and MDA L, and Area G and MDA G, as required by the Consent Order.

Option 2a: It is possible that schedule requirements, technical challenges, regulatory requirements, or other factors may prevent complete removal of transuranic waste from Area G and MDA G and shipment to WIPP in an accelerated timeframe that allows closure activities to begin. In this option, NNSA would move the remaining transuranic waste from Area G to another location outside of Area G to be stored until the waste could be processed and shipped. NNSA would construct two additional storage structures at the TRU Waste Facility or another location for storage of legacy transuranic wastes. This option considers that transuranic waste currently stored in Pit 9 and the shafts would require storage somewhere at the LANL site other than Area G. The transuranic waste in Pit 9 and the shafts would require approximately 7,986 drum equivalents of storage space. This would require shipments (and accompanying road closures) to be made. The number of shipments would be reduced if the storage location were combined with the TRU Waste Facility, since the TRU Waste Facility is assumed to ultimately process this waste under Option 2.

The two transuranic waste storage buildings would be similar in size to Dome 375, but with a different overhead confinement system. Each storage building would consist of approximately 30,000 square feet (2,787 square meters) that could hold up to a total of 8,000 drum equivalents (using Dome 375 as a baseline). The volume of these wastes would be approximately 7,190 drum equivalents (NNSA 2003). The Decontamination and Volume Reduction System would be used to perform size reduction of the crates and oversized boxes prior to storage in the two new storage buildings.

Option 2b: Under this option, the high activity remote-handled transuranic waste would be left in place in Shafts 200-232; the more easily-retrieved transuranic waste is assumed to be removed from underground storage areas. LANL staff would retrieve and store the other, more retrievable remote-handled transuranic waste in the two new storage buildings, as described in Option 2a. LANL staff would need to perform additional performance assessments for closure activities to upgrade closure activities to address this high-activity remote-handled transuranic waste, as described in Appendix I, Section I.3.3. Leaving the higher activity remote-handled transuranic waste in place may be contingent on environmental restoration decisions for MDA G to be made by the New Mexico Environment Department. DOE expects to submit a corrective measures evaluation report to the New Mexico Environment Department in September 2008.

Option 2c: In addition to either Option 2a or 2b, mixed low-level radioactive waste and hazardous and chemical waste would be stored at the TRU Waste Facility and the use of Area L would cease for these operations. LANL staff would continue to manage hazardous and chemical wastes through other sites and would obtain a RCRA permit for the TRU Waste Facility for storing hazardous wastes for periods greater than 90 days.

H.3.2.4 Options Considered but Eliminated

NNSA considered but eliminated one option associated with the management of transuranic wastes. The following presents this option and the reasons it was eliminated from further consideration.

Locate the TRU Waste Facility at a Major Generator Facility in an Existing Facility at TA-55

This option addresses newly generated transuranic waste that would be expected after waste management activities cease in TA-54, Area G. In this option, non-destructive analysis and real-time radiography activities would be conducted at TA-55 in existing facilities. The storage, loading, decontamination, and size reduction functions would be housed in an existing facility, such as the former Radioactive Materials Research, Operations and Demonstration Facility, which would require a RCRA permit (LANL 2005h).

This option was eliminated from further consideration because (LANL 2005h):

- The limited space in the Radioactive Materials Research, Operations and Demonstration Facility and the configuration of its floor space may not allow accommodation of all of the intended transuranic waste management functions.
- Road closures would be required to allow transfer of transuranic waste between TAs.

H.3.3 Affected Environment and Environmental Consequences

Detailed information about the LANL environment is presented in Chapter 4. Specific information relevant to the consequences of the proposed waste management facilities transition is addressed under each of the affected resource areas.

An initial assessment of the potential impacts of the proposed project identified resource areas for which there would be no or only negligible environmental impacts. Consequently, for the following resource areas, a determination was made that no further analysis was necessary:

- *Socioeconomics and Infrastructure*—No new employment is expected. Construction and remediation workers would be drawn from the pool of worker employed on various projects at LANL. Only infrastructure impacts are included in the impacts discussion.
- *Environmental Justice*—The proposed project would be largely confined to already developed areas and the new facilities would replace existing facilities with similar impacts. No disproportionate human health impacts on low-income or minority populations would be expected.

H.3.3.1 No Action Option

The No Action Option would result in continued operation as discussed in Section H.3.2.1. Processing of transuranic waste stored aboveground would continue as currently performed. All radioactive wastes stored belowground would remain. The current low-level radioactive waste processing facilities would remain in use. Hazardous and mixed radioactive waste storage operations in Area L would continue. The impacts related to the No Action Option are described in Chapter 5. If no action is taken, then NNSA would not be able to complete corrective actions and closure activities in Area L and MDA L, and Area G and MDA G, and would therefore not be in compliance with the Consent Order. Impacts to all resource areas would remain as currently observed with increased environmental contamination possible.

H.3.3.2 Option 1: Accelerated Actions for Meeting the Consent Order

Land Resources

Land Use

TA-54 (see Chapter 1, Figure 1–2) is where new low-level radioactive waste processing facilities, additional transuranic waste processing equipment and facilities, and DD&D activities would occur. TA-54 is one of the larger TAs at Los Alamos, measuring 943 acres (382 hectares) in size. The 3-mile (4.8 kilometer) northern border of the site forms the boundary between LANL and the Pueblo of San Ildefonso. The town of White Rock is located to the east of the TA. Land use within TA-54 is categorized as Experimental Science, Waste Management, and Reserve. Future land use is likely to remain similar, except that the area devoted to waste management is projected to expand such that it forms a continuous band along the TA's southern boundary (LANL 2003d). According to the *Comprehensive Site Plan* for 2001, TA-54 is within the Pajarito Corridor East Development Area. The area within which Area G and Area L fall is categorized as Potential Infill and Primary Development (LANL 2001a).

As noted in Section H.3.2.2.2, a location for the TRU Waste Facility has yet to be finalized. Thus, a generic area encompassing TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63, and TA-66 has been selected for analysis. For each TA, a generic site was selected within which the TRU Waste Facility could be constructed. The facility would be located on 2.5 to 7 acres (1 to 2.8 hectares) of land. **Table H–16** presents the current land use, planned future land use, and the development designation of each potential site.

Table H–16 Land Use and Development Designations for the TRU Waste Facility Site [a]

Technical Area	*Current Land Use*	*Planned Future Land Use*	*Comprehensive Site Plan Development Designation(s)*
35	Nuclear Materials Research and Development	Experimental Science	Primary Development, Potential Infill
46	Physical/Technical Support	Experimental Science	Primary Development
48	Experimental Science	Nuclear Materials Research and Development	Primary Development
50	Reserve	Reserve	Secondary Development
51	Experimental Science	Experimental Science	Potential Infill
52	Reserve	Reserve	Potential Infill
54 West	Experimental Science	Experimental Science	Potential Infill
63	Physical/Technical Support	Waste Management	Secondary Development
66	Reserve	Reserve	Secondary Development

[a] Many TAs have multiple land use designations; the listed land use is for the location in the TA most likely to be used for the TRU Waste Facility.

Sources: LANL 2001a, 2003d.

Construction, DD&D, and Operations Impacts—All actions within TA-54, including construction of a remote-handled transuranic waste retrieval facility; removal of the domes at MDA G; DD&D of most above-ground facilities in TA-54; construction of a TRUPACT II loading facility; relocation of transuranic waste processing equipment from outdoor areas to a transuranic waste storage dome; expansion into Zones 4 and 6 and construction of a low-level radioactive waste administration building, characterization and verification building, and compactor building; reconfiguration of storage facilities in Area L; and use of Dome 282 for hazardous waste storage would take place within previously disturbed parts of TA-54. These areas are currently designated Waste Management, a designation that would not change in the future; thus, there would be no impact on land use within TA-54 under this option.

The greatest potential impact to land use would occur at a generic site that is presently not developed. With the exception of TA-54 West, none of the generic sites contains buildings or structures. However, the potential facility sites are currently designated Primary Development, Secondary Development, or Potential Infill, indicating that they are suitable for development. Planned future land use at these sites, with the exception of TA-63, would need to change from current land use designations to Waste Management.

Visual Resources

Although a location for the TRU Waste Facility has yet to be finalized, a generic area encompassing TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63 and TA-66 has been selected for analysis. For each TA, a generic site was selected within which the new facility could be constructed. As noted in Section H.3.2.2.2, the TRU Waste Facility may be composed of multiple buildings or a combination of buildings, totaling approximately 30,000 to 40,000 square feet (2,790 to 3,720 square meters); it would require approximately 2.5 to 7 acres (1 to 2.8 hectares) of land. **Table H–17** indicates the development status of the generic sites and whether they would be visible from lands of the San Ildefonso Pueblo.

Table H–17 Potential Visibility of TRU Waste Facility

Technical Area	*TRU Waste Facility Within Undeveloped Site*	*TRU Waste Facility Visible from Lands of the San Ildefonso Pueblo*
35	Partially	No
46	Yes	No
48	Yes	No
50	Depends on location	No
51	Yes	Yes
52	Yes	Yes
54 West	No	Yes
63	Yes	No
66	Yes	No

TA-54 is at the eastern end of Pajarito Road and borders both the Pueblo of San Ildefonso and White Rock. While buildings and structures of the TA are visible from higher elevations to the west, near views of many elements of the TA are limited since Pajarito Road is closed to the public. However, the dominant feature of the site is the domes at MDA G, some of which are white-colored, in the eastern end of the TA. These domes contrast with the natural landscape and can be seen many miles away from areas in the Nambe-Española area and from areas in western and southern Santa Fe (LANL 2004b). They are also visible from the lands of the Pueblo of San Ildefonso.

Construction, DD&D, and Operations Impacts—Although a number of new buildings, including temporary and permanent structures, would be constructed within TA-54 under this option (including the remote-handled transuranic waste retrieval facility, low-level radioactive waste processing buildings, and relocation and addition of new equipment and a TRUPACT II loading area), all would be built within previously disturbed areas. Thus, construction would have minimal impact on visual resources under this option. However, removal of the domes at MDA G would have a beneficial impact on both near and distant views.

As noted from Table H–17, generic sites for the TRU Waste Facility, with the exception of TA-54 West and some areas of TA-50, are located within undeveloped areas. Thus, while construction of the new facility would have minimal visual impact within TA-54 West and portions of TA-50, it would create a change in the visual environment of the remaining sites. However construction would generally not be visible to the public since Pajarito Road is open only to laboratory personnel. Table H–17 also identifies TA-51, TA-52, and TA-54 West as areas where construction of the new facility would be visible from lands of the San Ildefonso Pueblo; however, construction within TA-54 West would be within a presently disturbed area. Regardless of where the TRU Waste Facility would be built, when viewed from higher elevations to the west it would add somewhat to the developed nature of LANL along Pajarito Road. DOE would mitigate the visual impacts from the TRU Waste Facility by following the design principles provided in the LANL architectural guide (LANL 2002a).

Proposed changes in Area L to remove and re-locate some mixed low-level radioactive waste and hazardous and chemical storage facilities would be conducted within previously disturbed areas to facilities not easily visible unless someone is traveling past Area L along Pajarito Road. Thus, any changes would have minimal impact on visual resources.

Geology and Soils

Geology, soils, and geological resources at LANL are addressed in Section 4.2 of this SWEIS. The generic area for the location of the proposed TRU Waste Facility is located along the eastern edge of the Pajarito Fault system, with TA-54 located further east. Specifically, the closest segment of the 9-mile (14-kilometer) long Rendija Canyon fault is located approximately 0.4 miles (0.6 kilometers) west of TA-50 and more than 3.7 miles (6 kilometers) northwest of TA-54. This fault exhibits as much as 130 feet (40 meters) of post-Bandelier Tuff displacement. Other small faults have been mapped in the area; they are generally subsidiary to the main fault and have limited displacement. Small fault traces have been mapped throughout central LANL; their potential rupture hazard is very small (LANL 1998). As noted in Chapter 4, Section 4.2.2.3, the seismic risk at LANL is considered very small.

Soils associated with the affected technical areas are generally thin and directly overlie the Bandelier Tuff. As discussed in Section 4.2.3 of this SWEIS, some soils have been affected by facility releases, but the majority of sites are well below contaminant screening levels.

Construction, DD&D, and Operations Impacts—Option 1 would include closure of MDA G and MDA L per the Consent Order (NMED 2005a). This action should reduce the potential for soil erosion that could occur through No Action based on the use of standard construction practices at LANL. Similarly, the use of standard practices in facility DD&D, as well as facility construction, should result in negligible impact to soils under Option 1.

Direct impacts on geology and soils under Option 1 would generally be proportional to the total area of land disturbed and earthwork necessitated for new construction (see Section 5.2), particularly the new waste management facilities in TA-54 and the new TRU Waste Facility to be constructed in the Pajarito Road corridor, and demolition and closure of appropriate container storage units in Area L and fabric domes in Area G. However, most of the work would be performed in areas where these resources already have been disturbed by existing or past activities.

Approximately 80,000 cubic yards (61,000 cubic meters) of earthwork would be required to implement Option 1. This estimate reflects the construction of the new low-level radioactive waste processing facilities to be constructed in Zone 4, the construction of the TRU Waste Facility, and the remote-handled transuranic waste retrieval facility, but it does not reflect the construction of a new TRUPACT II loading area since this would be placed inside an existing dome. Aside from earthmoving, excavation depths would generally be limited to 10 feet (3 meters) or less. In all instances, adherence to standard best management practices for soil erosion and sediment control, including watering during construction, would serve to minimize soil erosion and loss. After construction, disturbed areas that have not been paved would be stabilized and revegetated and would not be subject to long term soil erosion.

Potential release sites and potential release site-affected areas could be impacted by new facility construction. Prior to commencing any ground disturbance, potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with procedures established under the environmental restoration project. At areas where facilities would be removed or the facility footprint reduced, a decrease in the potential for contaminant releases would occur.

Geologic resource consumption would be negligible to small under Option 1 and would not be expected to deplete local sources or stockpiles of required materials. Approximately 4,900 cubic yards (3,746 cubic meters) of concrete including associated aggregate (sand and gravel) and Portland cement would be needed during construction. Component aggregate resources are readily available from onsite borrow areas and otherwise abundant in Los Alamos County, with the required concrete expected to be procured via an off-site supplier.

No mines, pits, or quarries are being operated along the Pajarito Road corridor so Option 1 would not impact geological resources (Stephens & Associates 2005). Prior to construction of any new facilities, an estimate of the seismic hazard to the proposed site would be conducted using the most current seismic information and in accordance with DOE seismic standards and applicable building codes.

It is anticipated that the new remote-handled transuranic waste retrieval facility and TRU Waste Facility would be Performance Category 3 facilities while the characterization and verification, and compactor buildings would be Performance Category 2 facilities, contingent upon nuclear safety analyses that would be performed prior to final design. Facility construction activities would adhere to standard best management practices for soil erosion and sediment control to minimize soil erosion and loss. This would minimize the potential for release of contaminants within the soil matrix. After construction, disturbed areas that have not been paved would be stabilized or revegetated and would not be subject to long term soil erosion.

Following the completion of Option 1, operations would not result in additional impacts on geologic and soil resources at LANL. As discussed above, new facilities would be evaluated, designed, and constructed in accordance with DOE Order 420.1B (DOE 2005b) and other governing DOE and LANL construction standards and sited to minimize the risk from geologic hazards, including earthquakes.

Water Resources

Hydrology and water resources are addressed in detail in Chapter 4, Section 4.3, and in Appendix E (Groundwater in the Vicinity of LANL) of this SWEIS. Appendix F of this SWEIS includes sample information pertaining to water resources. Appendix I, Section I.4.3, includes a discussion of water resources in TA-54, Area L and Area G.

TA-54 is one of the industrial sites at LANL covered by the Multi-Sector General Permit that has an individual stormwater pollution prevention plan. As a waste treatment, storage, or disposal facility, the stormwater pollution prevention plan includes stormwater controls, spill and leak procedures, maintenance procedures, and specific stormwater monitoring requirements (EPA 2000). Stormwater controls are inspected regularly as part of regular site inspections at the facility.

The technical areas along the Pajarito Road corridor are underlain by the Bandelier Tuff. The vadose zone, from the surface to the water table, at these locations is approximately 1,200 feet (366 meters) thick. Groundwater in the vadose zone cannot be produced in quantities that might be used for human or animal consumption. Moisture content of rock in the vadose zone is low and extraction in useful amounts is impractical using existing technology.

Construction and DD&D Impacts—Little or no effect on surface water resources is expected during removal or replacement of facilities required to close Area L and MDA L, and Area G and MDA G. Construction and eventual DD&D of the remote-handled transuranic waste retrieval facility would occur under the protection of a construction stormwater pollution prevention plan. Construction of the TRU Waste Facility would also require a construction stormwater pollution prevention plan. Construction of new low-level radioactive waste processing facilities in Zone 4 and DD&D of these facilities at MDA G would include construction stormwater pollution prevention plan controls. Another construction stormwater pollution prevention plan would be required for any structure removal and final cover installation at Area L and MDA L. All of the stormwater controls introduced for the construction and demolition projects would augment the controls already in place. Construction of a TRUPACT II loading facility and consolidating equipment in one of the fabric domes would not require any mitigative measures because they would be located inside an existing facility.

Infiltration rates at the surface are thought to be low, on the order of a few millimeters per year or less (Kwicklis et al. 2005). Construction and DD&D of the remote-handled transuranic waste retrieval facility, the TRU Waste Facility, and the current low-level radioactive waste buildings would likely result in surface disturbances which could result in increased infiltration rates (by up to about two orders of magnitude) as a result of rainfall events, snowmelt, or ponded water. It is difficult to estimate whether increased infiltration would change the rate of migration of any contaminants that may be situated under the disturbed areas, although near-surface contamination could be mobilized (or if currently mobile, transport could be accelerated over a small distance during periods of increased infiltration). Removal of waste, to the extent anticipated, would decrease the quantity of contaminants available for release to the environment, although increased infiltration could affect deeper contamination within the soil and tuff that is beyond the reach of the excavation. In any case, current rates of transport in the vadose zone overall are unlikely to change over the period addressed in this SWEIS, nor would groundwater resources be affected over this period. Consolidation of transuranic waste processes from outdoor areas to inside a dome would have minimal positive impacts.

Operations Impacts—Retrieval and processing of wastes should have little or no effect on surface water resources. Although remote-handled transuranic wastes that would be retrieved by the remote-handled transuranic waste retrieval facility should contain no liquids, processing areas would have shielded sumps to collect any liquids generated during processing. Similarly, although newly-generated contact-handled transuranic wastes should contain no free liquids, the floor of the TRU Waste Facility would direct any unexpected liquids to a sump for recovery, treatment, and proper disposal. Regardless of where the TRU Waste Facility is located, the site would be included in the Multi-Sector General Permit for industrial activities and would require an industrial stormwater pollution prevention plan.

Retrieval and processing of wastes, similar to construction activities, would entail disturbance of the surface and potentially increase infiltration to groundwater. Further, the handling of waste would run the risk of spill or loss; however, amounts would likely be small due to the small amount of liquid currently present and proper waste handling techniques.

Appropriately designed and constructed closure covers to be used for MDAs G and L should reduce the effects of stormwater infiltration that could mobilize contaminants and transport them to the groundwater.

Air Quality and Noise

Air Quality

Nonradiological air pollutant emission sources at the Solid Radioactive and Chemical Waste Management Key Facility include the use of various toxic chemicals. Emissions of toxic pollutants from the Solid Radioactive and Chemical Waste Management Key Facility are shown in **Table H–18** and are based on chemical usage. These emissions vary by year with the amounts of chemical being used but provide a basis for establishing baseline conditions.

Table H–18 Nonradiological Air Pollutant Emissions at Solid Radioactive and Chemical Waste Management Key Facility – 2005

Pollutant	*Tons per Year*
Ethanol	0.00198
Hydrogen chloride	0.45118
Potassium hydroxide	0.00117
Propane	0.00
Pyridine	0.00036
Sulfuric Acid	0.08431
Tetrahydrofuran	0.00032

Note: To convert tons to kilograms, multiply by 907.18.
Source: LANL 2006f.

A comparison of calculated maximum emission rate derived from health-based standards to the potential emission rate was made. A screening level emission value was developed for each chemical. A screening level emission value is a theoretical maximum emission rate that, if emitted at that TA over a short-term (8-hour) or long-term (1-year) period, would not exceed a health-based guideline value. This screening level emission value was compared to the emission rate that would result if all the chemicals purchased for use in the facilities at a TA over the course of one year were available to become airborne. At TA-54, chemicals would be emitted at levels below the screening levels identified.

Radiological air emissions, which contribute to the total radiological dose to a person, currently come from area sources and the Decontamination and Volume Reduction System at TA-54. Area source emissions include a) airborne soils from disturbing contaminated soils at TA-54, b) buried tritium-contaminated materials where tritium migrates to the surface and becomes airborne, and c) non-packaged waste as it is placed into the pits at Area G before it is covered. Appendix C of this SWEIS provides a breakdown of potential radiological air emissions from TA-54.

Construction and DD&D Impacts—Construction of new waste processing facilities under Option 1 (that is, the remote-handled transuranic waste retrieval facility, the TRU Waste Facility, the TRUPACT II loading facility, and the low-level radioactive waste processing buildings) would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Modeling of criteria pollutant concentrations for construction, with the possible exception of carbon monoxide, indicates that the maximum ground-level concentrations offsite would be below the ambient air quality standards and it is expected that the air quality impacts on the public would be minor. Most of the equipment that would be used for DD&D would be construction equipment. Vehicle emissions during DD&D would be similar to those during construction. Additional dust from the demolition of buildings and materials would also temporarily contribute to localized air quality impacts; however, these activities would not be expected to exceed ambient air quality standards.

For radiological emissions, during initial DD&D there would be emissions during the removal of equipment and decontamination of structural surfaces. While the building shell is intact, emissions would result from building or temporary ventilation systems used for dust and contamination control. These systems would use high-efficiency particulate air filtration prior to exhausting air from interior contaminated spaces to areas outside the building. Ventilation and other controls would be used to minimize worker inhalation and exposure to radioactivity and avoid recontamination of previously decontaminated areas. The result of the initial activities would be structural surfaces either decontaminated to unconditional-release levels or with selected contaminated surfaces stabilized to permit segregation of radioactively-contaminated and -uncontaminated debris after demolition.

The potential exists for contaminated soils, building debris, and possibly other media to be disturbed during building demolition. Release of radioactivity would be minimized by proper decontamination of buildings prior to demolition – if facilities are decontaminated to unconditional release levels as prescribed by the MARSSIM protocol (MARSSIM 2000), emissions would be similar to those from uncontaminated buildings. If residual levels of contamination remain after decontamination activities are complete, then small amounts of radioactivity would be emitted during demolition. The radionuclide concentrations resulting from demolition of contaminated facilities may be predicted based on the pre-demolition characterization of the building, and would be addressed in regulatory documents approved at that time. Such emissions are typically of short duration, and would be minimized using dust suppression techniques and monitored along with the fugitive dust.

Radiological air emissions from the Decontamination and Volume Reduction System would remain as currently observed until the facility undergoes DD&D in preparation for closure of Area G and MDA G. Two new facilities, the remote-handled transuranic waste retrieval facility and the TRU Waste Facility, would be assumed to emit radiological air emissions equivalent to the Decontamination and Volume Reduction System. **Table H–19** summarizes the annual air emissions to be expected from each of these three facilities.

Table H–19 Radiological Air Emissions from Each Waste Management Facility

Isotope	*Annual Air Emission Rate (curies per year)*
Americium-241	3.53×10^{-6}
Plutonium-238	1.76×10^{-5}
Plutonium-239	7.78×10^{-6}

Source: See Appendix C.

The radiological air emissions from the Decontamination and Volume Reduction System are assumed to continue until approximately 2015 (note however, that it must be decommissioned to allow for closure of MDA G in 2015.) The radiological air emissions from the remote-handled transuranic waste retrieval facility, to be located in TA-54 Area G, would occur from 2011 to 2015. The radiological air emissions from the TRU Waste Facility, would occur starting in 2012 and continue for the next 30 to 35 years.

Radiological air emissions from area sources in TA-54 are assumed to continue at current rates until closure of MDA G which is scheduled to be completed in 2015. The primary radionuclide in area air emissions is tritium, with approximately 60.9 curies per year projected to be released (see Appendix C, Table C–13).

Operations Impacts—During operations, toxic air pollutants would be generated from the use of various chemicals. Toxic pollutants released would be expected to be similar to current uses as shown in Table H–18 for the facilities at TA-54 and other locations associated with waste management operations. These emissions would vary by year with the activities performed. The emissions would be expected to be small and below the screening level emission values and it is expected that the air quality impacts on the public would be minor.

Noise

Operations noise sources from the Solid Radioactive and Chemical Waste Management Key Facility include heating, ventilation, and cooling equipment and vehicles. There are minimal noise impacts on the public from current waste management activities.

Construction and DD&D Impacts—Construction of new waste processing facilities under Option 1 would result in some temporary increase in noise levels near the area from construction equipment and activities. Some disturbance of wildlife near the area may occur as a result of operation of construction equipment. There would be no change in noise impacts on the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipment. Noise sources associated with construction of these facilities are not expected to include loud impulsive sources such as from blasting. DD&D activities may include blasting, but these events, if necessary, would only be for larger structures and the number of events would be small.

Operations Impacts—Noise impacts from operation of the waste processing facilities are expected to be similar to those from existing waste processing facilities at TA-50 and TA-54. Although there would be small changes in traffic and equipment noise (such as new heating and cooling systems) near the area, there would be little change in noise impacts on wildlife and no change in noise impacts on the public outside of LANL as a result of operating these new facilities.

Ecological Resources

TA-54 is largely located within the Pinyon-Juniper Woodland vegetation zone; however, the westernmost portion of the area falls within ponderosa pine forest. Wildlife using the TA would include species typical of both vegetation zones. Although most of the area was untouched by the Cerro Grande Fire, the northwestern portion of the site was burned at a low, unburned to medium severity level. At a medium severity level, seed stocks can be adversely affected and erosion can increase due to the removal of vegetation and ground cover (DOE 2000). Areas G and L are disturbed areas with minimal ground cover that are largely fenced; thus, wildlife use of these areas would be limited to small mammals, birds, and reptiles (Marsh 2001). There are no wetlands located within TA-54; however, a number of wetlands are located within Pajarito Canyon (TA-36) just to the south (see Section H.1.3.2) (ACE 2005).

A portion of TA-54 falls within the core and buffer zones of the southwestern willow flycatcher Area of Environmental Interest; however, the Area of Environmental Interest is restricted to the canyon and does not include any part of the Areas G and L. Areas of Environmental Interest for the Mexican spotted owl and bald eagle do not encompass any part of TA-54 (LANL 2000b).

Biological Resources

For the TRU Waste Facility, generic areas within TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63, and TA-66 have been selected for analysis. **Table H–20** indicates the type of vegetation present at the generic facility site, whether wetlands and aquatic resources are present, and if the facility would be within a Mexican Spotted Owl Area of Environmental Interest. None of the potential sites within the generic include Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Construction, DD&D and Operational Impacts—Under Option 1, all actions within TA-54, including new construction within Zone 4, DD&D activities, and removal of the white-colored domes, would take place within developed areas. Thus, there would be little to no direct impact on ecological resources. Although TA-54 includes a portion of the southwestern willow flycatcher Area of Environmental Interest, the area within which project-related activities would take place (TA-54 West) is about 450 feet (137 meters) from the core habitat. Thus, there would be no direct loss of foraging or nesting habitat. The biological assessment prepared by DOE determined that noise levels should not exceed 6 dB(A) above background levels in the core zone. Provided reasonable and prudent alternatives are implemented, the biological assessment concluded that the project may affect, but is not likely to adversely affect, the southwestern willow flycatcher. Reasonable and prudent alternatives would include designing all lighting so that it would be confined to the site, keeping disturbance and noise to a minimum, implementing appropriate erosion and runoff controls, avoiding unnecessary disturbance to vegetation (including wetland vegetation), revegetating with native plant species, and continuing to perform annual surveys adjacent to the project area before and during the action (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Table H–20 Ecological Characteristics of the TRU Waste Facility Site

Technical Area	*Vegetation*	*Wetland/Aquatic Resources*	*Within Mexican Spotted Owl Area of Environmental Interest Core/Buffer Zone*
35	Partially disturbed and ponderosa pine	None	Yes/No
46	Ponderosa pine	None	Yes/Yes
48	Ponderosa pine	None	No/No
50	Open field with some ponderosa pine	None	Yes/Yes
51	Ponderosa pine	None	No/No
52	Ponderosa pine	None	Yes/Yes
54 West	Disturbed	None	No/No
63	Open field	None	No/Yes
66	Ponderosa pine	None	Yes/Yes

With respect to the bald eagle and Mexican spotted owl, the biological assessment determined that there would be no effect on either species as a result of implementing the proposed project. This is the case because the TA does not include any portion of Areas of Environmental Interest for these species, foraging habitat would not be disturbed, and noise levels would be less than 6 decibels (A-weighted) above background (LANL 2006b). The U.S. Fish and Wildlife Service has concurred with this assessment (see Chapter 6, Section 6.5.2).

Most generic sites for the TRU Waste Facility would disturb ponderosa pine forest, although at TA-50 and TA-63 the facility may be built within an area that is primarily open field. It is possible that it may be constructed in a developed area at TA-54 West or TA-50. No more than a maximum of 7 acres (2.8 hectares) of habitat would be disturbed with the loss or disturbance of associated wildlife. In no case would wetlands or aquatic resources be directly disturbed; best management practices would control erosion and sedimentation. At least some portion of either the core or buffer zone of Mexican spotted owl Areas of Environmental Interest would be affected by construction of the TRU Waste Facility within all TAs except TA-48, TA-51, and TA-54 West. For those generic sites where the new facility has the potential to affect the spotted owl, either directly or indirectly (for example, by excess noise or light), it would be necessary to conduct a biological assessment and initiate formal consultation with the U.S. Fish and Wildlife Service. None of the generic sites are within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Human Health

This section summarizes the information on public and worker health affected by both nonradiological and radiological impacts that are currently observed in LANL operations. In particular, the focus is on those structures and processes in a generic area in the Pajarito Road corridor and TA-54 since the majority of waste management facilities are located in these two areas.

Nonradiological impacts include current occupational injury rates due to construction, operations, and DD&D, as well as toxic chemical and biological agent hazards. Radiological impacts are related to the amount of radiological dose that a member of the public and an on-site worker might receive due to radiological emissions and direct radiation in these technical areas. Section 4.6 generally describes off-site and on-site exposures due to LANL operations. This information cannot be assigned to specific areas within LANL, such as to TA-54.

Table H–21 summarizes the potential radiation dose to the facility-specific maximum exposed individual and population within 50 miles (80 kilometers) of waste management operations in TA-54. The facility-specific (TA-54) maximum exposed individual is assumed to be located approximately 394 yards (360 meters) northeast of TA-54. The primary isotopic contributor to the radiological dose to the maximum exposed individual shown in Table H–21 is tritium (71 percent of the 0.052 millirem per year). These radiological doses were calculated using the computer model CAP88-PC, which is described in Appendix C.

Table H–21 Potential Radiation Dose from Current Technical Area 54 Operations

Source	*Dose to the Facility-Specific Maximum Exposed Individual (millirem per year)*	*LCF Risk*
TA-54 Area Sources	0.045	2.7×10^{-8}
Decontamination and Volume Reduction System	0.0073	4.4×10^{-9}
Total	0.052	3.1×10^{-8}
	Dose to Population within 50 Miles (person-rem per year)	
TA-54 Area Sources	0.025	1.5×10^{-5}
Decontamination and Volume Reduction System	0.012	7.3×10^{-6}
Total	0.037	2.2×10^{-5}

TA = technical area, LCF = latent cancer fatality.

The 7-year average (1999 to 2005) collective total effective dose equivalent for the LANL worker population was 161 person-rem (LANL 2003d, 2006f). In general, determining the collective total effective dose equivalent for each Key Facility or technical area is difficult to determine because these data are collected at the group level, and members of many groups or organizations receive doses at several locations. The fraction of a group's collective total effective dose equivalent coming from a specific Key Facility or technical area can only be estimated. LANL staff report radiation exposure to waste management operations workers as an occupational group through DOE's Radiation Exposure Monitoring System database, but these workers may also perform other functions that do not support waste management activities.

The average measurable dose over the same 6-year period for waste management operations personnel at LANL was 141 millirem. Approximately 22 percent of the waste management operations personnel obtain measurable dose (DOE 2006). Waste management personnel primarily work in TA-50 and TA-54, but they may also periodically work in other TAs.

LANL staff currently monitor direct radiation (radiation from a source term, which can generally be correlated to an external dose) throughout the LANL site using thermoluminescent detectors.

LANL staff report these measurements through the LANL meteorology and air quality web site on a quarterly basis (LANL 2005g). The results include direct radiation contributions from natural background (that is, cosmic and terrestrial radiation). After subtracting out the approximate contribution of natural background radiation, it is found that LANL waste management operations in Area G contribute to direct radiation levels in the work environment outside the transuranic waste storage domes and the Decontamination and Volume Reduction System (direct radiation levels in TA-50 and TA-63 are within background levels) (LANL 2005g). These radiation levels contributed to a radiation dose ranging from 42 to 729 millirem per quarter from January 2003 through June 2005 and are a result of gamma and neutron exposures, depending on the location. These exposures reflect a worker who would be outside one of these locations 24 hours per day, 7 days per week (LANL 2005g).

Construction, DD&D and Operational Impacts—Compared to the No Action Option, additional point source radiological impacts can be expected due to the operation of the proposed remote-handled transuranic waste retrieval facility in TA-54 and the proposed TRU Waste Facility. It is assumed that the remote-handled transuranic waste retrieval facility and the TRU Waste Facility would be designed such that radiological releases would not exceed the releases that are documented from the Decontamination and Volume Reduction System.[10] The facility-specific maximum exposed individual dose associated with TA-54 from operation of the remote-handled transuranic waste retrieval facility would be the same as from the Decontamination and Volume Reduction System (0.0073 millirem per year) from 2011 to 2015. Both the remote-handled transuranic waste retrieval facility and the Decontamination and Volume Reduction System would cease operations in time to close MDA G in 2015. The TRU Waste Facility could potentially be located in one of several TAs on the Pajarito Road corridor: TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63 or TA-66. Taking into account the proximity of the Royal Crest Trailer park and LANL boundaries, the highest and therefore bounding potential dose to the facility-specific MEI resulting from emissions would be from a facility located at TA-51. This dose of approximately 0.0090 millirem per year would begin in 2012 and continue for about 30 to 35 years. The impact of the TRU Waste Facility, the remote-handled transuranic waste retrieval facility, and the Decontamination and Volume Reduction System on the LANL site-wide MEI (located approximately 800 meters north-northeast of LANSCE in the Expanded Operations Alternative) would be minor (an additional 0.0006 millirem per year) when compared to the dose from operations at LANSCE (7.5 millirem per year). Similarly, these additional waste management operations would add only 0.02 person-rem per year to the total dose (30 person-rem per year) the population would receive from normal operations at LANL under the Expanded Operations Alternative.

The 50-mile (80-kilometer) population radiological doses for emissions from the remote-handled transuranic waste retrieval facility would also be expected to be similar to the Decontamination and Volume Reduction System (0.012 person-rem per year) if these facilities are operated in TA-54. A potential location for the TRU Waste Facility is at the northwestern end of the Pajarito Road corridor in TA-48, which is in close proximity to the public at the Royal Crest Trailer park and the Los Alamos townsite. From this potential location, the TRU Waste Facility

[10] The remote-handled transuranic waste retrieval and processing facility would be processing highly radioactive waste; thus, it is conceivable that its emissions could be higher than the Decontamination and Volume Reduction System. LANL staff would prepare a Documented Safety Analysis for this proposed facility to more accurately determine its potential emissions and resulting impacts.

would contribute approximately 0.011 person-rem per year to the population, assuming emissions are the same as those from the Decontamination and Volume Reduction System. The population dose would be comparable or less if the facility were located in any of the other TAs being considered.

Population doses for area emissions at TA-54 were calculated to be 0.025 person-rem per year for the No Action Option. Area emissions should increase due to retrieval and DD&D activities.

In addition, an increase in the area sources related to soil disturbance during waste retrieval from trenches, pits and shafts and DD&D activities would occur. However, these increases would be offset by decreases in direct radiation associated with the transuranic waste stored in the domes as the above-grade waste inventory declines due to processing and shipping this waste to WIPP. It is therefore expected that direct radiation levels in Area G would stay relatively the same as transuranic waste is retrieved from below-ground storage and placed into above-ground storage in the storage domes. Retrieval would only occur as storage space becomes available in the storage domes. Direct radiation levels would ultimately decrease to close to background levels in Area G by 2016 once all transuranic waste is shipped offsite for disposal and DD&D activities are completed. In Area L, direct radiation levels would remain within background levels since mixed low-level radioactive waste storage volumes would not increase over current storage levels.

For the low-level radioactive waste processing facilities to be constructed in Zone 4, it is expected that direct radiation levels and radiological emissions associated with characterization, verification and compaction would remain at current levels since the only change in operations would be that the location of these activities would be different, and the new processing capabilities in Zone 4 would be similar to the current capabilities in Area G.

Worker exposures to direct radiation would be controlled ALARA using engineering design and administrative controls. The LANL performance goal is to maintain a worker's whole body dose to less than 2 rem per year (LANL 2002b). Waste management workers would be expected to maintain current exposure levels because of these administrative controls.

For nonradiological impacts, approximately 2 to 9 recordable injuries may occur for performing DD&D activities in TA-54 (which includes Areas L and G) using DOE and national safety statistics for construction activities. These values represent DD&D of all structures and processes; although not all of the structures and processes in Area L would be removed under Option 1, these would represent a small percentage of the overall total and would not appreciably lower the values. Several facilities would also be constructed in this option. Using DOE and national safety statistics for LANL, approximately 4 to 13 recordable injuries may occur during construction of the low-level radioactive facilities, the TRU Waste Facility, and the remote-handled transuranic waste retrieval facility.

Note that installation of a new TRUPACT II loading area would result in lower occupational safety impacts than the construction of the other facilities because this loading area would go in an existing fabric dome and would not require significant construction activities. In addition, occupational safety impacts due to moving transuranic waste processing equipment from outdoors to inside one of the fabric domes would be minimal.

Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment.

Cultural Resources

As noted in Section H.3.2.2.2, a location for the TRU Waste Facility has yet to be finalized. Thus, a generic area encompassing TA-35, TA-46, TA-48, TA-50, TA-51, TA-52, TA-54 West, TA-63, and TA-66 has been selected for analysis. For each TA, a generic site was selected within which the TRU Waste Facility could be constructed. The facility would be located on 2.5 to 7 acres (1 to 2.8 hectares) of land. **Table H–22** presents the number of archaeological resource sites identified within the vicinity of each generic TRU Waste Facility site, the number of the archaeological resources sites eligible or of undetermined status relative to listing on the National Register of Historic Places, and the number of eligible historic buildings and structures that could be affected.

Table H–22 Affected Cultural Resource Sites – TRU Waste Facility Site

Technical Area	*Archaeological Resource Sites Within Vicinity of TRU Waste Facility*	*NRHP Eligible/of Undetermined Status Sites Within Vicinity of TRU Waste Facility*	*NRHP Eligible Buildings and Structures Affected by TRU Waste Facility*
35	0	0/0	0
46	7	4/1	0
48	1	1/0	0
50	1	1/0	0
51	13	11/2	0
52	3	3/0	0
54 West	16	13/0	0
63	0	0/0	0
66	4	½	0

NRHP = National Register of Historic Places.

Due to its large size, TA-54 has many cultural resource sites; thus, only those resources within the TA that are in the vicinity of Area G and Area L are summarized in this section. There are 22 cultural resource sites near Area G and 10 in the vicinity of Area L and Zone 4. Of the 22 archeological sites located within Area G, 7 have been excavated within the MDA and 1 partially excavated with Zone 4. All identified cultural resource sites are prehistoric and include lithic and ceramic scatters, rock art, rock shelters, cavates, a 1- to 3-room structure, Pueblo roomblocks, and plaza Pueblos. Fourteen sites within the vicinity of Area G have been determined to be eligible for listing on the National Register of Historic Places, while 8 are ineligible. A number of prehistoric sites were located within Area G prior to its development; however, these were examined by archaeologists prior to development of the MDA. All 10 prehistoric sites located within TA-54 in the vicinity of Area L have been determined to be eligible for listing in the National Register of Historic Places. Of the 10 sites located in the vicinity of Area L, 1 has been excavated. Eight archaeological sites are located in Zone 4, which is where low-level radioactive waste disposal operations are being expanded.

Construction, DD&D, and Operations Impacts—Under this option all actions in TA-54, including new construction and removal of the domes, would take place within developed areas. Thus, there would be no direct impact on cultural resources. However, a number of cultural resource sites are located nearby; and, the potential exists for indirect impacts to these resources. In order to ensure these resources would not be affected, cultural resource site boundaries would be marked and fenced, as appropriate, prior to groundbreaking activities. Fencing would prevent accidental intrusion and disturbance to the sites.

As noted in Table H–22, archaeological resource sites are located within the vicinity of all generic TRU Waste Facility sites, except those in TA-35 and TA-63. National Register of Historic Places-eligible sites and sites of undetermined status include 1- to 3-room structures, rock and wood enclosures, pueblo roadblocks, lithic and historic scatters, caveats, and rock shelters. Although archaeological resources are located in the vicinity of a number of generic sites, only those in TA-50, TA-54 West, and TA-66 have the potential to be directly affected by construction of the TRU Waste Facility. Direct and indirect impacts to archaeological resources would require notifying appropriate LANL personnel and implementation of the requirements of the *Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico* (LANL 2006c). Mitigation measures, including avoidance, would be taken to ensure that construction activity, traffic, and ground disturbances would not result in damage to the resources. These measures would be incorporated into a formal Memorandum of Agreement between DOE and the New Mexico Historic Preservation Division to resolve adverse effects. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment. Construction of the TRU Waste Facility would not impact any National Register of Historic Places-eligible buildings or structures.

Adverse impacts on traditional cultural properties from activities associated with the waste management facilities would be unlikely since most activities would take place within previously disturbed portions of TA-54. However, removal of the domes at TA-54, some of which are white-colored and therefore highly visible, would have a positive impact on views from Pueblo of San Ildefonso lands which border the TA to the north. As noted for Visual Resources, the TRU Waste Facility would be visible from San Ildefonso Pueblo lands if built within TA-51, TA-52, or TA-54 West. Thus, impacts to traditional cultural properties are possible if the new facility were built within these TAs. Impact potential is reduced within TA-54 West since construction would take place within a developed area.

Socioeconomics and Infrastructure

Both from a utility infrastructure and secondary impacts perspective, the greatest impact would occur from selection of an undeveloped site that is not proximal to existing utility corridors. However, the eastern Pajarito Road corridor from TA-48 to TA-54 West, in which the new TRU Waste Facility is proposed to be constructed, is generally well served by electric power, water, and natural gas distribution lines (LANL 2000a, 2004b). For the purposes of analyzing the potential infrastructure impacts associated with waste management facilities transition options, it was assumed that planned electrical upgrades for TA-50 would occur regardless of this proposed project.

Construction and DD&D Impacts—Utility resource requirements to support construction of the proposed new waste management facilities are expected to have a minor incremental impact on site utility infrastructure. Approximately 422,000 gallons (1.6 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work, mainly for use by heavy equipment and for new facility construction. Liquid fuels would be procured from offsite sources and, therefore, would not be limited resources. In addition, it is anticipated that approximately 2.3 million gallons (9 million liters) of water would be needed for construction, primarily for dust suppression and soil compaction. The existing LANL water supply infrastructure would be capable of handling this demand. Electrical and water usage in Area L would slightly decrease due to a decrease in waste management operations.

Operations Impacts—Upon completion, operation of the new waste management facilities for the timeframes required would be expected to have a negligible incremental impact on LANL utility infrastructure. The operation of new low-level radioactive waste processing facilities in Zone 4, TA-54 would offset decreased infrastructure usage gained by the DD&D of the current facilities. The remote-handled transuranic waste retrieval facility and the TRU Waste Facility do not have energy-intensive operations, regardless of where they are located.

Waste Management

The Solid Radioactive and Chemical Waste Facilities at TA-54 manage a variety of wastes including industrial and toxic wastes, hazardous wastes, low-level radioactive waste, transuranic waste, and mixtures of these wastes. Most of the wastes managed at this Key Facility are generated elsewhere, with waste quantities and associated impacts attributed to the generating facilities. However, the Chemical and Radioactive Waste Management Facilities generate secondary wastes from the treatment, storage, and disposal of chemical and radioactive wastes. Examples of secondary wastes include: repackaging wastes from the visual inspection of transuranic waste, high-efficiency particulate air filters from waste operations, personnel protective clothing and equipment, and process wastes from size reduction and compaction (LANL 2004b). Although operations at this Key Facility include the retrieval of stored legacy transuranic waste, this waste is not included in the waste generation quantities for the Solid Radioactive and Chemical Waste Facilities. Historical chemical and radioactive waste generation information is provided in **Table H–23**.

Table H–23 Waste Generation Ranges and Annual Average Generation Rates for the Solid Radioactive and Chemical Waste Facilities

Waste Type	*Rates for the Period 1999 to 2005*	
Low-level Radioactive Waste (cubic yards)	Range	17 to 368
	Average	114
Mixed Low-level Radioactive Waste (cubic yards)	Range	0 to 0
	Average	0
Transuranic Waste (cubic yards)	Range	0 to 115
	Average	36
Mixed Transuranic Waste (cubic yards)	Range	0 to 77
	Average	18
Chemical Waste (pounds)	Range	70 to 6,240
	Average	2,203

Notes: The Solid Radioactive and Chemical Waste Facilities data were compiled jointly for waste management facilities at both TA-54 and TA-50. Only activities within TA-54 would be affected by closure of MDA L and MDA G; therefore, the values shown are a conservative estimate of waste management impacts to the affected environment. To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456.
Sources: LANL 2003d, 2004c, 2005d, 2006f.

Construction and DD&D Impacts—Construction of new facilities under Option 1 would generate some waste, primarily construction debris and associated solid waste. Construction debris is not hazardous, and is managed at solid waste landfills. Approximately 250 cubic yards (227 cubic meters) of construction debris would be expected from construction activities under Option 1.

A significant quantity of low-level radioactive waste and a small quantity of mixed low-level radioactive waste would be generated by DD&D of the aboveground facilities in Area L and MDA L, and Area G and MDA G, as detailed in **Table H–24**.

Table H–24 Estimated Waste Volumes from Decontamination, Decommissioning and Demolition Activities (cubic yards)

Low Specific Activity Waste	*Packaged Low-level Radioactive Waste*	*Mixed Low-level Radioactive Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
22,700	7,600	8	54,200	35	530

[a] Includes construction, demolition, and sanitary waste.
Notes: It is assumed 25 percent of the low-level radioactive waste volume requires packaging. To convert cubic yards to cubic meters, multiply by 0.76456.

Operations Impacts—Operations under Option 1 would be expected to produce additional quantities of low-level radioactive waste and transuranic waste, including some mixed low-level radioactive waste and mixed transuranic waste. As contact-handled transuranic waste is retrieved from trenches, pits, and shafts, and remote-handled transuranic waste is retrieved from shafts, secondary wastes would be generated through retrieval efforts, characterization, size reduction, and repackaging efforts. Because the retrieval facilities would be newly designed with waste minimization principles applied, some efficiency over past retrieval operations would be expected. Low-level radioactive waste would be disposed of onsite or shipped offsite, with the selected disposal path determined based on Zone 4 capacity and disposal priorities. Transuranic wastes would be transported to WIPP for disposal. Solid, hazardous and asbestos wastes would be dispositioned according to current practices. The quantities of secondary wastes to be generated would be expected to be small in comparison to the retrieved waste and to LANL-wide quantities from operations. No significant impacts to the waste management infrastructure would be expected from the additional quantities of secondary wastes generated from the wastes generated under Option 1.

Transportation

Motor vehicles are the primary means of transportation at LANL. Regional transportation route(s) to LANL include: Albuquerque and Santa Fe – Interstate-25 to U.S. 84/285 to NM 502; from Española – NM 30 to NM 502; and from Jemez Springs and western communities – NM 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to NM 4 to NM 502. Only two major roads, NM 502 and NM 4, access Los Alamos County. Los Alamos County traffic volume on these two segments of highway is primarily associated with LANL activities. Pajarito Road generally bisects the LANL site between NM 4 and Diamond Drive in an east-west presentation. NNSA recently closed Pajarito Road to public use; it is now only used by site personnel for accessing the site from Diamond Drive and White Rock and moving between technical areas.

Table H–25 presents results of traffic surveys performed on Pajarito Road just east of TA-63, which is between TA-50 and TA-54. This location would therefore be representative of the stretch of the road impacted by waste shipment activities for Solid Radioactive and Chemical Waste Management Facilities.

Table H–25 2004 Traffic Counts Along Pajarito Road Immediately East of Technical Area 63

Location	*Average Vehicles per Weekday*	*Average Vehicles per Weekend Day*	*AM Eastbound Peak Vehicles per Hour*	*PM Eastbound Peak Vehicles per Hour*
Pajarito Road immediately east of TA-63	5,758	674	859	825

TA = technical area.
Source: KSL 2004.

As part of current operations, LANL security periodically conducts road closures to allow shipments of transuranic waste to occur between TA-54 and TA-50 (where the Waste Characterization, Reduction, and Repackaging Facility is located), between TA-54 Area G and TA-54 West (where the Radioassay and Nondestructive Testing Facility is located), and to allow shipment of transuranic waste from production and research and development facilities to TA-54. These road closures are necessary to allow the safe shipment of transuranic waste that has yet to be packaged in U.S. Department of Transportation-approved containers (such as TRUPACT II containers) and to minimize radiation exposure to non-involved workers (that is, those workers traveling on the road but not supporting the waste management shipments). Since Pajarito Road is closed to public access, these road closures primarily impact only onsite workers and operations.

Construction and DD&D Impacts—The construction of the TRU Waste Facility and remote-handled transuranic waste retrieval facility would slightly increase traffic on Pajarito Road due to shipment of materials and construction equipment to these proposed facilities. This would occur only over a period of a few years (2007 to 2011) until construction is complete. There would not be a noticeable increase in construction workforce traffic because it is assumed that the construction workforce currently onsite on other projects would be sufficient to complete these new waste management facilities. There would not be a significant increase in the operational workforce traffic, as the operators for these two facilities would primarily be drawn from the existing workforce and these facilities would not have large staffing requirements. The construction of the replacement low-level radioactive waste processing facilities in Zone 4 would create temporary, but small increases in construction traffic volume on Pajarito Road. The transportation of DD&D wastes related to some of the facilities in Area L and all of the facilities in Area G would primarily be local and stay within TA-54 for radioactive waste shipments, with additional shipments of rubble and other industrial wastes transported to offsite disposal facilities.

The effects from incident-free transportation of these radioactive wastes for the worker population and the general public are presented as collective dose in person-rem resulting in excess LCFs in **Table H–26**. Excess LCFs are the number of cancer fatalities that may be attributable to the proposed project that may occur in the exposed population over the lifetimes of the individuals. If the number of LCFs is less than one, the subject population is not expected to incur any LCFs resulting from the actions being analyzed. The risk for development of excess LCFs is highest for workers under the offsite disposition option. This is because the dose is proportional to the duration of transport which in turn is proportional to travel distance. As shown in Table H–26, disposal offsite would lead to a higher dose and risk than disposal onsite.

Table H–26 Incident-Free Transportation Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities

Disposal Option	Low-level Radioactive Waste Disposal Location [a]	Crew		Public	
		Collective Dose (person-rem)	Risk (LCFs)	Collective Dose (person-rem)	Risk (LCFs)
Onsite disposal	LANL TA-54	0.02	1×10^{-5}	0.005	3×10^{-6}
Offsite disposal	Nevada Test Site	8.11	5×10^{-3}	2.35	1×10^{-3}
	Commercial Facility	7.86	5×10^{-3}	2.29	1×10^{-3}

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes are disposed of at WIPP.
Note: The number of shipments is based on DD&D of all above-ground facilities in TA-54, Areas G and L and includes only radioactive waste shipments. For Option 1, a few facilities in Area L would remain, but would not result in any appreciable change to the table values.

Table H–27 presents the impacts from traffic and radiological accidents. This table provides population risks in terms of fatalities due to traffic accidents, both from the collision and from excess LCFs due to exposure to radioactive releases. The analyses assumed that all generated wastes would be transported to offsite disposal facilities. The results indicate that no traffic fatalities and no excess LCFs are expected to occur from transportation accidents during DD&D activities in TA-54.

Table H–27 Transportation Accident Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities

Radioactive Waste Disposal Location [a, c]	Number of Shipments [b]	Distance Traveled for All Shipments (million miles)	Accident Risks	
			Radiological (excess LCFs)	Traffic (fatalities)
LANL TA-54	4,871	1.3	NA [d]	0.02
Nevada Test Site	4,871	5.9	2×10^{-7}	0.06
Commercial Facility	4,871	5.4	2×10^{-7}	0.06

LCF = latent cancer fatality, TA = technical area, NA = not applicable.
[a] All nonradiological wastes would be transported offsite.
[b] 37 percent of shipments are for radioactive wastes, with the remaining 63 percent for industrial, sanitary, asbestos, and hazardous wastes.
[c] Transuranic wastes are disposed of at WIPP.
[d] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.
Note: The number of shipments is based on DD&D of all above-ground facilities in TA-54 and includes radioactive and non-radioactive waste shipments. For Option 1, a few nonradiological facilities in Area L would remain, but would not result in any appreciable change to the table values.
Note: To convert miles to kilometers, multiply by 1.6093.

The above incident-free and accident impacts were derived using the assumptions provided in Appendix K.

Operations Impacts—In Option 1, additional transuranic waste processing capabilities (that is, installation of modular units and additional equipment, and addition of a TRUPACT II loading area) would be installed in Area G to accelerate the offsite shipment of this waste to WIPP. These additions would replace the capabilities currently provided by the Waste Characterization, Reduction, and Repackaging Facility in TA-50 and the Radioassay and Nondestructive Testing Facility in TA-54 West. In this case, the transportation of transuranic waste to and from TA-50 and TA-54 West would be eliminated, as would the need for closing Pajarito Road to transport transuranic waste to and from the Waste Characterization, Reduction, and Repackaging Facility and Radioassay and Nondestructive Testing Facility, which would otherwise occur under the No Action Option. Road closures would continue to allow for the shipment of newly-generated transuranic waste from LANL production areas to TA-54 while Area G and MDA G remains open. In Option 1, LANL staff would ship all transuranic waste stored above-ground and below-ground to WIPP. Appendix K addresses the transportation impacts for removal of these wastes.

The TRU Waste Facility would be located in Pajarito Road corridor somewhere between TA-54 West and TA-50. If this occurs, transportation impacts would be smaller than those for No Action for transporting transuranic waste from facilities generating the waste to waste processing facilities because the TRU Waste Facility would be located closer, or adjacent, to the facilities generating the transuranic waste. This would also mean that road closures to onsite traffic would be reduced or eliminated, and would not occur on Pajarito Road.

Transportation impacts due to use of the new low-level radioactive waste characterization and verification building and compactor building in Zone 4, and continued use of Area L for mixed low-level radioactive waste and hazardous and chemical waste storage would be similar to the impacts related to No Action.

Transportation impacts related to hazardous and chemical waste and mixed low-level radioactive waste storage would be similar to the impacts associated with the No Action Option, because the current transportation pattern would not significantly change.

Facility Accidents

Three accident scenarios not otherwise considered in this SWEIS could occur in association with proposed waste management facilities transition options. For Option 1, an accident scenario would be associated with the retrieval of the higher activity remote-handled transuranic waste from Shafts 200-232 in Area G, which contain 953 cubic feet (27 cubic meters) of this waste in 1-gallon (3.8 liter) cans (LANL 2005c). A remote-handled transuranic waste retrieval facility is proposed to be constructed to allow retrieval of this waste. A bounding accident would be an explosion while retrieving the inventory from a shaft, causing a loss of confinement by the waste facility. Although there is no indication of explosives or chemicals in the shafts which could cause such an explosion, their absence is not completely certain. This scenario is analogous to the accident scenario addressed in Appendix I involving an assumed explosion during waste removal from MDA G.

The radionuclide inventory of each of the shafts was compared and Shafts 205 and 206 were determined to be those which could potentially result in the greatest consequences in the event of an accident. The frequency of occurrence of the accident was estimated to be 1 in 1,000 years. Shaft 206 would result in the largest impacts from inhalation of radionuclide releases based on its transuranic radionuclide inventory, but the external dose to the noninvolved worker (located 110 yards [100 meters] from the source) and to the MEI (located at the site boundary) from the mixed fission product inventory in Shaft 205 together with internal and external dose from releases from this shaft was also investigated to assure that these consequences were not greater. The accident analysis for this facility therefore separately determined the potential impacts for retrieving waste from Shaft 205 and 206.

Also for Option 1, the TRU Waste Facility, which would be located along the Pajarito Road corridor, was analyzed for an accident scenario in which a seismic event occurs and the radiological contents are released. Such an accident would be equivalent to that analyzed for the Decontamination and Volume Reduction System in its Safety Analysis Report, based on the assumption that the operations at the TRU Waste Facility would be similar to current operations at the Decontamination and Volume Reduction System. The area in which the TRU Waste Facility could be located bounds potential sites in the following technical areas: TA-35, TA-46, TA-48, TA-50 (including the south side of Pajarito Road), TA-51, TA-52, TA-54 West, TA-63, and TA-66. To bound these sites, locations were selected for analysis that provide the largest impact to the MEI and the 50-mile (80-kilometer) population. The 50-mile (80-kilometer) population dose is based on two locations, one closest to White Rock and one closest to the Los Alamos townsite. The dose to the MEI was calculated using dose versus distance data in Appendix D. Impacts to the noninvolved worker, located 110 yards (100 meters) from the accident, would be identical for all potential sites.

Table H–28 shows the source information used to calculate impacts to the workers and public from these three accident scenarios. **Tables H–29, H–30, and H–31** present the associated impacts. The analysis of accidents is performed assuming that the exposed people take no protective action that would reduce their exposure.

Based on Table H–31, impacts from an accident involving an explosion at the remote-handled transuranic waste retrieval facility was verified to be higher for Shaft 206 than Shaft 205, although they are on the same order of magnitude. For Option 2a, the impacts from the accidental release of remote-handled transuranic waste from the TRU Waste Facility are less than those that would result from the release of contact-handled transuranic waste from the TRU Waste Facility. The population dose from an accidental release at the TRU Waste Facility is less than that at TA-54 from current operations, mainly as a result of locating two domes at the alternative location versus the eleven domes at TA-54; the decrease is tempered by conservatively assuming a TRU Waste Facility site in TA-48, which is closer to the town of Los Alamos. The MEI dose decreases by a factor of about 3 as a result of the greater distance to the receptor plus the decrease in dome inventory. The MEI dose decreases by an order of magnitude, chiefly as result of the greater distance to this receptor plus the decrease in dome inventory. The non-involved worker dose is roughly the same at the two sites, reflecting the different meteorological data stations used (TA-6 meteorological tower for the alternative site, TA-54 meteorological tower at TA-54) and the smaller dome inventory.

Table H–28 Alternative Site Source Terms

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Scenario Name: Explosion at MDA-G RH-TRU Shaft 205													
Explosion	Cesium-137	curies	113	1	0.001	1	-	1	0.113	1	0	0	N
	Europium-155		0.0719	1	0.001	1	-	1	0.0000719	1	0	0	N
	Promethium-147		0.00595	1	0.001	1	-	1	5.95×10^{-6}	1	0	0	N
	Plutonium-239		7.25	1	0.001	1	-	1	0.00725	1	0	0	N
	Ruthenium-106		3.55×10^{-9}	1	0.001	1	-	1	3.55×10^{-12}	1	0	0	N
	Antimony-125		0.00635	1	0.001	1	-	1	6.35×10^{-6}	1	0	0	N
	Strontium-90		101	1	0.001	1	-	1	0.101	1	0	0	N
	Tellurium-125m		0.00154	1	0.001	1	-	1	1.54×10^{-6}	1	0	0	N
	Uranium-235		0.00085	1	0.001	1	-	1	8.50×10^{-7}	1	0	0	N
	Yttrium-90		100	1	0.001	1	-	1	0.1	1	0	0	N
Suspension	Cesium-137	curies	113	1	-	1	4.00×10^{-6}	1	0.0108	1,440	0	0	N
	Europium-155		0.0718	1	-	1	4.00×10^{-6}	1	6.90×10^{-6}	1,440	0	0	N
	Promethium-147		0.00594	1	-	1	4.00×10^{-6}	1	5.71×10^{-7}	1,440	0	0	N
	Plutonium-239		7.24	1	-	1	4.00×10^{-6}	1	0.000695	1,440	0	0	N
	Ruthenium-106		3.55×10^{-9}	1	-	1	4.00×10^{-6}	1	3.40×10^{-13}	1,440	0	0	N
	Antimony-125		0.00634	1	-	1	4.00×10^{-6}	1	6.09×10^{-7}	1,440	0	0	N
	Strontium-90		101	1	-	1	4.00×10^{-6}	1	0.00969	1,440	0	0	N
	Tellurium-125m		0.00154	1	-	1	4.00×10^{-6}	1	1.48×10^{-7}	1,440	0	0	N
	Uranium-235		0.000849	1	-	1	4.00×10^{-6}	1	8.15×10^{-8}	1,440	0	0	N
	Yttrium-90		99.9	1	-	1	4.00×10^{-6}	1	0.00959	1,440	0	0	N
Scenario Name: Explosion at MDA-G RH-TRU Shaft 206													
Explosion	Cesium-137	curies	49.5	1	0.001	1	-	1	0.0495	1	0	0	N
	Europium-155		0.0353	1	0.001	1	-	1	0.0000353	1	0	0	N
	Promethium-147		0.00331	1	0.001	1	-	1	3.31×10^{-6}	1	0	0	N
	Plutonium-239		17.5	1	0.001	1	-	1	0.0175	1	0	0	N
	Ruthenium-106		3.01×10^{-9}	1	0.001	1	-	1	3.01×10^{-12}	1	0	0	N
	Antimony-125		0.00349	1	0.001	1	-	1	3.49×10^{-6}	1	0	0	N

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
	Strontium-90		44.4	1	0.001	1	-	1	0.0444	1	0	0	N
	Tellurium-125m		0.000844	1	0.001	1	-	1	8.44×10^{-7}	1	0	0	N
	Uranium-235		0.00178	1	0.001	1	-	1	1.78×10^{-6}	1	0	0	N
	Yttrium-90		43.9	1	0.001	1	-	1	0.0439	1	0	0	N
Suspension	Cesium-137	curies	49.5	1	-	1	4.00×10^{-6}	1	0.00475	1,440	0	0	N
	Europium-155		0.0353	1	-	1	4.00×10^{-6}	1	3.39×10^{-6}	1,440	0	0	N
	Promethium-147		0.00331	1	-	1	4.00×10^{-6}	1	3.17×10^{-7}	1,440	0	0	N
	Plutonium-239		17.5	1	-	1	4.00×10^{-6}	1	0.00168	1,440	0	0	N
	Ruthenium-106		3.01×10^{-9}	1	-	1	4.00×10^{-6}	1	2.89×10^{-13}	1,440	0	0	N
	Antimony-125		0.00349	1	-	1	4.00×10^{-6}	1	3.35×10^{-7}	1,440	0	0	N
	Strontium-90		44.4	1	-	1	4.00×10^{-6}	1	0.00426	1,440	0	0	N
	Tellurium-125m		0.000843	1	-	1	4.00×10^{-6}	1	8.09×10^{-8}	1,440	0	0	N
	Uranium-235		0.00178	1	-	1	4.00×10^{-6}	1	1.71×10^{-7}	1,440	0	0	N
	Yttrium-90		43.9	1	-	1	4.00×10^{-6}	1	0.00421	1,440	0	0	N
Scenario Name: Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location													
Initial Impact	Americium-241	curies	1.82	0.167	0.001	0.3	-	1	0.0000910	10	0	0	N
	Cobalt-60		0.661	0.167	0.001	0.3	-	1	0.0000331	10	0	0	N
	Cesium-137		508	0.167	0.001	0.3	-	1	0.0254	10	0	0	N
	Europium-155		0.392	0.167	0.001	0.3	-	1	0.0000196	10	0	0	N
	Promethium-147		0.0416	0.167	0.001	0.3	-	1	2.08×10^{-6}	10	0	0	N
	Plutonium-238		1.29	0.167	0.001	0.3	-	1	0.0000645	10	0	0	N
	Plutonium-239		77.6	0.167	0.001	0.3	-	1	0.00388	10	0	0	N
	Plutonium-240		2.42	0.167	0.001	0.3	-	1	0.000121	10	0	0	N
	Plutonium-241		29.4	0.167	0.001	0.3	-	1	0.00147	10	0	0	N
	Plutonium-242		0.00146	0.167	0.001	0.3	-	1	7.30×10^{-8}	10	0	0	N
	Ruthenium-106		7.57×10^{-8}	0.167	0.001	0.3	-	1	3.79×10^{-12}	10	0	0	N
	Antimony-125		0.043	0.167	0.001	0.3	-	1	2.15×10^{-6}	10	0	0	N
	Strontium-90		455	0.167	0.001	0.3	-	1	0.0228	10	0	0	N
	Tellurium-125m		0.0104	0.167	0.001	0.3	-	1	5.20×10^{-7}	10	0	0	N

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
	Uranium-234		0.000761	0.167	0.001	0.3	-	1	3.81×10^{-8}	10	0	0	N
	Uranium-235		0.00859	0.167	0.001	0.3	-	1	4.30×10^{-7}	10	0	0	N
	Uranium-236		2.76×10^{-6}	0.167	0.001	0.3	-	1	1.38×10^{-10}	10	0	0	N
	Uranium-238		0.0000401	0.167	0.001	0.3	-	1	2.01×10^{-9}	10	0	0	N
	Yttrium-90		450	0.167	0.001	0.3	-	1	0.0225	10	0	0	N
Suspension	Americium-241	curies	1.82	1	-	1	4.00×10^{-6}	1	0.000175	1,440	0	0	N
	Cobalt-60		0.661	1	-	1	4.00×10^{-6}	1	0.0000635	1,440	0	0	N
	Cesium-137		508	1	-	1	4.00×10^{-6}	1	0.0488	1,440	0	0	N
	Europium-155		0.392	1	-	1	4.00×10^{-6}	1	0.0000376	1,440	0	0	N
	Promethium-147		0.0416	1	-	1	4.00×10^{-6}	1	3.99×10^{-6}	1,440	0	0	N
	Plutonium-238		1.29	1	-	1	4.00×10^{-6}	1	0.000124	1,440	0	0	N
	Plutonium-239		77.6	1	-	1	4.00×10^{-6}	1	0.00745	1,440	0	0	N
	Plutonium-240		2.42	1	-	1	4.00×10^{-6}	1	0.000232	1,440	0	0	N
	Plutonium-241		29.4	1	-	1	4.00×10^{-6}	1	0.00282	1,440	0	0	N
	Plutonium-242		0.00146	1	-	1	4.00×10^{-6}	1	1.40×10^{-7}	1,440	0	0	N
	Ruthenium-106		7.57×10^{-8}	1	-	1	4.00×10^{-6}	1	7.27×10^{-12}	1,440	0	0	N
	Antimony-125		0.0430	1	-	1	4.00×10^{-6}	1	4.13×10^{-6}	1,440	0	0	N
	Strontium-90		455	1	-	1	4.00×10^{-6}	1	0.0437	1,440	0	0	N
	Tellurium-125m		0.0104	1	-	1	4.00×10^{-6}	1	9.98×10^{-7}	1,440	0	0	N
	Uranium-234		0.000761	1	-	1	4.00×10^{-6}	1	7.31×10^{-8}	1,440	0	0	N
	Uranium-235		0.00859	1	-	1	4.00×10^{-6}	1	8.25×10^{-7}	1,440	0	0	N
	Uranium-236		2.76×10^{-6}	1	-	1	4.00×10^{-6}	1	2.65×10^{-10}	1,440	0	0	N
	Uranium-238		0.0000401	1	-	1	4.00×10^{-6}	1	3.85×10^{-9}	1,440	0	0	N
	Yttrium-90		450	1	-	1	4.00×10^{-6}	1	0.0432	1,440	0	0	N

Accident Phase	*Nuclide*	*Material at Risk (curies or grams)*	*Material at Risk*	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Airborne Release Rate (per hour)*	*Leak Path Factor*	*Source Term (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Scenario Name: Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location													
Initial Impact Combustibles													
Drums	Plutonium Equivalent	curies	11,854	0.333	0.001	0.3	-	1	1.19	10	0	0	N
Overpacks			5,202	0.167	0.001	0.3	-	1	0.260	10	0	0	N
Initial Impact Non-combustibles													
Drums	Plutonium Equivalent	curies	35,660	0.333	0.000849	0.3	-	1	3.03	10	0	0	N
Overpacks			15,650	0.167	0.000762	0.3	-	1	0.596	10	0	0	N
Suspension													
Combustibles	Plutonium Equivalent	curies	4,814	1	-	1	4.00×10^{-6}	1	0.462	1,440	0	0	N
Non-combustibles			12,071	1	-	1	4.00×10^{-6}	1	1.16	1,440	0	0	N
Total													
Initial Impact	Plutonium Equivalent	curies	-	-	-	-	-	-	5.07	10	0	0	N
Suspension			-	-	-	-	-	-	1.62	1,440	0	0	N
Scenario Name: Seismic Event Releasing TRU from the TRU Waste Facility Assuming Equivalent to DVRS Operations													
PC-3 Seismic	Plutonium Equivalent	curies	1,100	1	0.001	1	-	1	1.1	1,440	0	0	N

MAR = material at risk, MDA = material disposal area, RH-TRU = remote-handled transuranic, N = no, CH-TRU = contact-handled transuranic, DVRS = Decontamination and Volume Reduction System.

Table H–29 Alternative Site Radiological Accident Consequences

Accident Scenario	MEI		Population to 50 Miles	
	Dose (rem)	LCF [a]	Dose (person-rem)	LCF [b, c]
Explosion at MDA G RH-TRU Shaft 205	0.33	0.00020	14	0.0081
Explosion at MDA G RH-TRU Shaft 206	0.75	0.00045	15	0.0087
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location [d]	0.19	0.00011	14	0.0085
Seismic Event Releasing Transuranic Waste from the TRU Waste Facility Assuming Equivalent to DVRS Operations	10	0.0062	1,080	0.65
Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location [d]	142	0.17	6,640	4.0

MEI = maximally exposed individual, LCF = latent cancer fatality, MDA = material disposal area, RH-TRU = remote-handled transuranic waste, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic waste.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Increased number of LCFs for the population, assuming the accident occurs.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 300,000 (generic site), 343,000 (MDA-G).

[d] Option 2 only.

Table H–30 Alternative Site Radiological Accident Onsite Worker Consequences

Accident Scenario	Non-involved Worker (at 100 meters)	
	Dose (rem)	LCF [a]
Explosion at MDA G RH-TRU Shaft 205	2.4	0.00143
Explosion at MDA G RH-TRU Shaft 206	5.5	0.00329
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location [b]	2.4	0.00142
Seismic Event Releasing Transuranic Waste from the TRU Waste Facility Assuming Equivalent to DVRS Operations	132	0.158
Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location [b]	1820	2.18

LCF = latent cancer fatality, MDA = material disposal area, RH-TRU = remote-handled transuranic waste, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic waste.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Option 2 only.

Table H–31 Alternative Site Radiological Accident Offsite Population and Worker Risks

Accident Scenario	Onsite Worker (LCFs)	Offsite Population (LCFs)	
	Non-involved Worker (at 100 meters) [a]	MEI [a]	Population to 50 Miles [b, c]
Explosion at MDA G RH-TRU Shaft 205	1.4×10^{-6}	2.0×10^{-7}	8.1×10^{-6}
Explosion at MDA G RH-TRU Shaft 206	3.3×10^{-6}	4.5×10^{-7}	8.7×10^{-6}
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at TRU Waste Facility Location [d, e]	7.1×10^{-7}	5.6×10^{-8}	4.3×10^{-6}
Seismic Event Releasing Transuranic Waste from the TRU Waste Facility Assuming Equivalent to DVRS Operations [e]	0.000079	3.1×10^{-6}	0.00032
Seismic Event Releasing CH-TRU from Two Storage Buildings at the TRU Waste Facility Location [d, e]	0.0011	0.000085	0.0020

MEI = maximally exposed individual, MDA = material disposal area, RH-TRU = remote-handled transuranic waste, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic waste.

[a] Increased risk of an LCF to an individual per year.

[b] Increased number of LCFs for the population per year.

[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 302,000 (TRU Waste Facility), 343,000 (MDA-G).

[d] Option 2 only.

[e] An updated probabilistic seismic hazard analysis has been completed for LANL (LANL 2007), which results in higher peak horizontal ground acceleration values for the same annual probability of exceedance. In the seismic accident analyses for the TRU Waste Facility, the radioactive source term was conservatively based on the assumption that all structures, systems, and components failed, therefore, the updated probabilistic seismic hazard analysis is not expected to change the accident consequences or risks.

These accident scenarios bound those that would be associated with other operation options. Leaving remote-handled transuranic waste in place in the shafts (Option 2b) could have a scenario similar to the retrieval explosion scenario analyzed, but would not be associated with a storage scenario described above.

H.3.3.3 Option 2: Interim Actions Necessary for Meeting Consent Order and Other Alternatives

As described in Section H.3.2.3, Option 2 varies from Option 1 in the event that legacy and newly generated stored wastes cannot be removed from storage, processed, and shipped to disposal facilities on an accelerated schedule that would allow completion of closure activities in Area L and MDA L, and Area G and MDA G, as required by the Consent Order. Under Option 2a, NNSA would move the remaining transuranic waste from Area G to two new storage buildings in another location to be stored until the waste could be processed and shipped. Under Option 2b, NNSA would leave the high activity remote-handled transuranic waste in place, while removing the other easier-to-retrieve transuranic waste for storage in two new storage buildings. Under Option 2c, mixed low-level radioactive waste and hazardous waste would also be stored at the TRU Waste Facility and the use of Area L would cease for these operations.

Land Resources

Land Use

As is the case for Option 1, actions taking place under this option within TA-54 would be within disturbed areas. Options 2a and 2b would require the construction of two storage buildings for legacy transuranic waste currently stored in Area G but which needs to be relocated. The two additional storage buildings could be co-located with the TRU Waste Facility or be separate from it. In Option 2c, mixed low-level radioactive waste and hazardous and chemical waste storage would also be provided at the TRU Waste Facility. Providing additional transuranic waste storage space would not result in a meaningful change to impacts described in Option 1 since land use designations would not change. Additional facilities that would be closed in Area L (that would not otherwise be closed in Option 1) are located in previously disturbed areas; therefore impacts to land use would be minimal.

Visual Environment

In addition to the processes and facilities constructed as part of Option 1, the two transuranic waste storage buildings proposed in Options 2a and 2b that would store legacy transuranic waste would cause varying visual impacts, depending upon the specific location chosen. Construction of the new storage buildings within a developed area north of Pajarito Road would result in minimal impacts to visual resources. However, if built south of Pajarito Road, the buildings would alter the current open view. NNSA would mitigate the visual impacts from these storage buildings during their design by taking into consideration visual impacts previously created by the use of white-colored fabric domes in Area G and following the design principles provided in the LANL architectural guide (LANL 2002a).

For Option 2b, since the high activity transuranic waste would be left in the shafts, no change to visual impacts would occur in TA-54 since the remote-handled transuranic waste retrieval facility would not be constructed.

Proposed hazardous and chemical waste management activities to be added to the proposed TRU Waste Facility in Option 2c would have the same visual impacts as those for Option 1, except that all above-ground facilities in Area L would be removed, potentially creating a positive local visual impact.

Geology and Soils

Construction, Operations, and DD&D Impacts—Impacts on geology and soils and impacts due to the consumption of geologic resources under Option 2 would generally be similar to but greater than those described under Option 1. In Option 2a, two additional transuranic waste storage buildings would be constructed in previously disturbed areas, requiring an additional 89,000 cubic yards (68,000 cubic meters) of earthwork over Option 1. In Option 2b, the additional transuranic waste storage buildings would be constructed, but the remote-handled transuranic waste retrieval and processing facility would not be constructed, resulting in an additional 82,000 cubic yards (63,000 cubic meters) of earthwork. In Option 2c, the addition to the TRU Waste Facility of additional storage space for mixed low-level radioactive waste and hazardous and chemical waste would require minimal earthmoving impacts.

Geologic resource consumption would be negligible to small under this option and would not be expected to deplete local sources or stockpiles of required materials. Approximately 5,500 cubic yards (4,205 cubic meters) of additional concrete including associated aggregate (sand and gravel) and Portland cement would be needed during construction, as compared to Option 1. Component aggregate resources are readily available from onsite borrow areas and otherwise abundant in Los Alamos County, with the required concrete expected to be procured via an off-site supplier.

As detailed under Option 1, all proposed new facilities under Option 2 would be designed, constructed, and operated in compliance with the applicable DOE Orders, requirements, and governing standards that have been established to protect public and worker health and the environment. In addition, construction would use best management practices to minimize process impacts to soils and the surrounding environment.

Following the completion of Option 2, operations would not result in additional impacts on geologic and soil resources at LANL. As discussed above, new facilities would be evaluated, designed, and constructed in accordance with DOE Order 420.1B (DOE 2005b) and other governing DOE and LANL construction standards and sited to minimize the risk from geologic hazards, including earthquakes.

Water Resources

Construction Impacts—In Option 2a, construction of two storage buildings to store transuranic waste would require a construction stormwater pollution prevention plan. The construction stormwater controls would augment the existing industrial stormwater pollution prevention plan controls. In Option 2b, construction of any additional covers or other closure actions required to secure the remote-handled transuranic waste that remains in the shafts would require a construction stormwater pollution prevention plan. The construction stormwater controls would augment the existing industrial stormwater pollution prevention plan controls at TA-54. There would be no impacts on surface water for pursuing alternate permitting options for hazardous waste storage in Option 2c.

Operations Impacts—The proposed two transuranic waste storage facilities in Option 2a would have engineered features to minimize the potential for any liquid release from the transuranic waste storage activities. If remote-handled transuranic waste remains in the storage shafts in Area G and MDA G as proposed in Option 2b, then maintenance and regular inspection of any closure cover to ensure site stabilization would protect surface water from potential contamination. Post-closure care provisions would be included in the site's closure or remedial action plan. All staging areas used to store waste at sites other than TA-54 would need to be added to the Multi-Sector General Permit and would require an individual industrial stormwater pollution prevention plan for a hazardous waste storage facility or would need to be added to the TA-54 industrial stormwater pollution prevention plan as an auxiliary site. These sites would need to create spill and leak procedures and maintenance procedures, and begin stormwater monitoring for specific contaminants. Option 2c, which would relocate hazardous and mixed low-level radioactive waste storage operations from Area L to the proposed TRU Waste Facility, would also require this facility to be added to the Multi-Sector General Permit and have an individual stormwater pollution prevention plan.

For groundwater, the observations and considerations described for Option 1 are also relevant to Option 2. Contaminant transport rates in the vadose zone overall are unlikely to change during the SWEIS timeframe, and groundwater resources would not be affected over this period. Appropriately designed and constructed covers should eliminate any increased infiltration resulting from construction, DD&D, and operations activities.

Air Quality and Noise

Construction and DD&D Impacts—Similar to Option 1, construction of new waste processing facilities under Option 2 (that is, the legacy transuranic waste storage buildings) would result in temporary increases in air quality impacts from construction equipment, trucks, and employee vehicles. Impacts would be similar to those described in Option 1, as would the impacts related to DD&D activities.

Operations Impacts—During operations, impacts due to toxic air pollutants would be expected to be small and below the screening level emission values and it is expected that the air quality impacts on the public would be minor. Noise impacts for Option 2 are expected to be similar to impacts for Option 1.

Ecological Resources

Construction, Operations, and DD&D Impacts—Impacts to ecological resources under Option 2 would be similar to those described for Option 1 because similar actions would be taken within the same TAs. Providing additional storage space for legacy transuranic waste using two new buildings would not result in a meaningful change to these impacts, although the land requirement would be approximately 2.25 acres (0.9 hectare). The new storage areas would not adversely affect ecological resources because they would be located adjacent to existing structures and processes.

Human Health

Construction, Operations, and DD&D Impacts—In Option 2, all facilities in Area L and Area G would undergo DD&D. The occupational safety information presented for Option 1 would be applicable to Option 2.

For construction, the structures and processes proposed in Option 1 would still be constructed (except for the remote-handled transuranic waste retrieval facility in Option 2b). In addition, two storage buildings of approximately 30,000 square feet (2,787 square meters) each would be constructed to store transuranic waste from Area G. Approximately 3 recordable injuries could occur, based on available statistics.

Potential impacts from hazardous and toxic chemicals would continue to be prevented through the use of administrative controls and equipment while there would continue to be no impacts related to biological agents.

The dose to the maximum exposed individual and the population would be similar to that for Option 1. For Option 2a, the radiological impacts from the proposed remote-handled transuranic waste retrieval facility and the TRU Waste Facility would be the same as the impacts stated in Option 1. Radiological emissions related to the two proposed storage buildings would be considered "insignificant relative to other sources at LANL," which is a similar determination to that of the Waste Characterization, Reduction, and Repackaging Facility where characterization and packaging activities occur.

For Option 2b, the remote-handled transuranic waste retrieval facility would not be constructed and operated, therefore there would be no radiological dose to workers or the public related to retrieving the higher activity remote-handled transuranic waste from Shafts 200-232. Overall, the area source term would be similar to Option 1, because some retrieval activities, and all DD&D activities, would still occur.

For Option 2c, direct radiation levels in Area L would remain within background levels since mixed low-level radioactive waste storage operations would be removed from Area L.

Worker exposures to direct radiation would be controlled ALARA using engineering design and administrative controls. The LANL performance goal is to maintain a worker's whole body dose to less than 2 rem per year (LANL 2002b).

Cultural Resources

Construction, Operations, and DD&D Impacts—Impacts to cultural resources under Option 2 would be similar to those described for Option 1 since similar actions would be taken within the same TAs. Providing additional storage space for legacy transuranic waste would not result in a meaningful change to these impacts. Although the land requirement would increase to 2.25 acres

(0.9 hectares), construction activities would not directly impact cultural resources. The upgraded storage areas would not adversely affect cultural resources since they would be located adjacent to existing structures and processes.

Socioeconomics and Infrastructure

Construction and DD&D Impacts—Utility resource requirements to support construction of the proposed new waste management facilities under Option 2 would be about two times greater than those described under Option 1. Approximately 893,000 gallons (3.4 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work mainly for use by heavy equipment and for new facility construction. Liquid fuels would be procured from offsite sources and, therefore, would not be limited resources. In addition, it is anticipated that approximately 4.9 million gallons (18.5 million liters) of water would be needed for construction mainly for dust suppression and soil compaction. The existing LANL water supply infrastructure would still be easily capable of handling this demand.

Operations Impacts—Upon completion, operation of the new waste management facilities for the timeframes required would be expected to have a negligible incremental impact on LANL utility infrastructure.

Waste Management

Construction, and DD&D Impacts—Under Option 2, a similar level of impacts associated with construction and DD&D would occur as under Option 1. New buildings would be constructed to retrieve and process waste and older buildings would be demolished to allow remediation activities to take place. Some additional construction (generating an additional 260 cubic yards [200 cubic meters] of construction waste) of waste storage units may be necessary, depending upon the sub-option considered. The types and quantities of waste generated by construction and DD&D would be within the capacity of the LANL waste management infrastructure and mainly disposed of offsite.

Operations Impacts—Under Option 2, the same level of impacts associated with operational wastes would occur as under the Option 1. Some wastes may be stored longer, but operational impacts associated with the longer storage periods would be small. Operations, including remote-handled transuranic waste management activities, may be consolidated within the new TRU Waste Facility, to be located outside Area G. The types and quantities of wastes generated would be the same as those generated under Option 1.

Transportation

Construction and DD&D Impacts—In this option, two transuranic waste storage buildings would be constructed in a location other than Area G to store legacy transuranic waste currently in underground facilities in Area G. Similar construction impacts to Option 1 would occur.

Operations Impacts—Operation of two new transuranic waste storage buildings would require more shipments of transuranic waste on Pajarito Road than what would occur under Option 1 or the No Action Option. If the two transuranic waste storage buildings are not co-located with the proposed TRU Waste Facility, then additional shipments would need to occur to move the transuranic waste from the storage buildings to the TRU Waste Facility for processing and eventual shipment to a disposal facility. The number of shipments from Area G to the two storage buildings would be large and accompanying road closures would occur. Radiological doses to the workers would be monitored and administratively controlled as currently required.

Transportation impacts related to hazardous and chemical waste and mixed low-level radioactive waste storage would be similar to the impacts associated with the No Action Option, as the transportation pattern as currently observed would not significantly change.

Accidents

For Option 2a, it is assumed that complete removal of transuranic waste from TA-54 Area G and shipment to WIPP would not be accomplished on a schedule that would allow closure of Area G and MDA G to occur per the terms of the Consent Order. If this were to occur, two waste storage buildings, equivalent to waste storage domes currently in Area G, could be constructed and co-located with the TRU Waste Facility.

Two analyses were performed that bound the processing and storage of transuranic waste in Option 2. The first considered a seismic event for which the material at risk would be the entire remote-handled transuranic waste in Shafts 200-232. The conservative assumption was made that containers holding the waste would be no stronger than the overpacks used in the present waste storage domes at TA-54, Area G. The TRU Waste Facility would be designed to withstand an earthquake corresponding to a frequency of occurrence of 5×10^{-4} per year (or 1 chance in 2,000 years). This frequency is conservatively taken as the probability of the seismic event resulting in waste release. This scenario is analogous to the Site-wide Seismic 02 event resulting in a release from the waste storage domes at Area G that is analyzed in Appendix D. The second analysis for Option 2 considered the risk if contact-handled transuranic waste relocated from Area G was stored in the two storage buildings and released because of a seismic event. The material at risk in the two storage buildings was conservatively assumed to be double that of the Area G storage dome with the largest waste inventory.

Table H–28 shows the source information used to calculate impacts to the workers and public from these two accident scenarios. Tables H–29, H–30, and H–31 present the associated impacts. The accident results presented for Option 1 are also applicable to Option 2.

H.4 References

ACE (U.S. Army Corps of Engineers), 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico,* Albuquerque District, Albuquerque, New Mexico, October.

Bachmeier, C., 2005, "TRU Waste Processing Facility," INP Meeting Presentation, Los Alamos National Laboratory, Los Alamos, New Mexico, May 18.

DOE (U.S. Department of Energy), 1995, *Environmental Assessment of the Relocation of Neutron Tube Target Loading Operations*, DOE/EA-1131, Los Alamos Laboratory, Los Alamos, New Mexico.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory, Los Alamos, New Mexico Environmental Assessment*, DOE/EA-1269, Los Alamos Area Office, Los Alamos, New Mexico, June 23.

DOE (U.S. Department of Energy), 1999c, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 1999d, *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico*, DOE/EIS-0293, Los Alamos Area Office, Los Alamos, New Mexico, October.

DOE (U.S. Department of Energy), 2000, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE-SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2002a, *Environmental Assessment for the Proposed Issuance of an Easement to Public Service Company of New Mexico for the Construction and Operation of a 12-inch Natural Gas Pipeline within Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1409, National Nuclear Security Administration, Office of Los Alamos Site Operations, Los Alamos, New Mexico, July 24.

DOE (U.S. Department of Energy), 2002b, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, National Nuclear Security Administration, Washington, DC, August.

DOE (U.S. Department of Energy), 2002c, *Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory, Los Alamos, New Mexico,* DOE/EA-1408, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 8.

DOE (U.S. Department of Energy), 2002d, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Transuranic Waste Characterization at Los Alamos National Laboratory,* DOE/EIS-0238-SA2, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 13.

DOE (U.S. Department of Energy), 2005a, *Final Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production,* DOE/EA-1532, Sandia Site Office, Albuquerque, New Mexico, June.

DOE (U.S. Department of Energy), 2005b, *DOE Order 420.1B, Facility Safety,* Office of Environment, Safety and Health, Washington, DC, December 22.

DOE (U.S. Department of Energy), 2006, "Radiation Exposure Monitoring System," REMS Database, Office of Environment, Safety and Health, Available at http://www.eh.doe.gov/rems/rems/ri.htm, Accessed on December 6.

EPA (U.S. Environmental Protection Agency), 2000, *Final Reissuance of National Pollutant Discharge Elimination System (NPDES) Stormwater Multi-Sector General Permit for Industrial Activities, Federal Register*/Vol. 65, No. 210/Monday, October 30.

KSL (Kellog Brown and Root Government Services; Shaw Environmental and Infrastructure International; and Los Alamos Technical Associates, Inc.), 2004, LANL Roads/NM-4/502, 24 Hour Vehicular Traffic Counts, Directional AM and PM Peak Hour Traffic, September 12, 2004 – September 18, 2004 and September 2003 (Map), Los Alamos, New Mexico, November 17.

Kwicklis, E., M. Witkowski, K. Birdsell, B. Newman, and D. Walther, 2005, "Development of an Infiltration Map for the Los Alamos Area, New Mexico," *Vadose Zone Journal*, 4:672-693, August 16.

LANL (Los Alamos National Laboratory), 1995, *Final Project Report, TA-21, Buildings 3 and 4 South*, LA-13207, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 1998, *High-Precision Geologic Mapping to Evaluate the Potential for Seismic Surface Rupture at TA-55, Los Alamos National Laboratory,* LA-13456-MS, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1999, *Historic Building Assessment for the Department of Energy Conveyance and Transfer Project*, LA-UR-00-1003, Environment, Safety, and Health Division, Los Alamos, New Mexico, December 23.

LANL (Los Alamos National Laboratory), 2000a, *Comprehensive Site Plan 2000*, LA-UR-99-6704, Los Alamos, New Mexico, January 31.

LANL (Los Alamos National Laboratory), 2000b, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory) 2000c, *U.S. Department of Energy Report, 1999 LANL Radionuclide Air Emissions*, LA-13732-ENV, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2001a, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory) 2001b, *U.S. Department of Energy Report, 2000 LANL Radionuclide Air Emissions*, LA-13839-MS, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2002a, *Site + Architectural Design Principles*, LA-UR-01-5383, Site Planning and Development Group, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2002b, *Occupational Radiation Protection Requirements*, LIR402-700-01.1, Attachment D, Chapter 4, Los Alamos, New Mexico, February 14.

LANL (Los Alamos National Laboratory), 2002c, *U.S. Department of Energy Report, 2001 LANL Radionuclide Air Emissions*, LA-13957-PS, Office of Los Alamos Site Operations, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003a, *Quality Assurance Project Plan for the Asbestos Report Task*, MAQ-ASBESTOS, R2, Risk Reduction and Environmental Stewardship Division, Meteorology and Air Quality Group, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003b, *U.S. Department of Energy Report, 2002 LANL Radionuclide Air Emissions*, LA-14058-PR, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory) 2003c, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, Meteorology and Air Quality Group, Environmental Stewardship Division Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2003d, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *U.S. Department of Energy Report, 2003 LANL Radionuclide Air Emissions*, LA-14155-PR, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2004b, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004c, *SWEIS Yearbook—2003, Comparison of 2003 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-04-6024, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004d, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005a, *Field Summary Report for Technical Area-21 Site Surveys*, Draft, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2005b, *U.S. Department of Energy Report, 2004 LANL Radionuclide Air Emissions*, LA-14233, Los Alamos Site Office, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005c, *Status Report for Integrated Closure Activities at Technical Area 54*, LA-UR-05-6767, Los Alamos, New Mexico, July 7.

LANL (Los Alamos National Laboratory), 2005d, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Ecology Group, Environmental Stewardship Division, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005e, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005f, *Our Mission*, http://www.lanl.gov/natlsecurity/index.html, Accessed on September 9.

LANL (Los Alamos National Laboratory), 2005g, *Direct Environmental Penetrating Radiation at LANL*, Environmental Stewardship Division, Los Alamos, New Mexico, Available at http://www.airquality.lanl.gov, Accessed on September 30.

LANL (Los Alamos National Laboratory), 2005h, *An Evaluation of LANL's Future TRU Waste Management Needs After Project 2010*, LA-UR-04-7125, Los Alamos National Laboratory, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006c, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, Ecology Group, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006d, *U.S. Department of Energy Report, 2005 LANL Radionuclide Air Emissions*, LA-14298, Los Alamos Site Office, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006e, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006f, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2007, *Update of the Probabilistic Seismic Hazard Analysis and Development of Seismic Ground Motions at the Los Alamos National Laboratory*, LA-UR-07-3965, Los Alamos, New Mexico, May.

Marsh, Laura K., 2001, *A Floodplains and Wetlands Assessment for the Potential Effects of the Wildfire Hazard Reduction Project*, LA-UR-01-3643, National Nuclear Security Administration, Los Alamos National Laboratory, Los Alamos, New Mexico, July 13.

MARSSIM, 2000, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575, Rev. 1, EPA-402-R-97-016, Rev. 1, DOE/EH-624, Rev. 1, August

NFS (Nuclear Fuel Services Radiation Protection Systems), 2005, "Perma-Con® Turnkey Containment Systems," http://www.nfsrps.com/docs/pcon.pdf, Accessed on September 14.

NMED (New Mexico Environment Department), 2005a, *Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act Section 74-4-10 and the New Mexico Solid Waste Act Section 74-9-36(D)*, Los Alamos, New Mexico, March 1.

NMED (New Mexico Environment Department), 2005b, Letter to G. P. Nanos, Director, Los Alamos National Laboratory and J. Ordaz, Assistant Manager, Los Alamos Site Office, from J. P. Bearzi, Chief, Hazardous Waste Bureau, Subject: Proposed Closure Strategy for Technical Area 54, Area L Landfill, Los Alamos National Laboratory, EPA ID# NM0890010515, May 10.

NNSA (National Nuclear Security Administration), 2003, *Program Plan for Waste Management, Fiscal Years 2003 To 2013*, Rev. 0, Los Alamos, New Mexico, June.

Stephens & Associates (Daniel B. Stephens & Associates, Inc.), 2005, *Borrow Source Survey for Evapotranspiration Covers at Los Alamos National Laboratory (Draft),* Albuquerque, New Mexico, January 18.

APPENDIX I
MAJOR MATERIAL DISPOSAL AREA REMEDIATION, CANYON CLEANUPS, AND OTHER CONSENT ORDER ACTIONS

APPENDIX I
MAJOR MATERIAL DISPOSAL AREA REMEDIATION, CANYON CLEANUPS, AND OTHER CONSENT ORDER ACTIONS

Los Alamos National Laboratory (LANL) conducts operations in support of the National Nuclear Security Administration (NNSA), a semi-autonomous administration within the U.S. Department of Energy (DOE). This appendix addresses possible environmental impacts associated with investigations and corrective measures being conducted at LANL in accordance with the Atomic Energy Act of 1954, as amended, and the Resource Conservation and Recovery Act (RCRA) and related legislation, particularly the Hazardous and Solid Waste Amendments (HSWA). RCRA-related investigations and corrective actions will be conducted in accordance with a Compliance Order on Consent[1] (Consent Order) entered into by DOE, the University of California as the management and operating contractor, and the State of New Mexico on March 1, 2005.

The Consent Order includes schedules for completion of investigations and corrective measures by the end of 2015. This appendix accordingly addresses environmental consequences through fiscal year (FY) 2016.

> **Implementing the Consent Order**
>
> NNSA intends to implement actions necessary to comply with the Compliance Order on Consent (Consent Order) regardless of decisions it makes on other actions analyzed in the LANL SWEIS. Actions associated with implementing the Consent Order are included in the Expanded Operations Alternative; however, their implementation is not contingent on other actions that are part of that alternative.

The analyses performed for this Site-Wide Environmental Impact Statement (SWEIS) mainly consider levels of operations and new projects proposed for 2007 through about 2011; the analyses in this appendix consider environmental restoration activities through FY 2016. However, these analyses are applicable to actions that may be taken during this period of time, and if necessary beyond, as long as the actions are bounded by the analytical results presented in this appendix.

I.1 Introduction

I.1.1 Need for Agency Action

In accordance with statutes such as RCRA and the Atomic Energy Act, LANL staff has conducted an environmental restoration project to identify locations where radioactive and hazardous constituents may have been released into the environment and to conduct corrective action. These potential release sites (PRSs)[2] include:

- Material disposal areas (MDAs), where radioactive or hazardous constituents have been disposed of, generally by burial within soil or underlying tuff

---

[1] The Consent Order can be viewed at http://www.nmenv.state.nm.us/hwb/lanl/OrderConsent/03-01-05/Order_on_Consent_ 2-24-05.pdf.

[2] For this SWEIS, a potential release site (PRS) means a site suspected of releasing or having the potential to release contaminants (radioactive, chemical, or both). PRS is a general term that includes solid waste management units and areas of concern that are cited and defined in the March 2005 Consent Order.

- Firing sites, where radioactive or hazardous constituents have been explosively dispersed
- Outfalls, where soils, sediments, water bodies, or aquifers have become contaminated with radioactive or hazardous constituents contained in discharged effluents
- Other areas of possible surface, subsurface, or groundwater contamination

Correction action activities at LANL are regulated primarily by DOE pursuant to the Atomic Energy Act, and by the New Mexico Environment Department (NMED) pursuant to RCRA, HSWA, and the New Mexico Hazardous Waste Act. For activities regulated by NMED, since 1990, LANL has conducted investigations and corrective measures in accordance with its Hazardous Waste Facility Permit. But as of March 1, 2005, the corrective action program specified in the permit was replaced by the Consent Order.

The Consent Order prescribes investigation programs for LANL PRSs subject to RCRA and HSWA requirements. From the investigation program results, a determination may be made that no further action is required, or that corrective measures may be needed. If the latter, interim measures may be performed as directed by NMED or as proposed by DOE and approved by NMED. (Emergency interim measures may be implemented without prior NMED approval). As needed and as directed by NMED, alternative corrective measures may be evaluated. After NMED selects the corrective measures to be implemented at the PRSs, the selected corrective measures are implemented and completions of the corrective measures are documented. Activities to be performed in compliance with the Consent Order are similar to those that have taken place for years at LANL (such as drilling exploratory wells or performing removals). But the timing and extent of some activities may be different from those previously anticipated.

The Consent Order provides schedules for all subject PRS remedy completion. Some schedules are explicitly stated, but most are prescribed through aggregate area schedules for remediation completion. That is, there is a schedule for completing remedies in each aggregate area, and every subject PRS is in an aggregate area. If regulatory delays occur in the investigations or corrective measure selection processes, then the remedy completion schedules are adjusted to account for these delays.

> An aggregate area is an area within a single watershed or canyon made up of one or more solid waste management units (SWMUs) and areas of concern (AOCs) and the media affected or potentially affected by SWMUs or AOCs releases and for which investigation or remediation, in part or in entirety, is conducted for the area as a whole to address area-wide contamination, ecological risk assessment, and other factors (NMED 2005).

The majority of investigations and corrective measures that will occur under the Consent Order will probably not be environmentally significant. For example, if a sump formerly used for drainage of liquids containing hazardous constituents is decontaminated, and a small amount of waste products are properly disposed of, then these corrective measures may be of such a short-term nature that they do not require a detailed National Environmental Policy Act (NEPA) analysis. But if a large number of small-scale corrective measures take place, then there may be concerns about the cumulative impacts of all actions. In addition, some corrective measures for some PRSs may be of larger significance in terms of cost, time to complete, and possible short- and long-term environmental impacts.

I.1.2 Purpose and Approach

The purpose of this appendix is to address Consent Order NEPA implications on LANL operations. The following approach is used:

- Review the Consent Order to identify and describe those PRSs that may require investigation or remediation through FY 2016 (Section I.2).
- Address in detail a limited number of large MDAs that may require significant efforts to remediate (Section I.3).
- Aggregate the remaining MDAs and other PRSs where remediation efforts will probably be more significant in totality than individually (Section I.3).
- Analyze a bounding range of remediation options (Section I.3).
- Review the environmental setting, emphasizing site-wide variations (Section I.4).
- Assess environmental impacts of the bounding range of options (Section I.5).

The analysis in this appendix is being conducted in advance of all information to be collected from the LANL corrective measure investigation program and is not meant to circumvent remediation decisions about any PRS. Work being performed to characterize, assess, and provide recommendations for corrective measures at all LANL PRSs may require several years to complete, and decisions will be made in accordance with prescribed regulatory processes. After a decision is reached on an MDA or PRS alternative, implementing that decision may require detailed engineering and safety assessments. Therefore, options in this appendix are meant to bound possible environmental impacts. The analysis is intended to provide information that could be used to develop mitigative measures, if needed, if a particular option is implemented. If it is determined that implementing an option may result in impacts that exceed those considered in this appendix, then additional NEPA review may be needed.

For this appendix, the PRSs that will be investigated and may be remediated through FY 2016 are grouped into large MDAs, small MDAs, and additional PRSs.

MDAs are emphasized because decisions about their remediation may significantly affect site-wide operations and the environment. Because MDAs contain contamination mainly in the subsurface, two broad-scope remediation options are envisioned: stabilization in place or removal (see Section I.1.3). Although several variations or suboptions may be addressed in future analyses, these two options should bound possible environmental impacts.

The large MDAs addressed in this appendix are listed in **Table I–1**. Schedules for submittal of corrective measure reports for these MDAs are presented in **Table I–2**. These MDAs generally contain larger inventories of hazardous and radioactive constituents compared with other MDAs and PRSs. A second group of smaller MDAs is listed in **Table I–3**.

Table I–1 Large Material Disposal Areas

Technical Area	*MDA and SWMU*	*Description*
TA-21	MDA A 21-014	Inactive. Contains two 50,000-gallon underground tanks, two small pits, and one large pit.
TA-21	MDA B 21-015	Inactive. Used for solid radioactive waste and chemical waste disposal. Uncertain number of disposal trenches.
TA-21	MDA T 21-016(a)-99	Inactive. Includes four absorption beds, more than 60 shafts, and other potential release sites associated with decommissioned waste treatment facilities and storage areas. Beds received untreated liquids containing plutonium from 1945 to 1952, and treated liquids thereafter until 1967. Liquids included fluoride and ammonium citrate. Shafts contain solids, sludge mixed with cement, and alkaline fluoride.
TA-21 [a]	MDA U [a] 21-017 (a-c)	Inactive. Contains two absorption beds used from 1948 to 1968 for subsurface disposal of contaminated liquid wastes. [a]
TA-49	MDA AB 49-001 (a-g)	Inactive. Includes multiple shafts and chambers at depths between 60 and 80 feet that were used from 1959 to 1961 for hydronuclear safety experiments. Contains uranium-235, plutonium-239, solid lead shielding, and beryllium.
TA-50	MDA C 50-009	Inactive. Contains seven pits and 108 shafts. One chemical waste pit contains pyrophoric metals, hydrides, and powders, sodium-potassium alloy, and compressed gasses. Other pits contain process wastes, demolition waste, classified materials, and tuballoy (a uranium alloy) chips. Shafts were used for disposal of high-surface-exposure waste.
TA-54	MDA G (multiple SWMUs)	MDA G is inactive. It consists of numerous pits and shafts within active Area G, which is used for low-level radioactive waste disposal and transuranic waste storage. Area G is being expanded but a portion will close consistent with the Consent Order requirement to complete corrective action for MDA G by August 2015 and with the need to develop new low-level radioactive waste disposal capacity.
TA-54	MDA L (SWMU-54-006)	Inactive. MDA L was used for waste disposal from 1959 through 1985 (contains one chemical waste disposal pit, 34 disposal shafts, and three chemical waste impoundments). MDA L is within Area L, which is used for storage of RCRA, PCB, and mixed wastes.

TA = technical area, MDA = material disposal area, SWMU = solid waste management unit, RCRA = Resource Conservation and Recovery Act, PCB = polychlorinated biphenyl.

[a] MDA U is smaller than the other MDAs in this table, and, in September 2006, NMED issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b). It was included for purposes of NEPA analysis and because of its location in TA-21.

Note: To convert feet to meters, multiply by 0.3048; gallons to liters, multiply by 3.7854.

Table I–2 Updated Corrective Measure Report Schedules for Large Material Disposal Areas

MDA	*Investigation Work Plan*	*Investigation Report*	*CME Work Plan*	*CME Report*	*Remedy Completion Report*
A	Submitted	Submitted	TBD	TBD	3/11/2011
B	Submitted	Not applicable	Not applicable	Not applicable	12/31/2010 [a]
T	Submitted	Submitted	TBD	TBD	12/19/2010
U	Submitted	Submitted	TBD	TBD	11/6/2011 [b]
C	Submitted	Submitted	TBD	TBD	9/5/2010
L	Submitted	Submitted	Submitted	Submitted	7/9/2011 [c]
G	Submitted	Submitted	Submitted	Pending [d]	12/6/2015
AB	Submitted	5/31/2010	TBD	TBD	1/31/2015

MDA = material disposal area, CME = corrective measure evaluation, TBD = to be determined.

[a] MDA B will not go through the Corrective Measure Evaluation Process, but will proceed directly to remediation by removal.

[b] In September 2006, NMED issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).

[c] The original schedule in the Consent Order was June 30, 2011.

[d] Submittal is expected in September 2008.

Note: Current schedules have been approved by NMED and may differ from those in the Consent Order.

Table I–3 Additional Material Disposal Areas

Technical Area	*MDA and SWMU*	*Description*
TA-6	MDA F 6-007(a)	Contains an uncertain number of pits and trenches.
TA-8	MDA Q 8-006(a)	Inactive site, received waste in 1946 from naval gun experiments for the Little Boy atomic weapon.
TA-15	MDA N 15-007(a)	Small site containing a pit that received demolition wastes.
TA-15	MDA Z 15-007(b)	Small site used from 1965 to 1981 for disposal of construction debris and other wastes. Some wastes are exposed.
TA-16	MDA R 16-019	Inactive site that received debris from a high-explosives burning ground. It was partially remediated after the Cerro Grande Fire.
TA-33	MDA D 33-003(a, b)	Small site consisting of two underground chambers and elevator shafts used for explosives tests of weapons components.
TA-33	MDA E 33-001(a)-99	Site contains an underground experimental chamber used for explosives tests plus four disposal pits.
TA-33	MDA K 33-002(a)-99	Site currently consists of two small surface-disposal areas containing piled debris.
TA-36	MDA AA 36-001	Small site consists of at least two trenches containing firing site debris.
TA-39	MDA Y 39-001(b)	Small site in Ancho Canyon containing three pits used for disposal of firing site debris.

MDA = material disposal area, SWMU = solid waste management unit, TA = technical area.

The third group of PRSs comprises hundreds of sites containing low levels of radioactive or hazardous constituents, generally concentrated on the surface of the ground or in the near subsurface. A variety of remediation activities may take place, often requiring removal of relatively small quantities of wastes. These PRSs would be investigated as part of the aggregate area investigations. Schedules for conducting aggregate area investigations are specified in the Consent Order. Once an aggregate area investigation is complete, plans for remediating the PRSs in the aggregate area would be determined. Examples of PRSs composing this last group are shown in **Table I–4**.

Table I–4 Examples of Potential Release Sites Being Addressed Under the Consent Order

Technical Area	*Potential Release Site*	*Description*
TA-15	Site E-F 15-004(f)-99	High-explosives firing site; inactive.
TA-15	Site R-44 15-006(c)	High-explosives firing site; inactive.
TA-16	260 Outfall 16-021(c)-99	Site contaminated by outfall from an explosives manufacturing facility.
TA-73	Ash pile 73-002	Site contaminated by ashes from a former incinerator.

TA = technical area.

I.1.3 Options Considered in this Appendix

Three broad-scope options are considered for purposes of NEPA:

> The No Action Option is considered in this appendix because such an action is required by NEPA. DOE is legally required to carry out the provisions of the Consent Order.

- **No Action Option**. Environmental investigations and restoration efforts are assumed not to be carried out in accordance with the Consent Order provisions. The LANL environmental restoration project would continue at pre-Consent Order levels, but no extensive corrective measures would be conducted for major PRSs.

- **Capping Option**. The Consent Order would be implemented. For this appendix it was assumed that MDAs would be stabilized in place by placing final covers over them and conducting certain other environmental restoration activities such as remediating volatile organic compound plumes in soil at some MDAs. The underground "General's Tanks" (see Section I.2.5.2.1) within MDA A would be grouted in place. Transuranic waste in subsurface storage at MDA G would be removed, processed, and shipped to the Waste Isolation Pilot Plant (WIPP). Because some of the stored, transuranic waste in subsurface shafts within MDA G may be difficult to retrieve, an option to leave this stored waste in place would be considered. If this option were pursued, a performance assessment pursuant to Title 40 of the *Code of Federal Regulations* (CFR) Part 191, may be required. If such an assessment is required, the assessment results may indicate the need for additional waste stabilization or MDA cover final design modification.

  In addition, numerous other PRSs would be remediated by methods such as contamination removal, surge bed grouting, contaminated sediment natural flushing, permeable reactive barriers, pump and treat system installation, or other measures.

- **Removal Option**. The Consent Order would be implemented. For this appendix it was assumed that LANL MDA waste and contamination would be removed. Transuranic waste stored belowground at MDA G would be removed and shipped to WIPP along with other transuranic-contaminated material disposed of before 1970. Remediation of other PRSs would again occur by various methods as discussed for the Capping Option.

Environmental impacts assessed under the three options should bound those that could result from eventual implementation of MDA and PRS corrective measures. Remediation decisions will be made for specific MDAs and PRSs rather than groups and may prescribe a combination of corrective measures. For example, some waste within an MDA may be removed and the remainder may be stabilized in place.

For all options, appropriate safety and environmental surveillance and maintenance would continue at LANL to maintain compliance with DOE and external criteria and standards, including those for nuclear environmental sites (Section I.3.2.3).

I.1.4 Related National Environmental Policy Act Analyses

Two NEPA analyses related to this appendix are:

- *Environmental Assessment for Proposed Corrective Measures at Material Disposal Area H within Technical Area 54 at Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE 2004b)
- *Categorical Exclusion for Proposed Remediation of MDA V within Technical Area 21 (TA-21)* (LANL 2004j)

I.2 Background

Introducing this chapter are sections summarizing (1) LANL's general setting, and (2) LANL's environmental restoration project and the March 1, 2005, Consent Order. The remaining sections address each PRS cited in the Consent Order consistent with their grouping in the Consent Order.

I.2.1 General Setting

LANL and its TAs are shown in **Figure I–1**. LANL is bordered by the Santa Fe National Forest to the north, west, and south. The Rio Grande and the Native American Pueblo of San Ildefonso border LANL on the east; the Bandelier National Monument and Bandelier Wilderness Area lie directly south. The areas surrounding LANL, Los Alamos County, and much of the neighboring counties are undeveloped. The two closest communities are the Los Alamos townsite and White Rock. Population centers within 50 miles (80 kilometers) of LANL include Española and Santa Fe. Thirteen American Indian Pueblos are within 50 miles (80 kilometers). LANL is on the Pajarito Plateau, consisting of east-southeast-trending canyons and mesas. The plateau mesas are generally devoid of surface water. Canyons may be wet or dry. Wet canyons contain continuous streams and may contain groundwater in canyon bottom alluvium. Dry canyons contain streams only occasionally flowing with water, and lack alluvial groundwater (LANL 1999b). The LANL region contains numerous natural and cultural resources, including habitats of threatened and endangered species such as the Mexican spotted owl (*Strix occidentalis lucida*), bald eagle (*Haliceetus leucocephalus*), and southwestern willow flycatcher (*Empidonex treillii extimus*) (see Chapter 4, Table 4–22, of this SWEIS).

I.2.2 The Los Alamos National Laboratory Environmental Restoration Project

Some of the hazardous and radioactive materials used at LANL have been released into the environment or disposed of as waste. Public and environmental protection has been maintained through a combination of site natural features; technology implementation; administrative and institutional controls; health, safety, and environmental monitoring; and adherence to applicable standards. Nonetheless, concerns about future efficacy of disposal and discharge areas to retain contaminants within regulatory standards have prompted efforts to remediate LANL areas where hazardous constituent releases may have occurred (LANL 2000b).

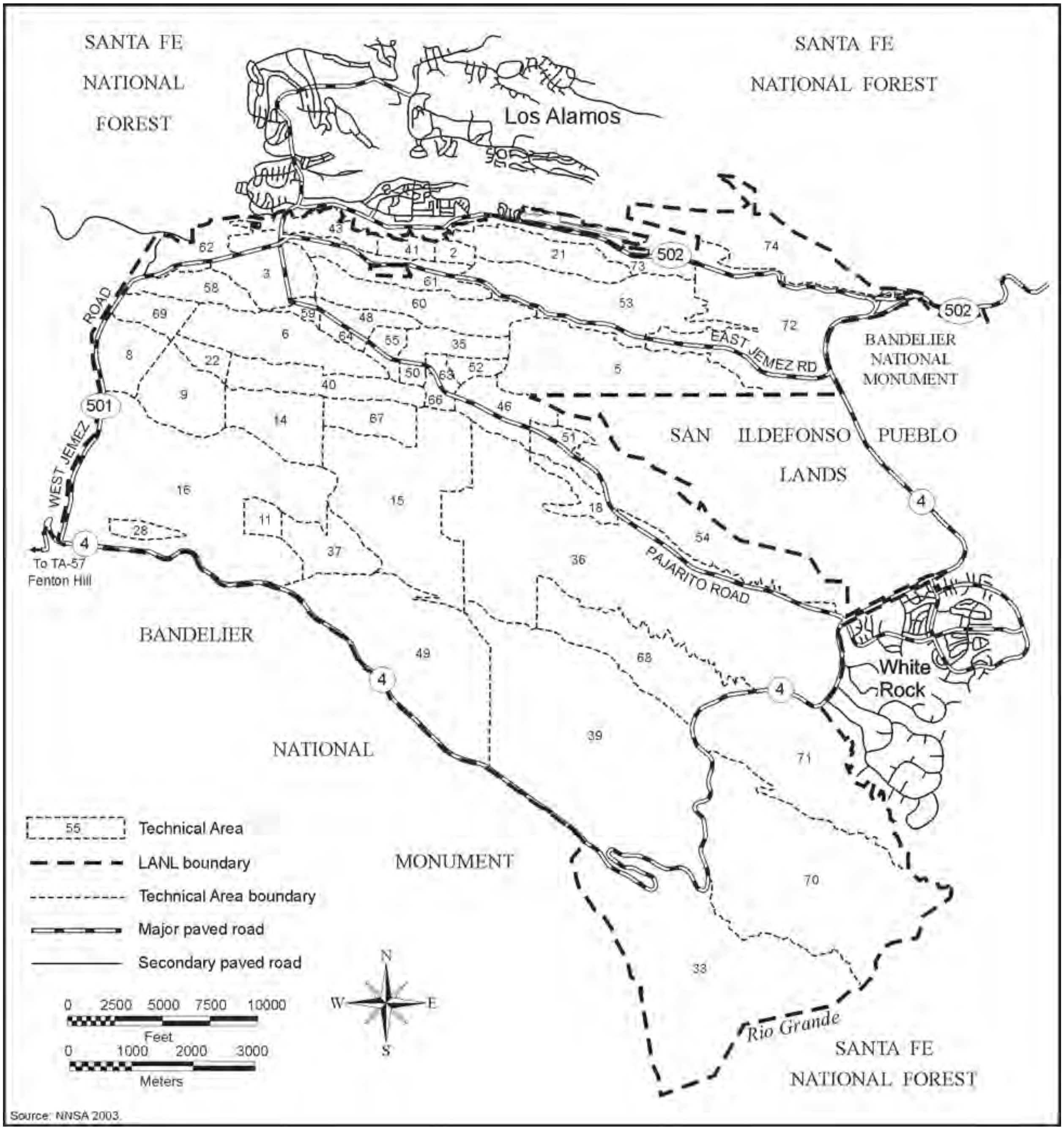


Figure I–1 Los Alamos National Laboratory Technical Area Locations

I.2.2.1 The Los Alamos National Laboratory Environmental Restoration Project Background

DOE and LANL employees must conduct activities in compliance with regulatory requirements derived from Federal and state statutes and Executive orders. Laws, regulations, agreements, and environmental protection orders applicable to LANL are presented in Chapter 6 of this SWEIS.

Operations involving radioactive materials have been historically conducted by DOE and its predecessors under Atomic Energy Act authority. However, during the last several decades, the

Congress enacted several major statutes addressing environmental protection, including RCRA, HSWA, and the Federal Facility Compliance Act. LANL currently operates under the regulatory authority of DOE, the U.S. Environmental Protection Agency (EPA), and the State of New Mexico. Under the Atomic Energy Act, DOE continues to have general landlord authority for protecting the public and environment, as well as specific authority for protecting workers, the public, and the environment from deleterious effects of radioactive and other toxic or hazardous materials. EPA has overall Federal regulatory authority for management of hazardous materials defined under RCRA and its amendments, particularly HSWA, as well as corrective actions taken pursuant to these statutes. EPA has authorized the State of New Mexico to implement this regulatory authority.

In 1989, DOE created the Office of Environmental Restoration and Waste Management; LANL's environmental restoration project was established the same year to undertake environmental restoration and decommissioning activities (LANL 2000b). In November 1989, the New Mexico Environmental Improvement Division (now NMED) issued LANL's Hazardous Waste Facility Permit. In March 1990, EPA issued Module VIII to the permit, setting forth procedural requirements for HSWA corrective actions and specifying development of an installation work plan. LANL's environmental restoration project identified 2,124 PRSs, consisting of 1,099 PRSs that EPA listed in the Hazardous Waste Facility Permit and 1,025 PRSs not listed in the permit. Through 1995, EPA had sole authority over HSWA corrective actions at LANL. In January 1996, EPA delegated this authority to NMED (LANL 2000b).

LANL staff grouped the PRSs into 24 operable units (LANL 2000b) and, in the early to mid-1990s, issued RCRA facility investigation (RFI) Work Plans describing the history of activities within each operable unit, potential contaminants and release pathways, and site investigation plans. Site investigations included: installation of borings and wells; sampling of surface soils, vegetation, drainage channel sediments; and subsurface material, including soil vapor; monitoring of surface water and groundwater; and measurement of external radiation and airborne contaminants. The investigations sampled and monitored for radionuclides and nonradiological contaminants, including polychlorinated biphenyls (PCBs), explosives, and organic and inorganic constituents (LANL 2000b).

In December 1997, LANL staff and NMED began to consolidate corrective action sites that were related by contaminant source, geographic location, and potential cumulative risk. In 1999, LANL staff began to use watersheds to identify discrete systems within which multiple, consolidated sites would be investigated, assessed, and remediated (LANL 2000b).

Phase I RFIs have been completed for most of the MDAs and many other PRSs. Additional investigations are ongoing. Since 1993, over 100 voluntary cleanup actions have been conducted (LANL 2002g). Through the end of 2005, 774 units had been approved for no further action, including 146 that had been removed from LANL's Hazardous Waste Facility Permit. Of these, 125 non-HSWA Module sites had previously been approved for no further action by DOE and, under the terms of the Consent Order, the no further action determinations will be re-evaluated by NMED. Based on prior no further action approvals and consolidation of geographically proximate sites, 829 sites remain within LANL's environmental restoration project (LANL 2006h).

I.2.2.2 Consent Order

On May 2, 2002, NMED issued a Determination of Imminent and Substantial Endangerment to Health and the Environment and a draft order compelling investigation and cleanup of environmental contamination. After receiving public comments, NMED revised its Determination and issued a final Compliance Order on November 26, 2002. On behalf of DOE, the U.S. Department of Justice filed a lawsuit challenging the final order. The University of California filed a separate lawsuit. NMED, DOE, the Justice Department, and the University of California entered settlement negotiations that led to a Consent Order to replace the November 2002 Compliance Order.

NMED issued a revised Consent Order for public comment on September 1, 2004. The comment period closed on October 1, 2004. NMED delayed issuance of the final Consent Order until surface water and watershed issues were addressed in a separate Federal Facility Compliance Agreement under the Clean Water Act. The agreement was signed on February 3, 2005. On March 1, 2005, the final Consent Order was entered into by NMED, the State of New Mexico Attorney General, DOE, and the University of California (NMED 2005).

The Consent Order requires LANL-wide investigation and cleanup pursuant to stipulated procedures and schedules (NMED 2004). (Schedules in the Consent Order may be adjusted to account for delays in NMED approvals; or to accommodate requests from DOE or its authorized contractor for time extensions.) Most PRSs contain constituents that are regulated under the Consent Order, as well as radionuclides that are regulated under the Atomic Energy Act. To avoid duplication of completed work, the Consent Order does not apply to those PRSs not listed in Module VIII that received No Further Action decisions from EPA when it had primary regulatory authority.

The Consent Order requires the installation of wells, piezometers, and other subsurface units to provide site characteristic or environmental information; the collection and investigation of sample data; and preparation and submittal of investigative reports for various PRSs. Following the investigation phase for a subject PRS, corrective measures are proposed, authorized, and implemented as needed. If NMED determines that a corrective measure evaluation is needed, a corrective measure evaluation report[3] must be prepared that addresses alternative remedies. NMED will determine the remedy to be implemented, although DOE may propose a remedy. After completing the approved corrective measure, a remedy completion report must be prepared and sent to NMED for approval.

Investigations and PRSs addressed in the Consent Order are summarized in the following sections of this appendix:

- Section I.2.3: Firing Sites and Other PRSs within Testing Hazard Zones
- Section I.2.4: Canyons
- Section I.2.5: Technical Area Investigations

[3] *A corrective measure evaluation report essentially corresponds to a RCRA corrective measures study report.*

- Section I.2.6: Other SWMUs and Areas of Concern (AOCs), Including Aggregate Areas
- Section I.2.7: Continuing Investigations

MDAs that are not specifically cited in the Consent Order but may be addressed as part of required aggregate area investigations are summarized in Section I.2.8.

I.2.3 Firing Sites and Other PRSs within Testing Hazard Zones

Consent Order Section IV.A.5 addresses firing sites and other PRSs within testing hazard zones. Consent Order Table IV-1 lists SWMUs and AOCs located within designated testing hazard zones. Investigations, and if appropriate, corrective actions must be performed for these SWMUs and AOCs. With some exceptions, investigation and corrective action may be deferred for any SWMU or AOC located within a testing hazard zone and identified in Consent Order Table IV-2. These SWMUs and AOCs need not be included in relevant aggregate area investigation work plans. The deferral may continue until the firing site used to delineate the relevant testing hazard zone is closed, or it is inactive and DOE determines that it is reasonably unlikely to be reactivated (NMED 2005). **Table I–5** lists the 107 nondeferred SWMUs and AOCs (Consent Order Table IV-1), and **Table I–6** lists the 45 deferred SWMUs and AOCs (Consent Order Table IV-2).

Each PRS listed in Table I–5 will be remediated in accordance with the schedule for the aggregate area containing the PRS (see Section I.2.6). Some PRSs listed in these tables may require a significant remediation effort. PRSs of particular interest for this appendix include two firing sites (Firing Sites E-F and R-44) and five MDAs (MDAs F, Z, AA, Y, and AB). Thumbnail descriptions of these PRSs are provided below.

I.2.3.1 Technical Area 15: Firing Site E-F

TA-15 (R Site) is in the center of LANL. Most of TA-15 is encompassed by Threemile Mesa, but Water Canyon transverses the southern site boundary and Potrillo Canyon intersects the main portion of Threemile Mesa, dividing the mesa into two areas (**Figure I–2**) (LANL 1993c).

TA-15 has been used since World War II for explosive testing of nuclear weapons components. Several early firing points are no longer used, and most of their structures have been decommissioned and dismantled (LANL 1993c). Firing Site G was in use by 1949, and is listed in the Consent Order as a deferred site (Table I–6). Areas R-40, R-183, and The Hollow contain office buildings. Firing Sites R-44 and R-45 were built in the 1950s (LANL 1993c). R-41 is a container storage area. The Pulsed High-Energy Radiographic Machine Emitting X-Rays (PHERMEX) facility was completed in the 1960s. A second radiographic machine, Ector, was installed in the early 1980s (LANL 1993c).[4]

[4] *A newer facility, the Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility, is not shown on Figure I–2 but is located near PHERMEX.*

Table I–5 Non-Deferred Sites Within Testing Hazard Zones

Site Identification	Description	Site Identification	Description
06-005	Firing site pit	15-009(e)	Septic system
06-007(a)	MDA F	15-009(g)	Septic system (active)
06-007(b)	MDA F	15-009(h)	Septic tank
06-007(c)	MDA F	15-009(i)	Septic tank
06-007(d)	MDA F	15-010(c)	Drain line
06-007(e)	MDA F	15-014(l)	Outfall (active)
06-008	Underground storage tank	C-15-001	Surface disposal
07-001(a)	Firing site	C-15-004	Transformers
07-007(b)	Firing site	C-15-011	Former site of underground tank
11-005(a)	Septic system	C-15-013	Underground fuel tank
11-005(b)	Septic system	18-001(a)	Lagoon
11-005(c)	Outfall	27-002	Firing sites
11-006(a)	Sump	27-003	Bazooka impact area
11-006(b)	Tank and/or associated equipment	36-001	MDA AA
11-006(c)	Tank and/or associated equipment	36-002	Sump
11-006(d)	Tank and/or associated equipment	36-003(a)	Septic system
11-011(a)	Industrial or sanitary wastewater treatment	36-003(b)	Septic system
11-011(b)	Industrial or sanitary wastewater treatment	36-004(c)	Firing site – open detonation (active)
11-011(d)	Industrial or sanitary wastewater treatment	36-005	Surface disposal site
C-11-002	Footprint of former laboratory	36-006	Surface disposal site
C-12-001	Footprint of former building	36-008	Surface disposal site
C-12-002	Footprint of former building	C-36-003	Storm drainages
C-12-003	Footprint of former building	37-001	Septic system
C-12-004	Footprint of former building	39-001(b)	MDA Y
14-001(g)	Firing site – Open burn/open detonation (active)	39-002(b)	Storage area
14-002(c)	Building	39-002(c)	Storage area
14-002(f)	Footprint of former junction box shelter	39-002(d)	Storage area
14-003	Open burning ground	39-002(f)	Storage area
14-005	Open burn site (active)	39-004(c)	Firing Site 39-6 (active) – open detonation RCRA unit
14-006	Tank and/or associated equipment	39-004(d)	Firing Site 39-57 (active) – open detonation RCRA unit
14-007	Septic system	39-007(a)	Storage area
14-009	Surface disposal site	39-007(d)	Storage area
14-010	Sump	39-008	Former building footprint (soil contamination)
C-14-001	Footprint of former building	39-010	Excavated soil dump
C-14-003	Footprint of former building	40-001(b)	Septic system
C-14-004	Footprint of former building	40-001(c)	Septic system
C-14-005	Footprint of former building	40-003(a)	Scrap burn site/open detonation (completed RCRA closure)
C-14-006	Footprint of former building	40-003(b)	Burning area (completed RCRA closure)
C-14-007	Footprint of former building	40-004	Operational release
C-14-008	Footprint of former building	40-005	Sump
C-14-009	Footprint of former building	40-009	Landfill
15-001	Surface disposal	40-010	Surface disposal site
15-004(f)	Firing Site E-F	49-001(a)	MDA AB
15-004(h)	Firing Site H	49-001(b)	MDA AB
15-005(c)	Container storage area (R-41)	49-001(c)	MDA AB

Site Identification	*Description*	*Site Identification*	*Description*
15-007(b)	MDA Z	49-001(d)	MDA AB
15-007(c)	Firing site shaft	49-001(e)	MDA AB
15-007(d)	Firing site shaft	49-001(g)	MDA AB
15-008(a)	Surface disposal at E-F site	49-002	Underground chamber
15-008(b)	Surface disposal	49-003	Leach field and small-shot area
15-008(c)	Surface disposal	49-005(a)	Landfill
15-008(g)	Surface disposal	49-006	Sump
15-009(b)	Septic system	49-008(d)	Firing sites and underground chamber
15-009(c)	Septic tank		

MDA = material disposal area, RCRA = Resource Conservation and Recovery Act.
Source: NMED 2005.

Table I–6 Deferred Sites in Testing Hazard Zones

Site Identification	*Description*	*Site Identification*	*Description*
06-003(a)	Firing site	14-002(b)	Firing site
06-003(h)	Firing site	15-003	Firing site
C-06-019	Footprint of former structure	15-004(a)	Firing site
07-001(c)	Firing site	15-004(g)	Firing site
07-001(d)	Firing site	15-006(a)	Firing site
11-001(a)	Firing site	15-006(b)	Firing site
11-001(b)	Firing site	15-006(c)	Firing site
11-002	Burn site	15-006(d)	Firing site
11-003(b)	Air gun	15-008(f)	Firing site
11-004(a)	Firing site	36-004(a)	Firing site
11-004(b)	Firing site	36-004(b)	Firing site
11-004(c)	Firing site	36-004(d)	Firing site
11-004(d)	Firing site	36-004(e)	Firing site
11-004(e)	Firing site	39-004(a)	Firing site
11-004(f)	Firing site	39-004(b)	Firing site
11-009	MDA S	39-004(e)	Firing site
11-012(c)	Footprint of former building	40-006(a)	Firing site
11-012(d)	Footprint of former laboratory	40-006(b)	Firing site
C-11-001	Footprint of former laboratory	40-006(c)	Firing site
14-001(f)	Firing site	49-008(a)	Soil contamination
14-002(a)	Firing site	49-008(b)	Soil contamination (Area 6)
14-002(d)	Firing site	49-008(c)	Soil contamination
14-002(e)	Firing site		

MDA = material disposal area.
Source: NMED 2005.

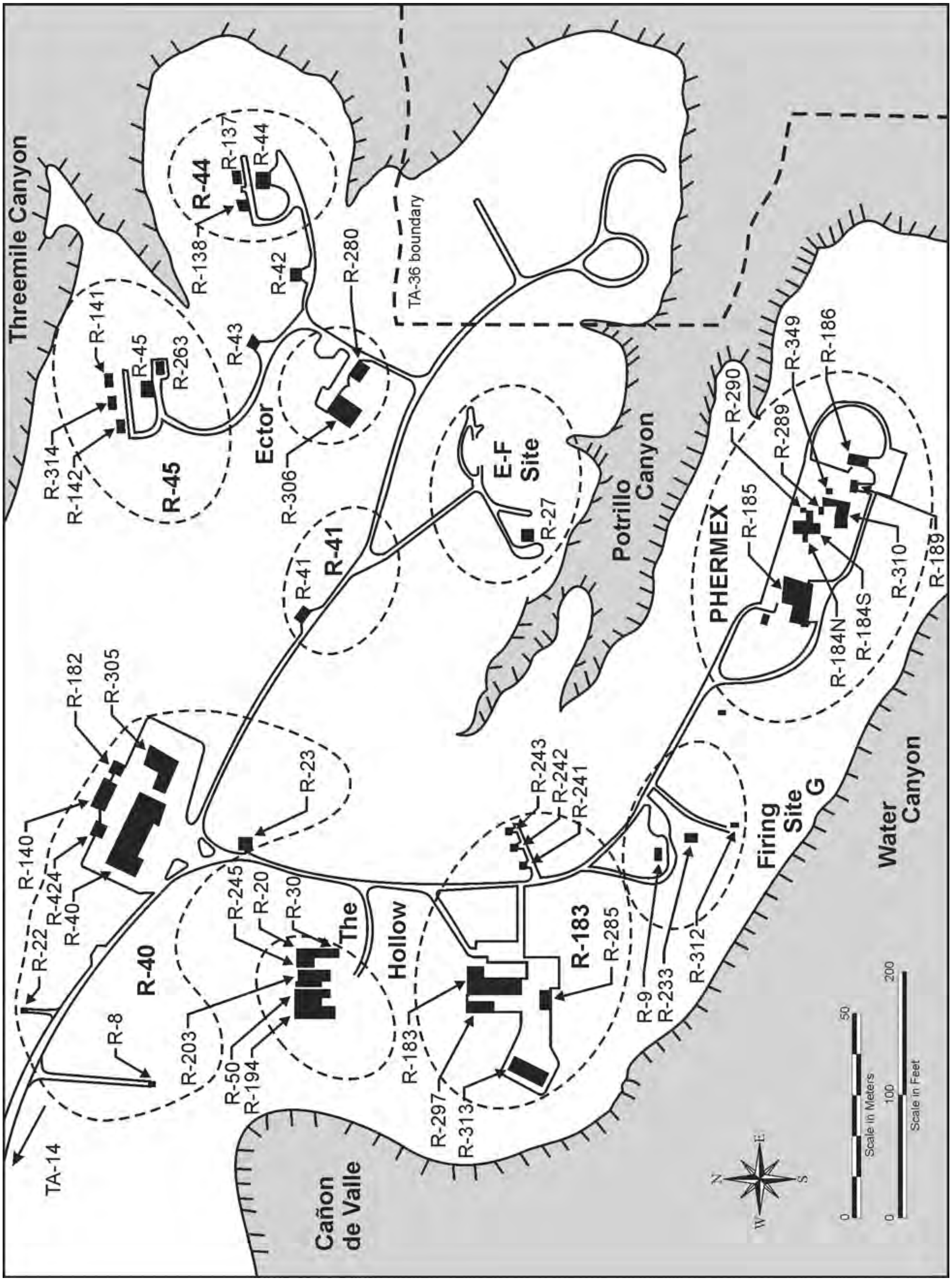


Figure I–2 Technical Area 15 Firing Sites and Other Facilities

The E-F Site (Consolidated Unit 15-004(f)-99) is north of Potrillo Canyon and southeast of Ector. It includes the firing site (SWMU 15-004(f)), a surface disposal area (SWMU 15-008(a)), a septic system (SWMU 15-009(e)), and the site of a removed transformer station (C-15-004) (LANL 1993c). The septic system has been recommended for no further action (LANL 2005c).

History of Firing Site E-F. Firing Site E-F was created in 1947, possibly from an earlier firing point. Firing Site E is larger and about 800 feet (244 meters) from Firing Site F. Firing Sites E and F were both connected to an underground, timbered, control room (Building TA-15-27, or R-27) 600 feet (183 meters) to the southwest of Firing Site E (LANL 1993c). The sites were used extensively through 1973 and were last used in 1981. Firing Sites E and F were once merely surface depressions. As testing progressed, soil was either regraded to the previous depression level or new gravel was imported to fill holes. Eventually, soil was mounded to the north and south to protect buildings from shrapnel. No major effort was made to remove the scattered materials, although, after each explosion, test debris and obvious pieces of uranium metal were recovered. Between 1945 and 1957, 95,000 pounds (43,000 kilograms) of natural uranium metal was expended. After 1957, 44,000 pounds (20,000 kilograms) of depleted uranium was expended (LANL 1993c).

Two small surface-disposal areas (SWMU 12-008), 200 feet (61 meters) apart, are south of Firing Site E-F. The areas contain mounded rubble (LANL 1993c).

Waste Inventory. Up to 139,000 pounds (63,000 kilograms) of natural and depleted uranium may have been expended. Shrapnel or other pieces of uranium may have scattered up to 3,500 feet (1,070 meters) from the firing site, although most debris deposited within 1,000 feet (305 meters). Much of the uranium has oxidized. About 705 pounds (320 kilograms) of beryllium metal was scattered, and much of this metal has oxidized. Other toxic metals include lead (about 220 pounds [100 kilograms]), mercury (less than 220 pounds [100 kilograms]), bismuth, copper, cobalt, nickel, tin, and thorium. Little high explosive (HE) probably survived the tests (LANL 1993c).

The two disposal areas south of Firing Site E-F include metal pieces, soil, plastic, rock, pebbles, electrical cable, electrical accessories, and miscellaneous debris. Potential contaminants include uranium, beryllium, lead, and mercury (LANL 2005c).

Site Investigations. Studies since the late 1970s have shown extensive uranium contamination, varying from concentrations exceeding 4,500 milligrams per kilogram at the firing point to less than 200 milligrams per kilogram 980 feet (300 meters) away. Soil samples collected in 1980 showed an order of magnitude decrease in uranium concentrations within the top 10 to 12 inches (25 to 30 centimeters) of soil, although the trend was not uniform (LANL 1993c). In 1994, numerous surface and subsurface samples were collected as part of a Phase I RFI. Contaminants included uranium, protactinium-234m, thorium-234, americium-241, cesium-137, barium, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc. Similar radionuclides and inorganic chemicals were found at the surface disposal site (LANL 2005c).

Current Configuration. Firing Site E-F is wooded. Scattered debris includes chunks of oxidized metal. The two piles of debris in the surface disposal area are each 8 feet (2.4 meters) in diameter and 2 feet (0.6 meters) high (LANL 2005c).

I.2.3.2 Firing Site R-44

Firing Site R-44 (Consolidated Unit 15-006(c)-99) is near Firing Site E-F (Figure I–2) (LANL 1993c, 2001f) and includes the firing site itself (SWMU 15-006(c)), the septic system associated with the R-44 site (SWMU 15-009(c)), and a surface disposal area (SWMU 15-008(b)). The firing site itself is listed as a deferred site (Table I–6).

History of Firing Site R-44. Named after the site control room, R-44 was built in 1951 and used from 1956 through 1978 for tests of weapons components. But since PHERMEX and Ector were put into operation, the site was used less and for small experiments. R-44 was last used in September 1992. From 1953 to 1978, 15,000 pounds (7,000 kilograms) of uranium (mostly depleted uranium), 770 pounds (350 kilograms) of beryllium, and 33 pounds (15 kilograms) of lead were expended. Debris scattered into the canyons on either side of the firing site. The surface disposal area comprises two small areas at the edge of Threemile Canyon containing pieces of metal and plastic, soil, rocks and pebbles, electrical cable, other electrical accessories, and other debris (LANL 1993c).

Waste Inventory. An aerial radiological survey suggested that in 1982, the amount of uranium in the soil at R-44 was about four percent of that at Firing Site E-F, or about 5,070 pounds (2,300 kilograms) (LANL 1993c). A 1991 land-based radiological survey found pieces of uranium near the firing site. The area was partially remediated. In 1987, samples were collected at four radial distances (10, 100, 250, and 450 feet [3, 30, 76, and 137 meters]) from the center of the firing site. High explosives were not detected. Concentrations of lead, beryllium, and uranium-238 at 450 feet (137 meters) were all more than a magnitude smaller than those in the center. Average soil background levels were 28.4 milligrams per kilogram for lead, 2.4 milligrams per kilogram for beryllium, and 3.4 milligrams per kilogram for uranium (LANL 1993c).

The 1993 RFI Work Plan for Operable Unit 1086 estimated that the volume of piled debris in the surface disposal area amounted to a few dump truck loads. At least 80 percent was contaminated with uranium, beryllium, and lead (LANL 1993c).

Site Investigations. The Phase I RFI for the firing site (June 1995 through March 1996) found uranium, beryllium, lead, arsenic, and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). The Phase I RFI for the surface disposal area found uranium and inorganic chemicals, including antimony, arsenic, beryllium, chromium, copper, lead, mercury, nickel, silver, and zinc (LANL 2005c).

Current Configuration. The Cerro Grande Fire damaged the firing site, which is wooded with ponderosa pine. Debris was exposed throughout the site, mainly toward the east. Within a year, straw wattles, rock check dams, and silt fencing were installed and the area was hydromulched. Sediment migration was minimal. A year after the fire, the site had a vegetative cover greater than 70 percent (LANL 2001f). Much of the exposed debris was recovered and disposed of.

I.2.3.3 Technical Area 6: Material Disposal Area F

TA-6 (Twomile Mesa Site) is on Twomile Mesa, which is bordered to the north by Twomile Canyon and to the south by Pajarito Canyon. During the Manhattan Project, TA-6 was used to test explosive detonators for the Fat Man weapon; to purify the explosive pentaerythritol tetranitrate (PETN), used to achieve implosion; and to destroy shaped explosive charges called lenses. After the war, MDA F was created to dispose of classified objects. Test firing continued at TA-6 until 1952. Explosives development, laser, chemical laboratory, and photographic operations continued through February 1976, and several small operations continued until the 1980s (LANL 1993g).

History of MDA F. MDA F is a small site to the north of Twomile Mesa Road. MDA F is at an elevation of 7,460 feet (2,274 meters). Runoff flows north to the southwest fork of Twomile Canyon, which is part of the Pajarito Canyon Watershed (LANL 1999b).

A May 15, 1946, memorandum from the Director of Los Alamos Scientific Laboratory, N. E. Bradbury, announced preparation of a pit for disposal of classified objects and shapes. The memorandum stated that the pit was located at TD Site, but a penciled correction indicated Twomile Mesa (Rogers 1977). A second pit was dug in 1947 in accordance with a July 16, 1947, memorandum from Bradbury. The locations of these two pits were not recorded on contemporary documents (LANL 1993g).

From 1949 through 1951, work orders were written for three smaller pits on Twomile Mesa (LANL 1993g):

- 1949 – A pit 40 by 20 by 10 feet deep (12 by 6.1 by 3.0 meters)
- 1950 – A pit 6 by 6 x 6 feet deep (1.8 by 1.8 by 1.8 meters)
- 1951 – A pit 2 by 2 by 4 feet deep (0.6 by 0.6 by 1.2 meters)

The locations of these pits are unknown, as are their as-built dimensions and contents.

From 1950 to 1952, three shafts may have been drilled to dispose of spark gaps containing cesium-137. None of the shafts correlates with archived job and work orders (LANL 1993g). Arial photographs from 1954 show two large disturbed areas that may be the two pits referenced in the Bradbury memoranda (LANL 1993g). The two chain-link fences at MDA F were erected in 1981. The smaller fenced area basically corresponds to the disturbed areas on aerial photographs, but the larger fenced area is mostly north of the larger pits.

Waste Inventory. The inventory is poorly known. MDA F was used for disposal of classified items. Spark gaps containing cesium-137 were probably buried. In 1964, the total estimated amount of cesium-137 was 30 microcuries. Other hazardous materials may have been placed in the pits (LANL 1993g).

The pits may contain explosives. This concern was prompted by a statement from a person responsible for digging the 1946 pit that "large blocks of HE, Primacord, etc." were placed in the pit (LANL 1993g). Yet later this individual stated that no hazardous materials were buried, and that burial was not the accepted practice for disposal of explosives (LANL 1993g). The RFI Work Plan for Operable Unit 1111 found no primary sources stating that explosives were buried. All reports of squibs, detonators, depleted uranium, and strontium-90 buried in pits at MDA F were from secondary sources (LANL 1993g).

Current Configuration. MDA F comprises a small area encompassed by, and in the vicinity of, a pair of fenced areas (**Figure I–3**). Southeast of MDA F are depressions that may have resulted from explosive destruction of defective lenses for the Fat Man weapon in 1945 (LANL 1993g, 1999b). Some of these lenses contained Baratol, which contains barium nitrate and 2,4,6-trinitrotoluene (TNT) (LANL 1999b). West of MDA F is the "timbered pit" that may have been used for test firing Jumbino vessels.[5] A 1944 progress report contains a photograph of a Jumbino in a pit, and a 1986 geophysical survey located an anomaly in this area (LANL 1993g). Aerial photography and satellite imagery in 2000 suggested two long, narrow trenches and six small pits in the vicinity of the two fenced areas (Pope et al. 2000). One pit may be the timbered pit.

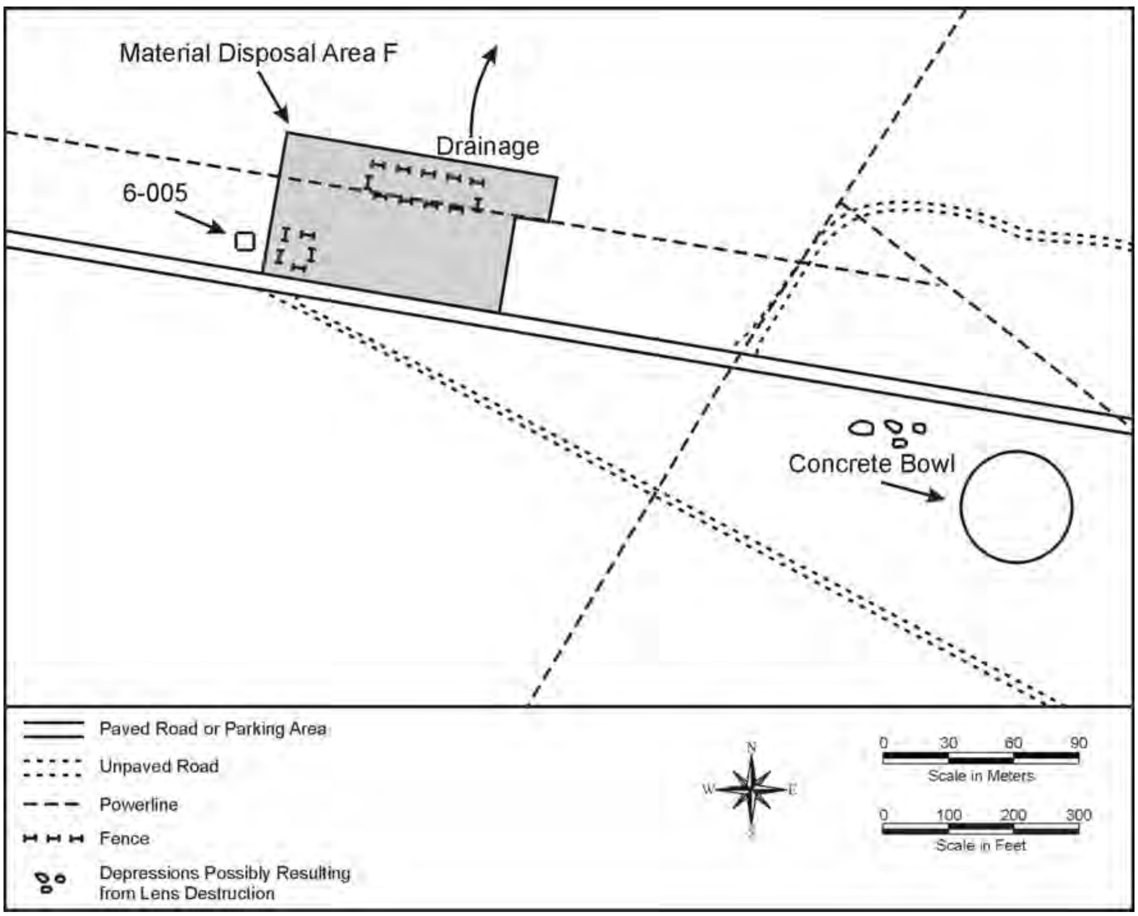


Figure I–3 Material Disposal Area F

[5] A Jumbino is a stainless steel vessel used to test methods for containment and recovery of fissionable materials such as plutonium from explosives implosion tests. Recovery was needed because of the very limited supply of the fissionable materials. From 1944 tests involving Jumbino vessels, Los Alamos scientists constructed a much larger vessel called Jumbo for containment of the Trinity Test. Jumbo was never used for this purpose because by 1945 plutonium availability was much greater (LANL 1993b).

The site was contoured and reseeded with native grasses in 1996. The MDA vicinity is dotted with scrub oak (Pope et al. 2000). A power line crosses the site in an east-west direction.

Waste management units are:

- SWMU 6-005 – the timbered pit to the west of the smaller fenced area
- SWMU 6-007(a) – the pair of fenced areas
- SWMU 6-007(b) – the pit from the 1940s photographs
- SWMUs 6-007(c and d) – the two pits described by the 1946 and 1947 Bradbury memoranda
- SWMU 6-007(e) – additional pits that may exist at MDA F

Site Investigations. The areas inside the fences have been monitored for radioactivity since 1981. No readings above background have been observed (LANL 1999b). According to the 1993 RFI Work Plan for Operable Unit 1111 (LANL 1993g), vegetation at MDA F was sampled in 1981 and 1983 for radioactive contaminants; none were found. In 1986, a site survey was performed using ground-penetrating radar and magnetometry. Survey data were difficult to interpret. The Phase I RFI for MDA F was to determine: (1) pit boundaries, (2) whether contaminants of concern were present in media surrounding the pits, and (3) whether barium and TNT were in surface soils south and east of MDA F (LANL 1993g). Aerial photography and satellite imagery were conducted in 2000 to help locate the disposal unit positions.

I.2.3.4 Technical Area 15: Material Disposal Area Z

MDA Z (SWMU 15-007(b)) is south of the side road leading to Building TA-15-233 near Firing Site G. MDA Z is teardrop-shaped and measures 200 feet (60 meters) by 50 feet (15 meters) at its widest. The MDA was used between 1965 and 1981 for disposal of construction debris. The waste was placed in a natural depression. (Concrete-filled sandbags at the site were probably piled as a retaining wall.) One face of the MDA grades to native soil; the other face is exposed, standing 15 feet (4.6 meters) high. The debris on the exposed face was probably bulldozed from PHERMEX and includes metals from wire and blast mats, volatile organic compounds or semi-volatile organic compounds from charred wood, road and construction debris, and radioactive substances (LANL 1993c, 1999b). One reference states that chunks of uranium are visible (LANL 1999b), although a 1982 aerial radiological survey detected no radioactive contamination above background values (LANL 1993c).

A Phase I RFI conducted from June 1995 to March 1996 collected surface and subsurface samples. Inorganic chemicals found above background values were beryllium, copper, lead, mercury, and silver. Uranium was found with a maximum concentration of 349 milligrams per kilogram. Twelve organic chemicals were found. The RFI report recommended material removal following a baseline ecological risk assessment (LANL 2005c).

I.2.3.5 Technical Area 36: Material Disposal Area AA

Located in the southeastern portion of LANL, TA-36 (Kappa Site) has four active firing sites.

MDA AA (SWMU 36-001) is within Potrillo Canyon. MDA AA is near the active Lower Slobbovia firing range (SWMU 36-004(d)) and consists of two to four disposal trenches used to burn and dispose of debris and sand from firing sites. The trenches likely contain wood, nails, and sand contaminated with barium, uranium, other inorganic chemicals, plastics, and possibly high explosive. When a trench became filled with waste, it was covered with 4 feet (1.2 meters) of soil. The first trench was dug in the mid-1960s, and the site was closed in 1989 in accordance with New Mexico solid waste regulations.[6] The MDA AA trench area was graded to lessen the potential for stormwater runon. Samples taken from the last active trench in 1987 and 1988 showed elevated levels of cadmium and uranium (LANL 1993a, 1999b, 2005c).

A Phase I RFI was conducted from 1993 through 1995. Two trenches were identified: the northern trench is 80 by 40 by 8 to 13 feet deep (24 by 12 by 2.4 to 4.0 meters deep); the southern trench is 120 by 20 to 30 by 3 to 12 feet deep (37 by 6.1 to 9.1 by 0.9 to 3.7 meters deep). Boreholes into the trenches were sampled for inorganic and organic chemicals and radionuclides. The RFI report recommended no further action. NMED disagreed. A Phase II sampling and analysis program was planned. In 1996, an interim action stabilized erosion gullies using wire mesh and cobbles (LANL 2005c).

I.2.3.6 Technical Area 39: Material Disposal Area Y

TA-39 (Ancho Canyon Site) is at the bottom of Ancho Canyon between Los Alamos and White Rock. MDA Y (SWMU 39-001(b)) is part of Consolidated Unit 39-001(b)-00 consisting of SWMUs 39-008 and 39-001(b) (LANL 1999b, 2005c).

SWMU 39-008 is a former firing range. Testing began in 1960, continued until 1975, was suspended for 13 years, and resumed in 1988. Building 39-137 housed a gun using gas to fire projectiles at targets on a cliff face. Most debris from this and other gas gun experiments lies in an area west of the building, but projectiles and target fragments occasionally hit the cliff face 200 feet (61 meters) west of Building 39-56. The area between the buildings and the cliff was leveled and surface materials pushed into a mound. A 1977 RFI report, later withdrawn, recommended deferring action on SWMU 39-008 because it was still active. However, SWMU 39-008 is a nondeferred site in the Consent Order, where it is described as soil contamination associated with a former building footprint (see Table I–5) (LANL 2005c).

SWMU 39-001(b) (MDA Y) consists of three pits that, beginning in the late 1960s, received debris from the firing range (SWMU 39-008), empty chemical containers, and office waste (LANL 1999b, 2005c). The RFI Work Plan for Operable Unit 1132 indicates that the first pit measured 148 by 20 by 12 feet deep (45 by 6.1 by 3.7 meters deep); the second pit next to and west of the first pit had the same dimensions, and the third pit was south of the other pits (LANL 1993b). Figure 5–3 of this reference suggests that the first two pits were 40 feet (12 meters) apart. The third pit is depicted as being about twice as long as the first two pits but

[6] *A permitted burn area west of MDA AA is still used to burn combustible firing site debris (LANL 1999a).*

about as wide. Pit 1 may have been surveyed and dug in 1973; Pit 2 was in use from about 1976 to 1981; and Pit 3 from 1981 to 1989 (LANL 1993b).

The most probable locations of the pits were estimated from geophysical surveys, historical information, and radiation surveys. In 1994, two separate field activities investigated whether waste constituents had migrated from the pits. The 1994 field activities guided RFI sampling conducted in 1996. Test pits were trenched to below 12 feet (3.7 meters), the approximate depth of waste burial. The 1994 and 1996 field activity results were summarized in an RFI report that was later withdrawn (LANL 2005c).

I.2.3.7 Technical Area 49: Material Disposal Area AB

PRSs associated with MDA AB are addressed in Section I.2.5.3.

I.2.4 Canyons

The Consent Order requires investigations within canyon watersheds in accordance with approved work plans.[7] The Consent Order requires construction of new wells, abandonment of some existing wells, and environmental sampling. Newly constructed wells must include alluvial, intermediate, and regional aquifer wells in the following watersheds (NMED 2005):

- Los Alamos/Pueblo Canyons Watershed
- Mortandad Canyon Watershed
- Water Canyon/Cañon de Valle Watershed
- Pajarito Canyon Watershed
- Sandia Canyon Watershed
- Other canyons (Ancho, Chaquehui, Indio, Potrillo, Fence, and North Canyons [Bayo, Guaje, Barrancas, and Rendija])

These wells would supplement existing wells. The numbers and locations of the wells, however, will be defined in approved work plans and may be different from numbers and locations identified in the Consent Order.

Canyon investigations implemented in 2005 focused primarily on Mortandad Canyon, and involved the characterization of sediment, biota, and groundwater to determine the nature and extent of contamination in media and to collect sufficient data to perform human and ecological risk assessments. Additional investigations in Pajarito Canyon were focused on sediment characterization to evaluate the nature and extent of contamination and the distribution of contaminant inventory (LANL 2006h).

[7] *At the time of Consent Order issuance, some canyon work plans had already been submitted to NMED while others were still under development.*

The canyon investigation results may lead, as approved by NMED, to corrective measure programs. The scope of any remediation program for any watershed cannot be fully defined at this time. However, potential remediation alternatives could range from no action to more significant activities such as installation of additional shallow and deep groundwater monitoring wells, vadose zone monitoring systems, in situ bioremediation, permeable reactive barriers, or groundwater pump-and-treat systems. The more complex and involved remedies might require staging areas and moderate augmentation of infrastructure (such as plumbing for extracted water or other wastes) to support remedy operational aspects.

I.2.5 Technical Area Investigations

Requirements for TAs are typically prescribed for individual MDAs. (An exception is the investigative program prescribed for the Bayo Canyon Site, which consists of several PRSs but no MDAs.) Investigations for each MDA must be conducted in accordance with approved work plans and may include disposal unit surveys, drilling explorations, soil and rock sampling, sediment sampling, vapor monitoring and sampling (if present or discovered), intermediate and regional aquifer groundwater well installation, and groundwater monitoring.

I.2.5.1 Technical Area 10: Bayo Canyon Site

The Bayo Canyon Site (former TA-10) is in Bayo Canyon next to the western boundary of TA-74 and 4 miles (6.4 kilometers) west of the intersection of Bayo and Los Alamos Canyons. From 1943 to 1961, tests were conducted for nuclear weapons development. The Radiochemistry Laboratory, Building TA-10-1, prepared radiation sources for blast diagnostics. Explosives dispersed aerosols and debris containing uranium, lanthanum, and strontium-90. Liquid wastes were discharged to Bayo Canyon (NMED 2005). Bayo Canyon PRSs were investigated in accordance with the RFI Work Plan for Operable Unit 1079 (LANL 1992d). They include: (1) Consolidated Unit 10-001(a)-99; (2) Consolidated Unit 10-002(a)-99; (3) SWMU 10-004(a); (4) SWMU 10-006; and (5) AOC 10-009. The Consent Order requires additional investigations in accordance with the Bayo Canyon Aggregate Area Investigation Work Plan (NMED 2005). The work plan was submitted to NMED by the July 30, 2005, deadline, as was the required Historical Investigation Report for Bayo Canyon (LANL 2005m).

I.2.5.2 Technical Area 21: Material Disposal Areas A, B, T, and U

TA-21 (DP Site) is on DP Mesa east-southeast of the Los Alamos township. From 1945 to 1978, TA-21 was used for chemical research and for plutonium and uranium metal production (LANL 1999b, 2002a). DP West was used for radioactive-materials processing. Operations ceased in the 1980s, although process buildings remained until decommissioning began in the 1990s. DP East includes the Tritium Science and Fabrication Facility and the Tritium Systems Test Assembly (DOE 1999a). Operations will be relocated and structures decommissioned as addressed in Appendix H, Section H.2, of this SWEIS.

MDAs A, B, T, U, and V within TA-21 are shown in **Figure I–4** (LANL 2005b). The complex of structures to the east of MDA A is DP East, while the complex of structures to the west of MDA A is DP West. MDA V within TA-21 has been removed.

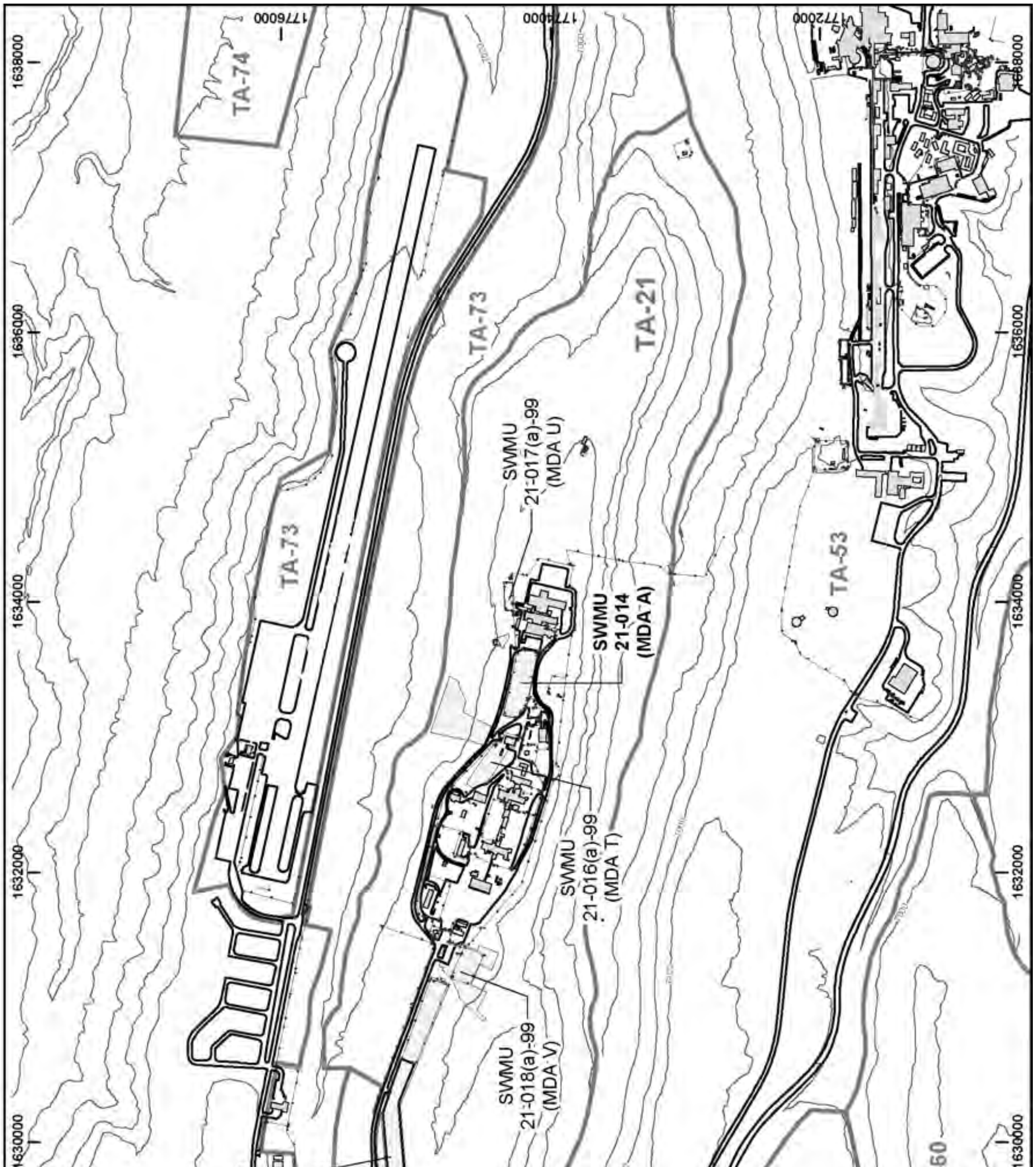


Figure I–4 MDAs A, B, T, U, and V within TA-21

I.2.5.2.1 Material Disposal Area A

MDA A (SWMU 21-014) is on a site covering 1.25 acres (0.51 hectare) between DP West and DP East.

History of MDA A. In 1945, two disposal pits were dug at the east end of the MDA, and two underground tanks ("General's Tanks") for liquid waste storage were emplaced at the west end. During 1969, a large pit in the center of the MDA was dug for demolition debris (**Figure I–5**) (LANL 1991).

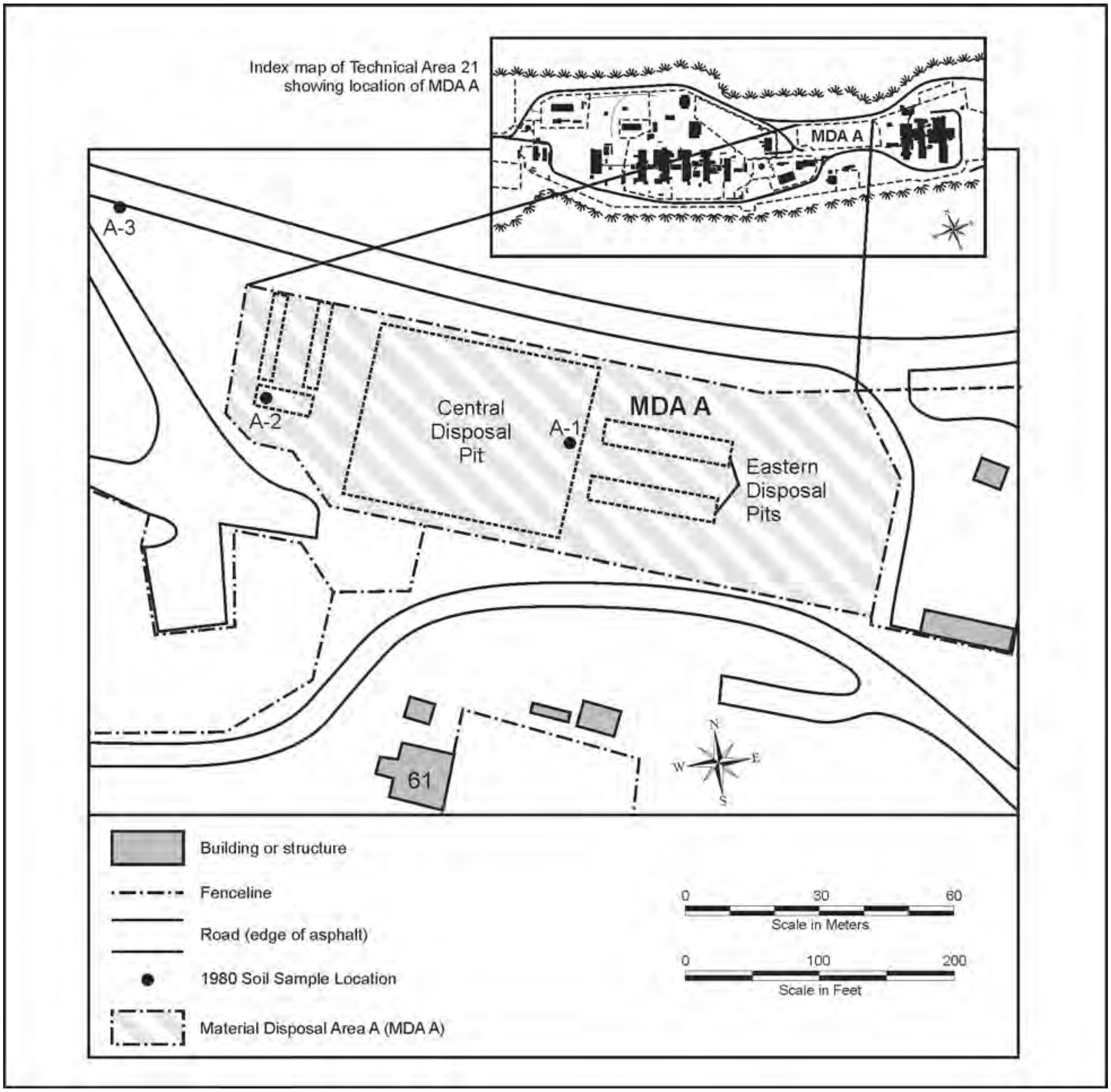


Figure I–5 Material Disposal Area A

Eastern Pits. Contemporary engineering drawings depict four pits. Yet only two pits were built, based on later engineering drawings showing pits roughly 15 feet (4.6 meters) wide at the top and 12 feet (3.7 meters) deep, as well as other documentation (Rogers 1977, LANL 1991). The MDA Core Document (LANL 1999b) states that the pits were 13 feet (4 meters) deep and received 36,000 cubic feet (1,020 cubic meters) of "solid wastes with alpha contamination accompanied by small amounts of beta and gamma" (Rogers 1977). The work plan for TA-21 states that the pits received "laboratory equipment, building construction material, paper, rubber gloves, filters from air cleaning systems, and contaminated or toxic chemicals." The possibility exists that "plutonium, polonium, uranium, americium, curium, Radium-Lanthanum [sic], actinium, and waste products from the Water Boiler" were present in the waste. "Polonium and plutonium-239 and plutonium-240 were also thought to be the major contaminants in the waste" (LANL 1991).

During the early 1950s, several 55-gallon (208-liter) drums were stored at the east end of the MDA containing a solution of sodium hydroxide and stable iodine used to scrub ventilation air containing plutonium and possibly uranium. The liquid volume and its chemical content are unknown. Drum corrosion released some of the solution to surface soil. The drums were removed in 1960 and the storage area paved (LANL 1999b).

General's Tanks. In 1945, two 50,000-gallon (189,000-liter) steel tanks (named after General Leslie Groves) were buried on the west end of the MDA to store solutions containing plutonium-239 and plutonium-240 (LANL 1999b). The tanks are shown in **Figure I–6** and described below (Rogers 1977):

> The tanks are 12 feet (3.7 meters) in diameter and 62 feet-10 inches (19.1 meters) long. They were placed 20 feet (6.1 meters) apart in pits 12 feet (3.7 meters) deep, 15 feet (4.6 meters) wide, and probably 86 feet 10 inches (21.0 meters) long on four concrete piers. Each pier was 4 feet-10 inches (1.5 meters) high, with the bottom 2 feet (0.6 meters) below the bottom of the pit. Each tank rested on piers 1 foot (0.3 meters) above the bottom of the pit. Sand was placed in the bottom of the pit up to the top of the piers—a depth of 1 foot-10 inches (0.5 meters). Thoroughly packed earth filled the area between the tank and most of the rest of the pit. Directly above the tanks, loose dirt fill was specified. A concrete slab 8 inches (20.3 centimeters) thick, 56 feet (17.1 meters) wide, and 68 feet 10 inches (21 meters) long was poured 1.5 feet (0.5 meters) above the tanks. Approximately 5 feet (1.5 meters) of earth fill was placed above the concrete slab. This final earth fill formed a mound 2.25 to 5.75 feet (0.7 to 1.8 meters) above grade. On the north end of each tank, a vent extended 15 feet (4.6 meters) above the mound. On the south end of each tank, the fill pipe is enclosed in a concrete box with outside dimensions 2 feet-10 inches (0.9 meters) high, 2 feet-10 inches (0.9 meters) wide, and 4 feet-4 inches (1.3 meters) long. The box extended 1 foot (0.3 meter) above the mound.

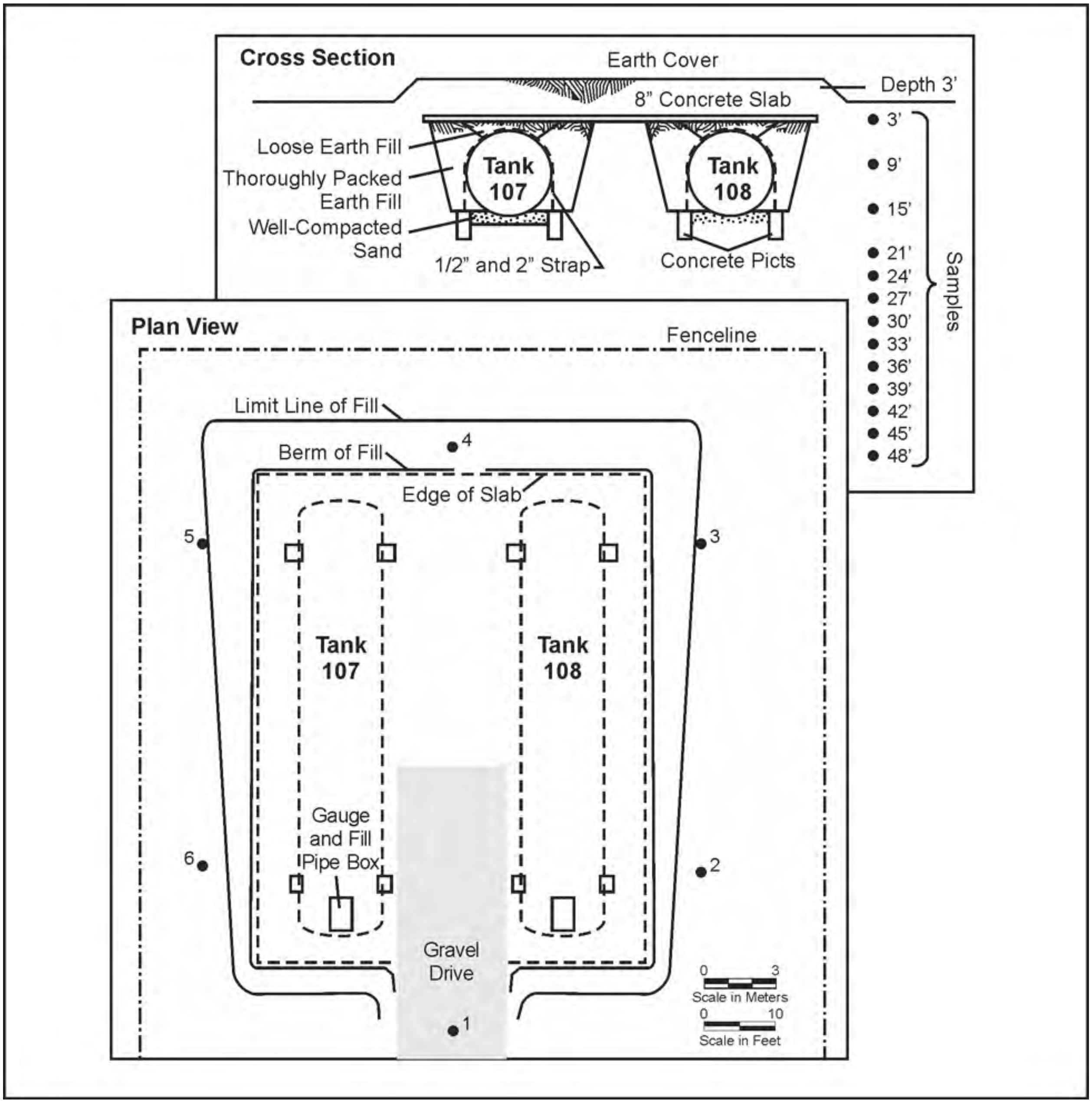


Figure I–6 General's Tanks within Material Disposal Area A

Solutions containing plutonium-239 and plutonium-240 in sodium hydroxide were to be stored until the plutonium could be extracted (LANL 1991, 1999b). But in 1975, the solution was removed, solidified in cement, and buried in MDA A, leaving a residual sludge within the tanks. The solidified waste was subsequently moved to Pit 29 in MDA G, where it is being stored (LANL 1999b). Evidence of rain water entry into the tanks led to the sealing of openings in the top of the tanks in 1985 (LANL 1991).

Central Pit. In 1969, a pit was dug in the center of MDA A to a depth of 22 feet (6.7 meters), leading to a waste capacity of 4,885 cubic yards (3,735 cubic meters). The pit received waste from operations in TA-21. In 1972, the pit was enlarged (but not deepened) to a total capacity of

18,736 cubic yards (14,325 cubic meters). The pit received plutonium-contaminated debris from demolition of a frame and masonry building. Demolition was finished in 1974, after which the remaining portions of the pit were filled with waste. A soil cover was emplaced in May 1978. Radionuclides included plutonium-238, plutonium-239, plutonium-240, uranium-235, depleted uranium, and other isotopes (LANL 1989, 1991).

Waste Inventory. Documentation about waste inventory is limited.

Eastern Pits. Memoranda and other information suggest that the dominant radionuclide contaminants were plutonium-239, plutonium-240, and polonium. The pit may contain small quantities of uranium, americium-241, and other isotopes. The pit and its surroundings may contain residues from the leaking drums of iodine in a sodium hydroxide solution (LANL 1991).

General's Tanks. The 1991 work plan for TA-21 estimated the total tank inventory to be 12 to 25 curies, mostly plutonium-239 and plutonium-240, but including plutonium-241 and americium-241 (LANL 1991).[8] It was estimated that one-third of the activity was americium-241 (Rogers 1977). A more recent report estimates 54.3 curies of plutonium-239, 78.9 curies of plutonium-241, 6.07 curies of americium-241, and small quantities of uranium-235 and plutonium-238 (LANL 2004l). The tanks probably contain metals and solvents (LANL 1991).

Central Pit. This pit probably contains plutonium-238, plutonium-239, plutonium-240, uranium-235, depleted uranium, and other isotopes (Rogers 1977). It is unknown whether the pit contains chemically hazardous wastes (LANL 1991).

Current Configuration. MDA A consists of a fenced grassy area between DP East and DP West, bordered to the north and south by paved roads. Photographs suggest that about 10 to 20 percent of the MDA is paved with asphalt.

Site Investigations. Historical site investigations included surface and subsurface sampling in 1980 and 1984 and a geophysical investigation in 1989. Four test holes were drilled next to the General's Tanks in 1974 and six holes in 1983. Surface soil samples found uranium and plutonium-238, plutonium-239, plutonium-240, above background levels in most of the area over and near the General's Tanks. Limited data suggested elevated uranium levels in vegetation. This contamination was covered after site remediation in 1985 and 1987. Subsurface samples collected in 1974 and 1983 near the General's Tanks to 30-foot (9.1-meter) depths found uranium and plutonium-238, plutonium-239, and plutonium-240, above background levels in most sampling intervals (LANL 1991). The 1989 geophysical investigation used several remote sensing techniques (magnetics, electromagnetics, resistivity, radar, and self-potential) to improve knowledge of pit and trench geometries and to locate other buried material (LANL 1989).

The MDA A Investigation Work Plan required by the Consent Order was submitted to NMED by the January 31, 2005 due date (LANL 2005m, 2005b). The MDA A Investigation Report was completed and submitted to NMED on November 9, 2006.

[8] *Having a 13-year half-life, plutonium-241 is formed along with plutonium-239/240 in a nuclear reactor and is essentially inseparable from it. Plutonium-241 decays to americium-241, an isotope having a 458-year half-life (LANL 1991).*

I.2.5.2.2 Material Disposal Area B

MDA B (SWMU 21-015) is the largest MDA in TA-21. It is within a narrow site covering 6 acres (2.4 hectares) south of and parallel to DP Road west of MDA V (**Figure I–7**).

History of MDA B. MDA B operated from 1945 to 1948 (LANL 1999b) and received waste from DP East and DP West, including laboratory waste and debris, and probably limited volumes of liquid wastes (LANL 2004d). It also received waste from other areas of LANL. Unlike the practice at other MDAs of layering waste within disposal pits (see MDA C in Section I.2.5.4), the depth and width of the MDA B pits were filled with waste before backfilling. This disposal practice used pit capacity efficiently but led to cover subsidence. After MDA B was closed following a 1948 pit fire[9], subsidence craters were filled with noncontaminated concrete and soil from construction sites (LANL 1991).

The 1948 pit fire was probably caused by spontaneous combustion of mixed chemicals in waste. The fire was intense, lasted an estimated 2 hours, and covered an area of 2,500 square feet (232 square meters) (LANL 1991). MDA B was closed and another disposal site was developed (probably MDA C) that was farther from living and working areas (Rogers 1977). In 1966, the western two-thirds of the MDA was fenced, paved, and leased to Los Alamos County for trailer storage. The storage park has since been closed (LANL 1991).

Work performed in 1982 to stabilize the eastern end of MDA B included moving the fence, decontaminating surfaces, removing vegetation, and covering the area with soil that was compacted and seeded (LANL 1991). In 1984, the eastern portion of MDA B was resurfaced using several different experimental cover systems. The experimental program included field studies of barriers against biological intrusion and erosion (LANL 1986). The current cover features several variations of a nominal 3-foot-thick (1-meter-thick) crushed-tuff cover placed over the original cover (LANL 1999b).

Waste Inventory. Inventory information is largely anecdotal. The following description is from the Historical Investigation Report for the 2004 MDA B Investigation Work Plan (LANL 2004d):

> The principal radioactive contaminants consist of the types of radioactive materials used at the time: plutonium, polonium, uranium, americium, curium, radioactive lanthanum, actinium, and waste products from the water boiler reactor. However, approximately 90 percent of the waste consisted of radioactively contaminated paper, rags, paper gloves, glassware, and small metal apparatuses placed in cardboard boxes by the waste originator and sealed with masking tape. The remainder of the material consisted of metal, including air ducts and large metal apparatuses. The latter type of material was placed in wood boxes or wrapped with paper. At least one truck, contaminated with fission products from the Trinity test, is buried in MDA B.

Limited volumes of liquid waste are believed to have been emplaced in at least one chemical trench in the eastern end of the MDA (LANL 2004d).

---

[9] *A chemical fire also occurred in 1946 that lasted about two hours and was extinguished by bulldozing dirt over the affected area (LANL 2006f).*

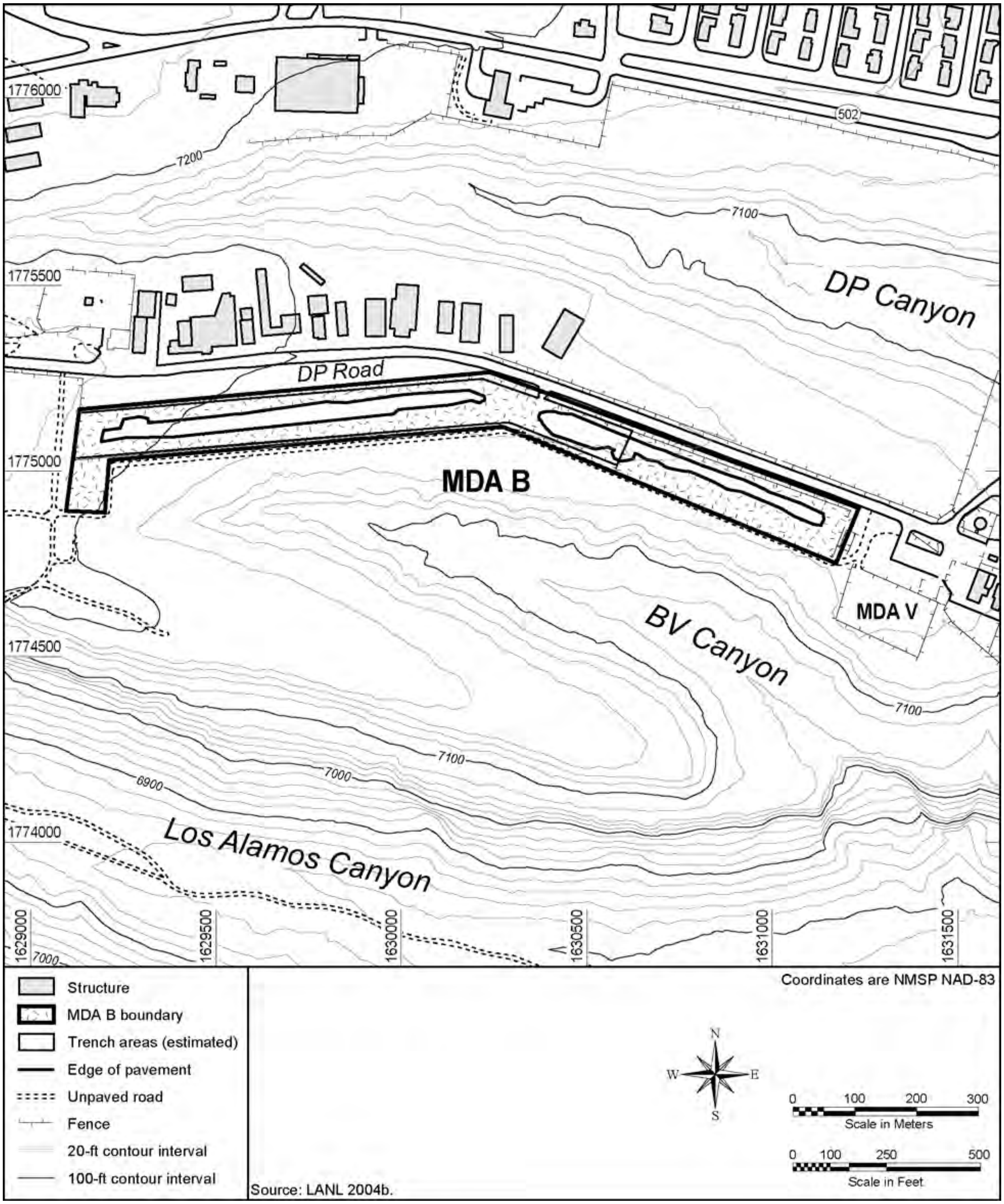


Figure I–7 Material Disposal Area B Incorporating 1998 Geophysical Survey Information

The 1977 report by Rogers (Rogers 1977) references a January 4, 1971, memorandum:

> The total volume of the pits, after deducting the three foot of cover materials, is 28,000 cubic yards. These pits actually contain very little plutonium. At the time they were in use, plutonium was scarce and only that which was present as contamination was buried. (It is estimated) that the entire pit contains no more than 100 grams (6.13 curies) of plutonium-239.

The following summary of nonradioactive wastes is from the MDA B Historical Work Plan (LANL 2004d):

> There are some indications hazardous chemicals may be present at MDA B. Drager, commenting on the 1948 fire, reported there was some evidence chemicals had been disposed of in the dump in an unauthorized manner; that is, in cardboard containers used for the regular disposal of common laboratory waste. In the fire, several cartons of waste caused minor explosions, and on one occasion, a cloud of pink gas arose from the debris in the dump. Documented employee interviews stated chemical disposal occurred at the east end of MDA B. Chemicals disposed of included old bottles of organic chemicals, including perchlorate, ethers, and solvents. The 1987 DOE document also stated lecture bottles, mixtures of spent chemicals, old chemicals, and corrosive gases may be in trench(es) at the east end of MDA B.

Current Configuration. The number of disposal units is uncertain (LANL 1991). A 1977 report estimated at least five pits (Rogers 1977). This reference suggests that four disposal pits were dug parallel to the fence along DP Road and that two pits were dug in the MDA at its western end (Rogers 1977). The RFI Work Plan for TA-21 references a 1964 memorandum stating that a covered shallow trench was at the extreme eastern end of the MDA. Another source indicated that several small slit trenches were dug in the eastern end of the MDA for chemical disposal (LANL 1991). The RFI Work Plan for TA-21 concluded that the MDA likely contained a minimum of four pits plus at least one chemical trench (LANL 1991). The 1991 RFI Work Plan estimated that the disposal trench surface area was 1.1 acres (0.46 hectare), covering 27,780 cubic yards (21,240 cubic meters) of buried waste (LANL 1991).

Geophysical surveys conducted in 1998 (LANL 2004d) found a single primary trench in the eastern leg of MDA B, and one to three trenches in the western leg (Figure I–7). The eastern trench is 800 feet (244 meters) long and varies from 25 to 60 feet (7.6 to 1.8 meters) wide. The western trench may contain one continuous trench or three trenches excavated end to end. The total length is 1,000 feet (305 meters)—or 300 to 400 feet (91 to 122 meters) per trench if three trenches—and its width is about 40 feet (12.2 meters). Trench depths appear to be 11 to 15 feet (3.4 to 4.6 meters) beneath the current ground surface. Depths from the top of the ground surface to the top of the waste (estimated to occur at the locations of numerous metal objects) range from 1.3 to 7.2 feet (0.4 to 2.2 meters) (mean 4.1 feet [1.2 meters]) (LANL 2004d). The MDA B Investigation Work Plan estimates that the disposal trench surface area is 2.4 acres (0.97 hectare), and the volume is 47,910 cubic yards (36,630 cubic meters) (LANL 2004d).

The investigations were not able to distinguish the slit trenches for chemical wastes reputed to be at the eastern end of MDA B. The investigations did suggest that several small chemical pits may be in the area of these slit trenches. The investigations were not able to distinguish the short trenches reputedly excavated in the western portion of the MDA, although buried metal objects were found. The area occupied by buried objects appears to extend beyond the fence to the west and south. Their calculated depths range from 0.1 to 6.8 feet (0.03 to 2.1 meters). Partially exposed buried objects were seen (LANL 2004d).

In 2004, workshops were conducted wherein subject matter experts concluded that for purposes of a planned program of investigation and remediation, MDA B could be best envisioned as comprising two sections containing chemical slit trenches, a section that may contain slit trenches or disposal pits, five sections containing debris pits, and two sections of suspected chemical waste discharge (LANL 2005p). The investigation and remediation program for MDA B is addressed in Section I.3.3.2.7.

MDA B contains no structures. The site is surrounded by a galvanized steel chain-link fence and consists of (LANL 2004d):

- a soil-covered, unpaved area covering 15,750 square feet (1,463 square meters) (105 by 150 feet [32 by 46 meters]) at the western end of MDA B
- an asphalt-paved area comprising the long western leg and the central portion of the site (1,500 by 120 feet [457 by 37 meters])
- an unpaved area comprising the eastern leg of the site (600 by 150 feet [183 by 46 meters])

Vegetation has penetrated through cracks in the asphalt, and portions of the northern and southern boundaries of the site are lined with trees (LANL 2004d).

North of the MDA and south of DP Road is an unpaved area used by businesses for parking and deliveries. Commercial buildings occupy the paved area alongside and north of DP Road. West of MDA B is a vacant lot. An abandoned underground radioactive liquid waste line that ran outside the fence along the southern boundary of the site was removed in 2007. Buried water and communication lines are beneath the area between DP Road and the north fence. A water hydrant is inside the northwest corner of the fence, and air monitoring stations are located on the northern and northeastern sides of the fence along DP Road (LANL 2004d, 2006a, 2006i).

Site Investigations. Numerous investigations have occurred since 1948. Pre-RFI investigations are summarized in the Operable Unit RFI Work Plan for TA-21, the Investigation Work Plan for MDA B, and Revision 1 of the Investigation/Remediation Work Plan for MDA B (LANL 1991, 2004d, 2006i). RFI investigations are summarized below:

Surface investigations from 1966 to 2001 have included surface soil sampling and surface flux measurements of volatile organic compounds. Americium-241, cesium-137, plutonium-238, plutonium-239, and tritium were detected consistently across the surface of MDA B. Organic chemicals were detected very infrequently at the surface of MDA B. Lead and zinc were detected above background values consistently across MDA B. Other inorganic chemicals were also detected (LANL 2006i).

Three subsurface investigation campaigns occurred in 1966, 1983, and 1998. The 1966 and 1983 investigations included vertical boreholes drilled alongside the MDA boundary. The 1983 investigations indicated potential tritium contamination at depth. The 1998 investigations included seven angled boreholes drilled beneath the disposal trenches. Lead was found at several depths in one borehole in the west end of the MDA, and in one sample from a borehole in the central portion of the MDA. Aluminum, arsenic, cadmium, mercury, and zinc were also detected. Tritium was found above background in six of seven boreholes. The tritium concentration in the borehole beneath the assumed location of the chemical trench increased slightly over the length of the boring, but decreased in concentration in the deepest sample. Hence, tritium may have been released from the disposal trenches to the subsurface tuff. Tritium sample results over all of DP Mesa may also have been affected by the operation of the Tritium Systems Test Assembly and Tritium Systems Fabrication Facility. In 1983, both of these facilities had atmospheric releases of tritium that would have been noted over all of DP Mesa (LANL 2006a). Americium-241 and strontium-90 were found in this borehole in concentrations that decreased with depth. In a different borehole, uranium-234, uranium-235, and uranium-238 were found above background in one sample (LANL 2006i).

Pore-gas sampling from the angled boreholes found trace levels of several volatile organic compounds, primarily trichloroethene (TCE) and 1,1,1-trichloroethane (TCA), in the parts-per-billion-by volume range (LANL 2006i).

The average moisture content in soils beneath the asphalt at MDA B (10.6 weight-percent) is elevated compared with surrounding surface soils (5.1 weight percent) and subsurface materials (5.6 weight percent) (LANL 2006i).

The objectives of Revision 1 of the Investigation/Remediation Work Plan are to characterize the types and quantities of waste contained in the historical disposal trenches at MDA B; to remove and properly dispose of the waste in these trenches; to collect confirmation samples to characterize the radiological, organic chemical, and inorganic chemical concentrations in the soil and rock next to the disposal trench sides and bottoms and in the deeper subsurface beneath the site; and to obtain data needed to prepare a sampling and analysis plan to support the evaluation of any potential residual risk to human health and the environment after the waste is removed (LANL 2006i). In January 2007, the work plan was approved with modifications by NMED (NMED 2007b). Additional information about the investigation/remediation program for MDA B is in Section I.3.3.2.7.

I.2.5.2.3 Material Disposal Area T

MDA T is on a site covering 2.2 acres (0.9 hectare) (**Figure I–8**). MDA T comprises Consolidated Unit 21-016(a)-99, consisting of SWMUs 21-007, 21-010(a-h), 21-011(a), 21-011(c-g, i, j), and 21-01g(a-c); and AOCs 21-001, 21-011(h), 21-028(a), C-21-009, and C-21-012 (LANL 2005c). It includes four absorption beds, more than 60 shafts, an area once used for solidified waste storage, two industrial wastewater treatment plants, associated buried piping, and various surface features that may have been impacted by facility operations (LANL 2005c).

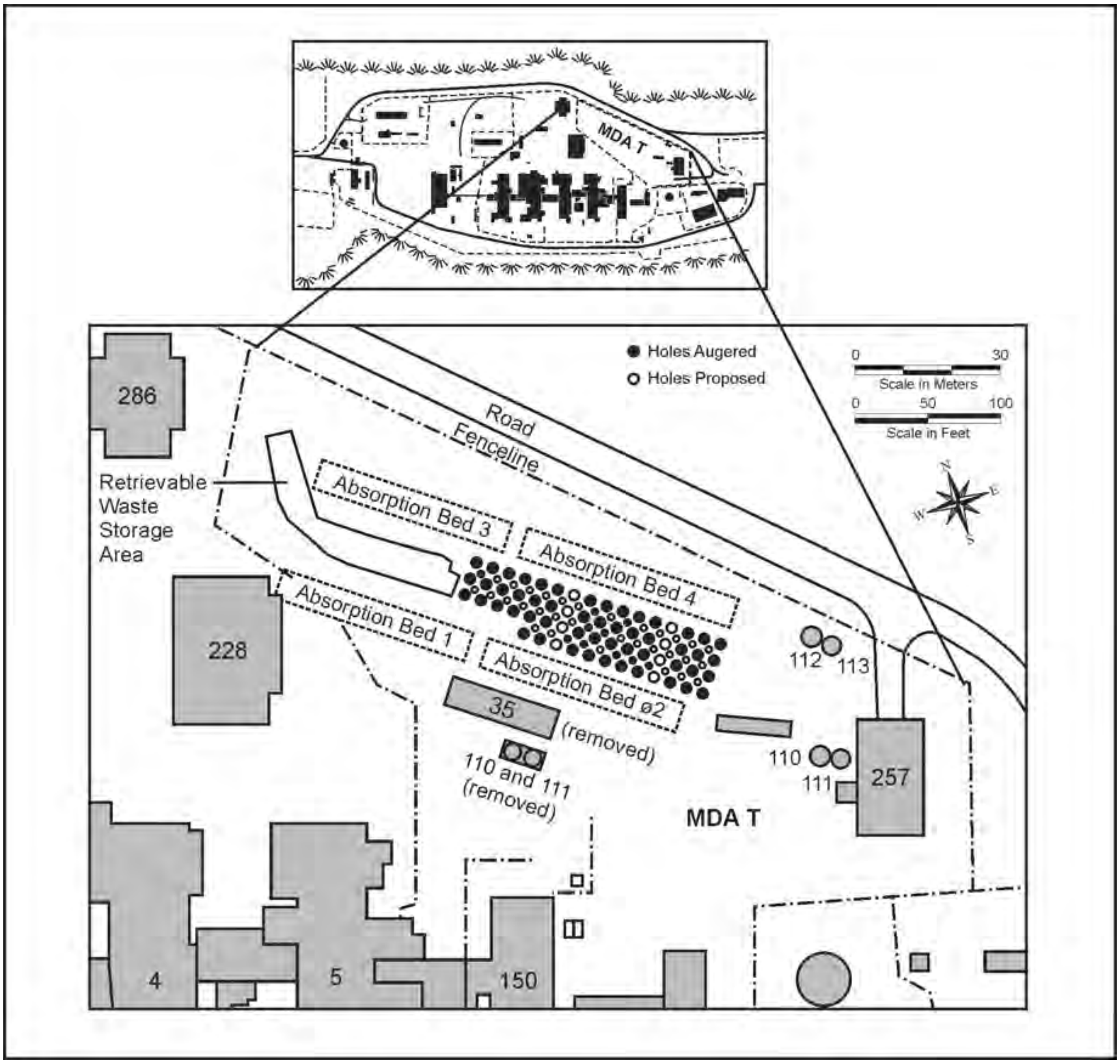


Figure I–8 Material Disposal Area T

History of MDA T. From 1945 to 1952, the absorption beds received liquids from the TA-21 plutonium laboratories. After 1952, when a liquid waste treatment plant was installed in Building 035, the beds were used only occasionally, receiving small quantities of liquid effluent until 1967, when a new liquid waste treatment process began operating in Building 257. The shafts were used between 1968 and 1983 for disposal of liquids combined into a cement paste as well as some solid wastes (LANL 1991, 2004a).

Absorption Beds. The four absorption beds (SWMU 21-016(a)) were built "about 1945" (LANL 1991).[10] The four absorption beds were each 120 by 20 by 6 feet deep (36.6 by 6.1 by 1.8 meters deep).[11] The distance between the centers of Beds 1 and 3 and Beds 2 and 4 is 80 feet (24.4 meters) (Rogers 1977). The beds are shown in cross section in **Figure I–9** (LANL 1991).

[10] *MDA T may have received wastes as early as 1943 (LANL 1991).*
[11] *The beds were 4 feet (1.2 meters) deep, the bottoms of the beds were cut level, and the east and west sides of each bed were sloped so that only the center 100 feet (30.5 meters) of each bed had a depth of 4 feet (1.2 meters) (Rogers 1977).*

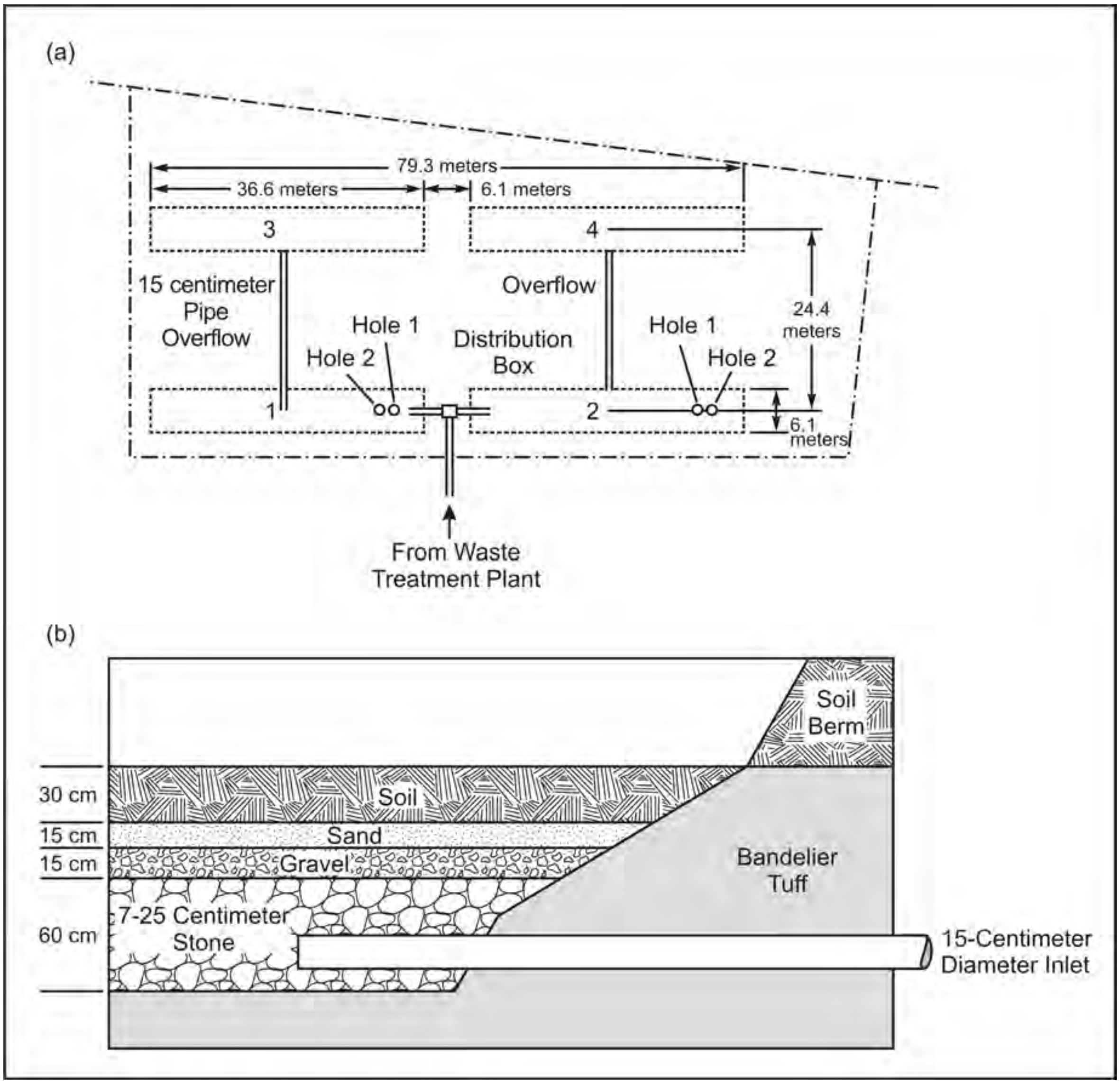


Figure I–9 Absorption Bed and Distribution Pipe Cross-Section

The two sources for liquid waste from DP West were (**Figure I–10**) (LANL 1991, Rogers 1977):

- Effluent from sumps in Buildings 2, 3, 4, and 5 that was piped to a distribution box located between Beds 1 and 2
- Effluent from the Building 12[12] floor drain that was piped directly to Bed 1

The concrete distribution box (SWMU 21-011(c)) has dimensions of 4 by 3 by 4 feet (1.2 by 0.9 by 1.2 meters) with 6-inch-thick (15.2-centimeter-thick) walls. Overflow pipes connect Bed 1 with Bed 3 and Bed 2 with Bed 4 (Rogers 1977).

[12] *This building was removed in 1973 (Rogers 1977).*

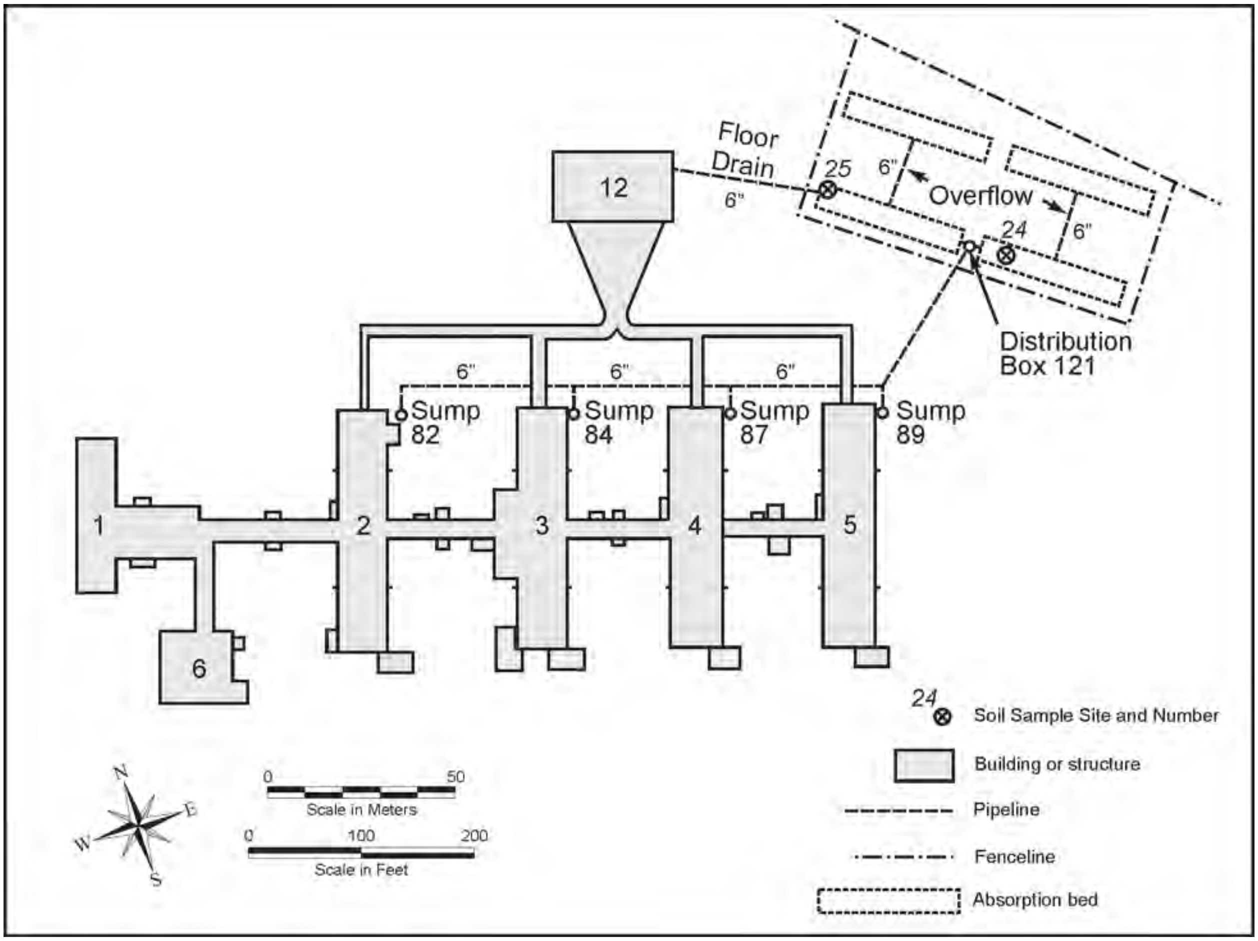


Figure I–10 Location of Lines Discharging to Absorption Beds at Material Disposal Area T Before 1952

The absorption beds occasionally became saturated and overflowed northward toward DP Canyon (Rogers 1977). Overflow associated with operational use of the beds, release of effluents from outfalls, and possibly from experimental studies has contributed to contamination in soils north of the site. The western end of the MDA has experienced erosion (LANL 1993h).

Disposal Shafts. Starting on May 1, 1968, more than 60 disposal shafts (SWMU 21-016) were augured (**Table I–7**), mostly between Beds 2 and 4 and, after being lined with asphalt, used mostly to dispose of cement paste from liquid waste treatment at Building 257 (LANL 1991). The larger shafts (numbers 1 through 60) are on 12-foot (3.7-meter) centers. (There are gaps in the sequencing of the shafts because several shafts were not augured.) The smaller shafts (shafts 70 through 100) were placed between the surface matrices of the larger shafts (Rogers 1977).

Wastes in Retrievable Storage. In 1974, a pit 30 by 60 by 20 feet deep (9 by 18 by 6 meters deep) was dug between Absorption Beds 1 and 3 for storage of liquid wastes cemented into corrugated metal pipes. These pipes were moved to MDA G in the 1980s (LANL 1991). The excavation (SWMU 21-016(b)) was backfilled (LANL 2004a).

Table I–7 Material Disposal Area T Waste Disposal Shaft Depths and Diameters

Shaft	*Diameter (feet)*	*Depth (feet)*	*Shaft*	*Diameter (feet)*	*Depth (feet)*
1	8	61	42	8	21
2	8	21	43	8	62
3	8	27	44	8	63
5	8	29	46	8	66
6	8	27	47	8	25
8	8	67	48	8	63
9	8	63	49	8	67
10	8	23	50	8	65
11	8	28	51	8	30
13	8	65	52	8	23
17	8	50	53	8	52
18	8	59	54	8	63
19	8	65	55	8	69
20	8	63	56	8	62
21	8	62	57	8	25
22	8	64	58	8	22
23	8	63	59	8	54
24	8	61	60	8	63
25	8	16	70	6	68
26	8	15	75	6	67
27	8	58	76	6	67
28	8	67	78	6	65
29	8	61	80	6	66
30	8	62	82	6	64
31	8	18	83	6	24
32	8	15	84	6	50
33	8	64	87	6	66
34	8	60	91	6	26
35	8	62	92	6	27
36	8	61	94	6	22
41	8	62	95	6	16
–	–	–	100	6	66

Note: The citations in the source for this table (LANL 1991) are in meters. To convert feet to meters, multiply by 0.3048.
Source: LANL 1991.

Additional Facilities and PRSs. Numerous additional faculties and PRSs are associated with MDA T (Consolidated Unit 21-016(a)-99), including:

- Building 035 (SWMU 21-010(a)). Construction on this industrial liquid waste treatment plant began in 1949 and was completed in 1952. It operated until 1967. It was decontaminated and decommissioned in 1967, and the building and some associated tanks and piping were removed and disposed of; other tanks were relocated (LANL 2005c). A septic tank and leach field were abandoned in place (LANL 2004a).

- Building 257 (SWMU 21-011(a)). This treatment plant treated and prepared wastes for disposal at MDA T and included an outfall (SWMU 21-011(k)) that discharged to

DP Canyon.[13] The treatment plant includes a clarifier-flocculator, aboveground storage tanks and pumps, and a cement silo. Tanks associated with Building 257 include a 13,500-gallon (51,103-liter) acid holding tank (SWMU 21-011(d)), effluent holding tanks (SWMUs 21-011(f) and 21-011(g)), the Pug Mill Tank (AOC 21-011(h)), a sodium-hydroxide storage tank (SWMU 21-011(i)), and an americium raffinate storage tank (SWMU 21-011(j)) (LANL 2005c).

- SWMU 21-007. This SWMU represents airborne releases from salamanders (incinerators for waste oils and organics). The incinerators were used between 1964 and 1972 and were located atop MDA T (LANL 2005c).

- AOC 21-018(a). This former surface storage area within the MDA T fence was the location for temporary storage of alcohol, acetone, and freon (LANL 2005c).

Waste Inventory

Absorption beds. Between 1945 and 1952, the beds received 14 million gallons (53 million liters) of untreated wastewater containing plutonium and fluoride. In addition, from June 1951 to July 1952, 10,450 gallons (40,000 liters) of ammonium citrate effluent were released containing plutonium and fluoride. From 1953 through 1967, 4.3 million gallons (16 million liters) of effluent were discharged (LANL 2004a). As of January 1973, the absorption beds had received 4 curies of tritium and 10 curies of plutonium-239, plutonium-240 (94 weight-percent plutonium-239 and 6 weight-percent plutonium-240). The beds also received plutonium-238, uranium-235, and americium-241. Wastewater discharged to the beds contained fluorine, iodine, cadmium, beryllium, lead, mercury, sodium, nitrates, and chorine. It probably contained solvents and other organic chemicals (LANL 2004a).

Shafts. Radioactive wastes included cement-stabilized americium, alkaline fluoride, and plant sludge. Some shafts temporarily held wastewater. Personal protective equipment and other contaminated items were also disposed of, including (LANL 2004a):

- Shafts 3, 17, 18, 19, and 26 contain 3-foot diameter (0.9-meter-diameter) "bathyspheres" containing plutonium-239 and plutonium-240 and other mixed fission products. **Table I–8** presents the plutonium-239 inventory contributed by the bathyspheres.

- Shaft 17 contains six drums of cyanide salts fixed in asphalt.

Table I–8 Plutonium-239 Disposed of in Material Disposal Area T Shaft Bathyspheres

Shaft Number	*Plutonium-239 Bathysphere Inventory (grams)*
3	290
17	342
18	134
19	245
20	210

Note: To convert grams to ounces, multiply by 0.035274.

[13] *Remediation of the outfall SWMU (21-011k) has been completed (see Section I.2.7.6).*

- Shafts 50 and 54 contain demolition debris from Filter Building 012.
- Shafts 52 and 58 together contain four drums of uranium-233.

Shaft-specific inventories (as of 2004) of plutonium-239, plutonium-238, plutonium-240, americium-241, uranium-233, and uranium-235 are listed in **Table I–9**, along with volumes of the plutonium cement pastes. The shafts also contain mixed fission products (LANL 2004a).[14]

Table I–9 Radionuclide Inventories and Cement Paste Volume by Shaft

Shaft	*Cement Paste Volume (liters)*	*Pu-239 (grams)*	*Pu-238 (grams)*	*Pu-240 (grams)*	*Am-241 (grams)*	*U-233 (grams)*	*U-235 (grams)*
1	67,440	20.8	0.025	1.2	21	–	–
2	23,920	3.7	0.004	0.2	2.5	–	–
3	10,750	300.2	0.012	18	5.3	–	–
5	87,200	12	0.014	0.7	24.1	–	–
9	88,780	25	0.029	1.5	23.3	–	–
10	18,660	4	0.005	0.2	4.2	–	–
11	18,950	3.2	0.004	0.2	2.6	–	–
13	85,500	39.6	0.047	2.4	34.6	–	–
17	87,240	373.9	0.038	22.42	16.6	–	–
18	83,440	152.8	0.022	9.14	17.1	–	–
19	80,280	261.3	0.019	15.7	6.2	–	–
20	89,540	11.6	0.014	0.7	26.4	–	–
21	87,290	13.3	0.016	0.8	22.6	–	–
22	88,760	18.8	0.022	1.1	20	–	–
23	80,700	20.4	0.024	1.2	31.4	–	–
24	84,100	17.4	0.021	1	25	–	–
25	23,460	7.2	0.009	0.4	10	–	–
26	21,310	214.5	0.005	12.9	5.6	–	–
27	82,770	32.5	0.038	2	18.1	–	–
28	89,880	40.4	0.048	2.4	33.5	–	–
29	87,850	4.2	0.005	0.3	9.8	–	–
30	87,090	14	0.017	0.8	18.8	–	–
31	25,900	3	0.003	0.2	2.9	–	–
32	22,510	5.4	0.006	0.3	9.4	–	–
33	90,490	24.8	0.029	1.5	20.5	–	–
34	89,270	11.4	0.013	0.7	21.3	–	–
35	87,730	16	0.019	1	25.3	–	–
36	89,410	12.4	0.015	0.7	25.9	–	–
41	68,600	20.5	0.024	1.2	18.1	–	–
42	32,730	4.2	0.005	0.3	2.5	–	–
43	89,000	28.1	0.033	1.7	29.5	–	–
44	87,890	14.5	0.017	0.9	21.2	–	–
46	82,540	33	0.039	2	35.6	–	–

[14] *In July 1976, the shafts were estimated to contain 7 curies of uranium-235, 47 of plutonium-238, 191 of plutonium-239, 3,761 of americium-241, and 3 of mixed fission products (LANL 2004a).*

Shaft	Cement Paste Volume (liters)	Pu-239 (grams)	Pu-238 (grams)	Pu-240 (grams)	Am-241 (grams)	U-233 (grams)	U-235 (grams)
47	35,100	16.6	0.02	1	15.5	–	–
48	65,760	21.7	0.026	1.3	23.4	–	–
49	92,800	62.2	0.073	3.7	49.4	–	–
50	72,290	18.5	0.022	1.1	21.2	–	–
51	38,620	11.4	0.013	0.7	11.7	–	–
53	71,610	28.7	0.034	1.7	33.9	–	–
55	90,600	45.9	0.054	2.8	26.7	–	–
56	83,870	23.9	0.028	1.4	32.6	–	–
57	37,200	19.1	0.023	1.1	11.9	–	–
59	77,400	44.2	0.052	2.7	31.1	–	–
60	90,460	38.2	0.045	2.3	33	–	–
70	52,400	79.9	0.094	4.8	29.8	–	–
75	52,800	32.9	0.039	2	35.4	–	–
76	52,600	56.7	0.067	3.4	53.1	–	–
78	49,800	7.6	0.009	0.5	0.8	–	–
80	56,300	20	0.024	1.2	4	–	–
82		8.9	0.01	0.5	2.4	–	–
83	18,000	19.6	0.023	1.2	4.8	–	–
84	37,700	9.5	0.011	0.6	0.3	–	–
87		7.7	0.009	0.5	0.4	–	–
Complex B (52, 58)	64,690	34.2	0.04	2.1	20.1	713	–
Complex A (6, 8, 54, 90, 91, 92, 94)	125,630	99.8	0.118	6	79.6	–	713
Total (grams):	–	2,471	1.5	148	1,112	713	713

Pu = plutonium, Am = americium, U = uranium.
Note: To convert liters to gallons, multiply by 0.26418; grams to ounces, multiply by 0.035274.
Source: LANL 2004a.

Current Configuration. The absorption beds and shafts are enclosed by a chain-link fence (except the southwest corner of Absorption Bed 1). The surface is vegetated with weeds, grasses, chamisa bushes, and two young ponderosa pine trees (LANL 2004a). MDA T has a downward slope from south to north. Backfilling and grading have added 5 to 6 feet (1.5 to 1.8 meters) of soil to the original surface of the beds, shafts, and the retrievable waste storage area. The bottoms of the absorption beds are about 9 feet (2.7 meters) below current ground surface (LANL 2004a).

MDA T is a complex site containing or contingent to several SWMUs, some active and some not. In addition to buried and abandoned piping and lines from utilities and waste treatment and transfer operations, complex groupings of utility lines and corridors pass through MDA T. A corridor of acid waste lines runs underground from the northwest corner of Building 257 to the southwest of former Building 035. Waste drain lines also run from the northwest corner of Building 257 north to effluent tanks 112 and 113. An acid waste line runs southeast from former Building 035 before angling northeast to the effluent tanks. An acid waste line also runs from the southwest corner of former Building 035, under Building 257, and east out of MDA T. A natural gas line runs east-west under Building 257 and along the south side of former Building

035. Main water lines run just south of the MDA T fence lines, with feeder lines north to former Building 035 and Building 257. Aboveground electrical lines run just north of the MDA T fence line, splitting to the south between former Building 035 and Building 257, and to the east over tanks 112 and 113 and along the north side of Building 257. Underground electrical lines run between former Building 035 and Building 247 (LANL 2004a).

Site Investigations. Pre-RFI site investigations at MDA T are summarized in the Operable Unit RFI Work Plan for TA-21 and in the February 2004 Investigation Work Plan for MDA T (LANL 1991, 2004a). Pre-RFI investigations occurred in 1946, 1947, and 1948. In 1953, the U.S. Geological Survey concluded that no appreciable horizontal migration of contamination had occurred. From 1959 to 1961, the U.S. Army Corps of Engineers dug a test pit (caisson) next to Absorption Bed 1 and drilled six angled boreholes under the bed. In 1960 and 1961, infiltration studies were performed by adding large quantities of raw liquid waste and ordinary tap water to Absorption Bed 1 (LANL 2004a).

Additional boreholes were drilled in 1967 and 1974 to measure tuff moisture content. Paleochannels at depths of 15 to 25 feet (4.6 to 7.6 meters) were found. Moisture migration studies occurred in 1978, and shallow soil sampling and radiological characterizations occurred in 1984 and 1986 (LANL 2004a). Results of the field study initiated in 1978 showed plutonium and americium-241 at depths to 100 feet (30 meters) below ground surface (LANL 1984).

Phase I RFIs collected surface soil samples in 1992, 1994, 1995, 1996, and 1997, as well as tuff samples from boreholes. The following contaminants were found (LANL 2004a):

- In the surface soil and shallow subsurface extending to DP Canyon, americium-241, plutonium-238, and plutonium-239 were elevated compared with background values.

- In soil and subsurface soil and tuff samples from boreholes, several metals were detected above background values. Levels of cadmium, copper, and nickel above background values were found near the influent line for Building 035 and at a nearby location.

Additional work was proposed in the 2004 MDA T Investigation Work Plan: a site-wide radiation mapping survey; sampling of drainage channels; borings to characterize release from the absorption beds and the possible presence of perched water and bedrock fractures; and further characterization of the area surrounding former Building 035 and existing Building 257 (LANL 2004a). The Investigation Report for MDA T was completed and submitted to NMED on September 18, 2006. In October 2007, DOE issued a proposed subsurface vapor monitoring plan for MDA T that included installation of three wells for quarterly sampling of tritium and volatile organic compounds (LANL 2007f).

I.2.5.2.4 Material Disposal Area U

MDA U is within a fenced, 0.2-acre (0.08-hectare) site north of Buildings 21-152 and 21-153 in DP East (**Figure I–11**). It contains two absorption beds (SWMUs 21-017(a) and (b)).

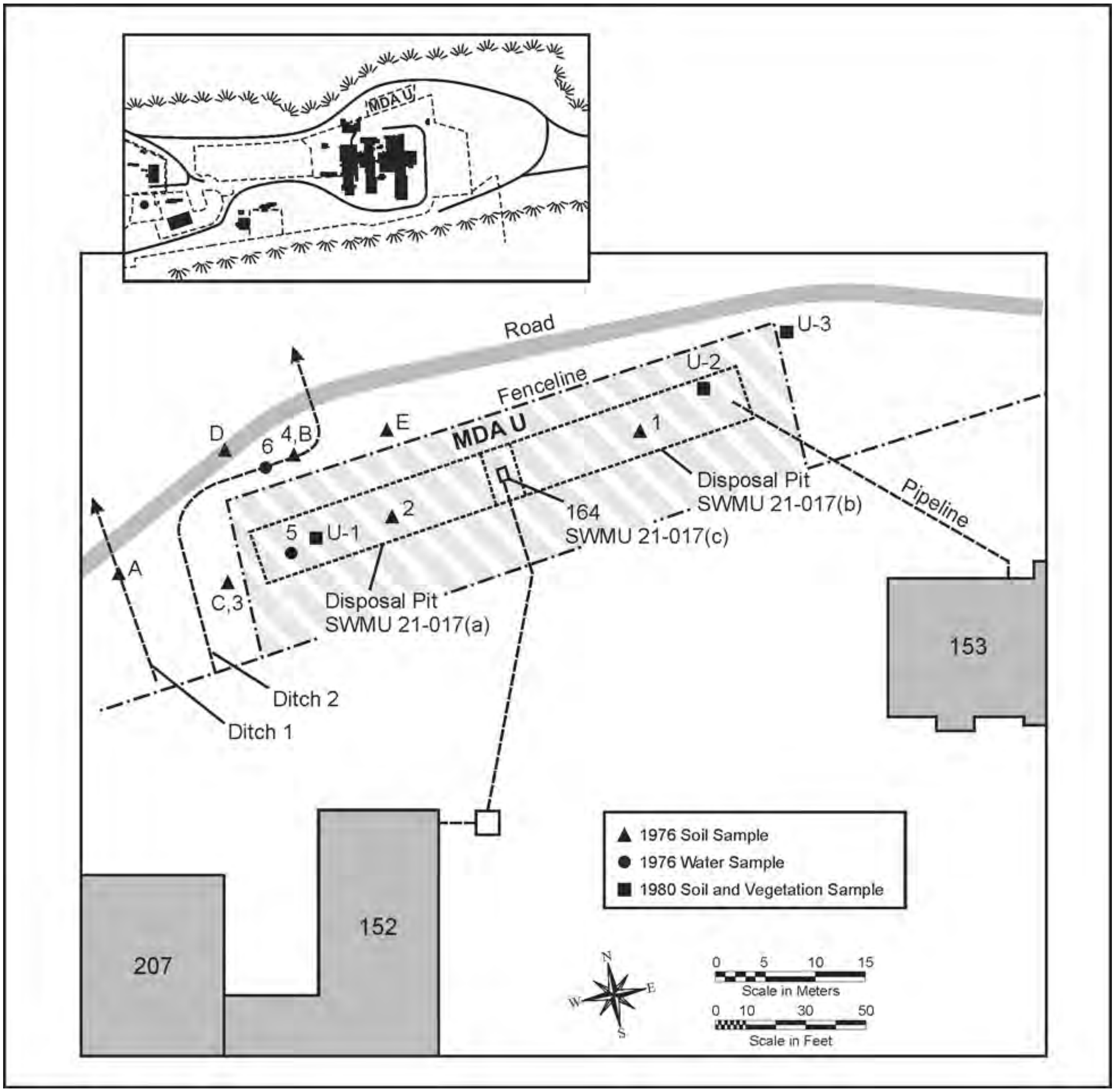


Figure I–11 Material Disposal Area U Showing Pipelines for Liquid Effluents

History of MDA U. The absorption beds were used from 1948 to 1968 for disposal of liquid wastes (LANL 1991). Each bed was 80 by 20 by 6 feet (24 by 6.1 by 1.8 meters) (LANL 2004k). The beds were filled with 24 inches (61 centimeters) of cobbles and overlain by 6 inches (15 centimeters) of gravel and 6 inches (15 centimeters) of sand. Covering the sand was 12 inches (30 centimeters) of soil (LANL 2004k). Between the two beds was a distribution box (SWMU 21-017(c)) with lines leading to the beds (LANL 1999b). Liquid waste included effluent from Buildings 21-152 and 21-153, and from 21-155, the Tritium Systems Test Assembly[15] (LANL 2004k).

Effluent from Buildings 21-152 and 21-153 was received until 1968 (LANL 2004k). Effluent discharge from Building 21-155 presumably ceased at the same time. In addition, until 1976 the west bed received water from a cooling tower for Building 21-155 (LANL 1991, 2004k). MDA U also received oil from precipitrons[16] and from Building 21-152 floor drains (LANL 2004k).

In 1985, the distribution box and lines were removed (LANL 1991), as was a portion of the line from the cooling tower (LANL 2004k). A trench 20 feet (6.1 meters) wide, 100 feet (30 meters) long, and 4 to 13 feet (1.2 to 4.0 meters) deep was dug, and some, but not all, contaminated soil was removed. After a plastic liner was placed in the trench to denote the excavation boundary, the trench was filled with soil. The excavated area was covered with 6 inches (15 centimeters) of topsoil and drainage problems were remedied (LANL 1991).

In 1987, ditches were placed along the south fence to prevent runon; additional topsoil, gravel mulch, and seeds were deposited inside the fence; and brass markers were placed at the corners of the site. Additional collection ditches were excavated in 1990 to prevent runoff from the surrounding area from flowing across MDA U (LANL 1991).

In 2001, exploratory trenches were dug across each absorption bed to find the plastic liner placed over the excavated areas when the drain line and absorption bed material were removed in 1985. Black plastic was found in the west absorption bed at a depth of 3.5 to 4 feet (1.1 to 1.2 meters). Cobbles up to 20 inches (0.5 meters) in diameter were seen under the plastic. In the east absorption bed, a clear liner was found at about 3 feet 0.9 meter) below ground surface and a black liner at 7 feet (2.1 meters), above a cobble layer (LANL 2006g).

Waste Inventory. Between 1945 and 1968, the beds received 135,000 gallons (511,000 liters) of liquid. The primary radionuclide was polonium-210.[17] The beds also received actinium-227, plutonium, and tritium. About 2.5 curies of actinium-227 were discharged in 1953, mainly from Building 21-153.[18] A 1946 memorandum referenced in the MDA U Investigation Work Plan states that plutonium and polonium were measured in effluent discharged to the beds. The beds probably received inorganic materials, organic chemicals, acids, and oils (LANL 2004k).

Much of the contamination discharged to the beds has been removed.

---

[15] Building 21-155 (Tritium Systems Test Assembly) is not shown in Figure I–11.
[16] Precipitrons were air filters installed in the filter building, Building 21-153, and used to filter air exhausted from Building 21-152 (LANL 1991).
[17] Because polonium-210 has a half-life of 138.4 days, current inventories of polonium-210 are effectively nonexistent. Polonium-210 decays to stable lead.
[18] A filter building decommissioned in 1978.

Current Configuration. MDA U is a grassy area, fenced to the north, east, and west by a security fence, and to the south by an industrial site. Building 21-153 was unused after March 1970 and demolished in 1978. The effluent pipeline from Building 21-153 has been removed, along with the pipeline from Sump 173 at Building 21-152. Sump 173 remains (LANL 2004k).

Site Investigations. Early site investigations included effluent sampling in 1946; surface soil and water sampling in 1976; an investigation of soil, vegetation, and tar in 1980; a subsurface investigation in 1983; and soil and vegetation sampling in 1984. RFIs were conducted in 1992, 1994, 1998, and 2001. Samples of soil and sediment found americium-241, plutonium-238, plutonium-239, tritium, chromium, lead, mercury, uranium, and zinc in concentrations above background values. Organic chemicals were infrequently found in low concentrations (LANL 2004k).

The 1998 and 2001 investigations sampled fill from the beds. Tritium and uranium-234 were found in levels above background values, and actinium-227 progeny were found in the eastern beds. The 1998 investigations found uranium-234, uranium-235, actinium-227 progeny, and tritium in boreholes. Subsurface samples found aluminum, arsenic, barium, beryllium, chromium, copper, lead, manganese, and mercury at levels above background values. Subsurface pore-gas samples showed numerous low-level detections of organic chemicals (LANL 2004k).

Field investigations in 2005 included characterization drilling and logging of nine boreholes, continuous core sampling in 5-foot (1.5-meter) intervals, field screening for radiation and volatile organic compounds, collecting surface and subsurface samples for chemical characterization, and collecting subsurface samples for geotechnical characterization.

In the 2006 Investigation Report for MDA U, LANL staff concluded that the nature and extent of contamination in surface and subsurface media had been defined, and that no perched saturation zones existed under the site. LANL staff also concluded that neither additional corrective action nor further characterization was warranted. LANL staff recommended that the three SWMUs within the MDA U boundary be designated as “complete with controls,” the controls being the maintenance of the land use as industrial (LANL 2006g). On September 28, 2006, NMED approved the Investigation Report and issued a Corrective Action Complete with Controls certification of completion for SWMUs 21-017(a-c) and 21-022(f) pursuant to the Consent Order (NMED 2006b).

I.2.5.3 Technical Area 49: Material Disposal Area AB

Created in 1959 from TA-15, TA-49 is on the southwestern edge of LANL (see Figure I–1). MDA AB is on Frijoles Mesa.

History. Beginning in the fall of 1959, underground hydronuclear experiments were conducted to investigate the possibility of a nuclear yield from accidental detonation of a nuclear weapon's high explosive component. Experiments were conducted through August 1961 (LANL 1992b), mainly in four underground shaft areas (Areas 1-4) to which Areas 2A and 2B were added. (These six areas, plus an area of surface contamination, compose MDA AB.) A site diagram (**Figure I–12**) shows the areas containing the hydronuclear shafts, central control area, supporting areas, and other nearby PRSs and site features (LANL 1992b), including:[19]

- Areas 1, 2, 2A, 2B, 3, and 4: SWMUs 49-001(a-f)
- Surface contamination, particularly in Area 2: SWMU 49-001(g)
- Area 5, central control area: SWMU 49-008(a), soil contamination; SWMU 49-005(b), a small landfill; and SWMU 49-006, a sump
- Area 6, open burning/landfill area: SWMU 49-004
- Area 10, underground experimental area: SWMU 49-002, the experimental area; and SWMU 49-005(a), a small nearby landfill
- Area 11, radiochemistry and small-scale shot area: SWMU 49-008(c), soil contamination; and SWMU 49-003, inactive leach field and drain lines
- Area 12, Bottle House Area: SWMU 49-008(d), soil contamination

Areas 1, 2, 2A, 2B, 3, and 4. Between January 1960 and August 1961, about 4 dozen hydronuclear, calibration, and equation of state experiments were conducted. At least 23 additional underground containment, equipment development, and mockup experiments were conducted using high explosives, and, in a few cases, small quantities of uranium-238 or radioactive tracer. The experiments caused explosive dispersal of uranium-235, plutonium-239, lead, beryllium, and uranium-238 at the bottoms of backfilled shafts that varied in depth from 31 to 142 feet (9.4 to 43 meters) (LANL 1992b). Some experiments used radioactive tracers, and many experiments with and without special nuclear material used uranium-238. The maximum fission energy released in any experiment equaled only a few tenths of a pound of high explosive (LANL 1992b). Less than 10 millicuries of fission products probably remain, and only a few curies of tritium were expended. Special nuclear material was never used in Area 3 (LANL 1992b).

Essentially all of the contamination is deep underground. Most contaminants are confined to within maximum radii of 10 to 15 feet (3.0 to 4.6 meters) from detonation points. Small levels of surface contamination in Area 2 resulted from inadvertent drilling into a subsurface region contaminated from a previous experiment (LANL 1992b).

---

[19] *Also shown on Figure I–12 is the Hazardous Devices Team training area (HDT Area). Remediation of SWMU 49-007(b) is administratively complete (LANL 2005a).*

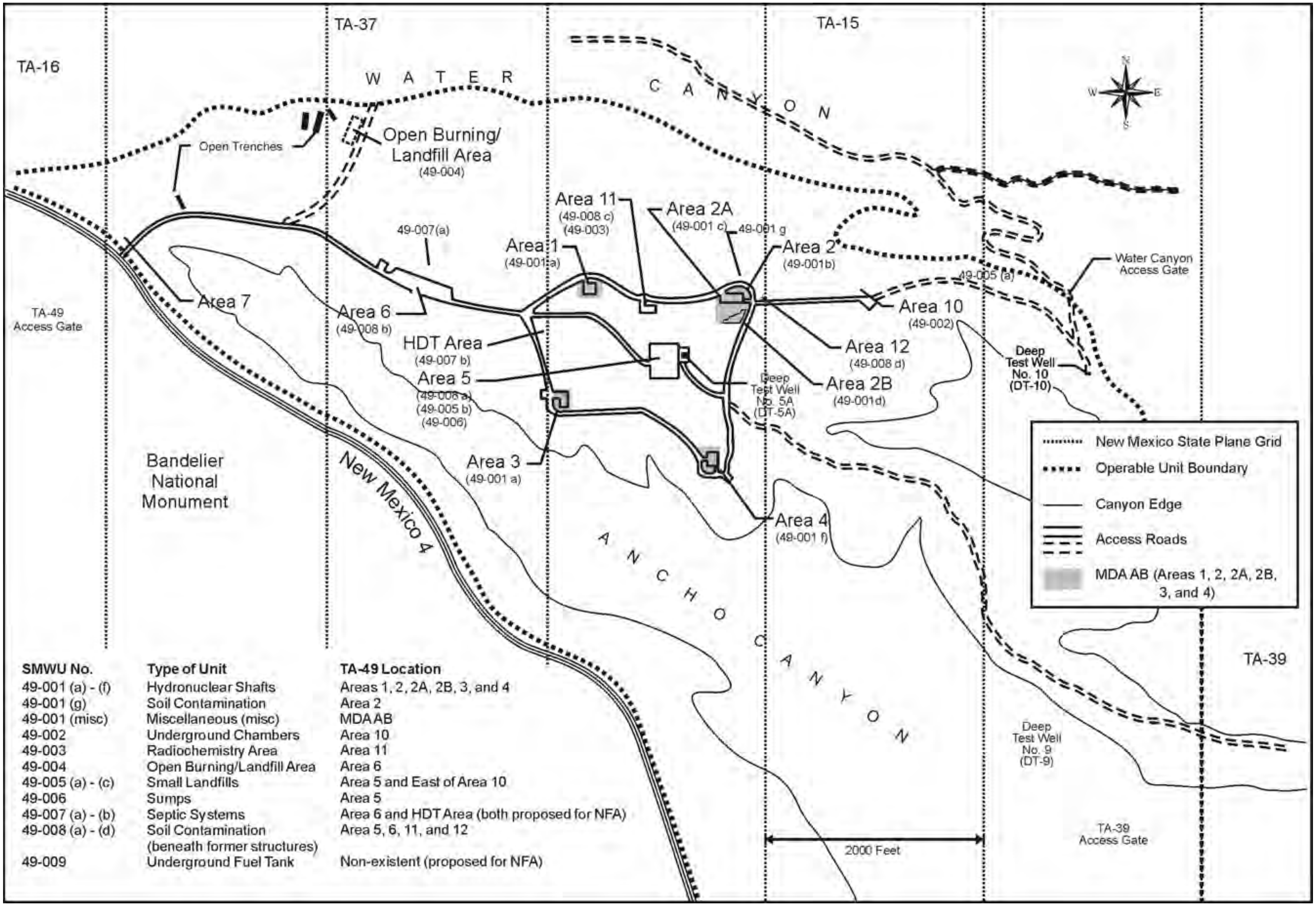


Figure I–12 Technical Area 49 Shaft Areas and Other Solid Waste Management Units

Before the experiments began, deep test wells were drilled into the main aquifer to determine the thickness of the tuff and volcanic sediments, hydrologic characteristics of the main aquifer, and presence of perched water (none was found). Two other deep boreholes were drilled that did not penetrate the aquifer. Four boreholes were drilled to depths from 300 to 500 feet (91 to 152 meters) to map the geologic and hydrologic characteristics of the underlying tuff (Core Holes 1 through 4). These holes are used for subsurface monitoring. A large but unquantified volume of drilling fluid was lost in Core Hole 2. Perhaps several million gallons of fluids were also lost in deep test well DT-5A below a level of 285 feet (87 meters) (LANL 1992b).

Before the underground experiments were conducted, containment experiments using "quarter-scale" quantities of high explosive occurred in Area 11. Subsequently, "full-scale" containment experiments occurred in Areas 1, 2, 3, and 4 using much larger quantities of high explosive than those in ensuing experiments (LANL 1992b).[20]

Experimental holes in Areas 1, 2, 3, and 4 were spaced at 25-foot (7.6-meter) intervals on 100-foot (30-meter) square grid patterns. Areas 2A and 2B have irregular shapes. Experimental holes were typically 6 feet (1.8 meters) in diameter and ranged in depth from 31 to 142 feet (9.4 to 43 meters). Experimental holes were not drilled at all grid locations. Some of the holes were backfilled without further use and some were used to bury contaminated debris (LANL 1992b).

Associated with many experimental holes were small-diameter holes containing pipes leading from the shafts to steel boxes near the ground surface. The boxes collected samples of radioactive particles entrained in explosive gases. Recovery of sample collection devices from the boxes occasionally caused localized surface contamination that was cleaned to field detection limits or covered with soil. Pipes connected the boxes to large-diameter gas expansion holes. Each gas expansion hole served several experimental holes (LANL 1992b).

Researchers typically placed an experimental configuration in the bottom of a hole, installed instrument cables leading to the surface, and backfilled the hole with sand and crushed tuff. The down-hole package usually included substantial amounts of metallic lead. After completing measurements and sample collection, researchers severed the cables and backfilled hole subsidence. Holes containing special nuclear material were capped with concrete. The steel sampling boxes were usually filled with concrete and left in place. Researchers usually disconnected the sampling pipes from the sampling box and expansion hole and then reused or buried them in pipe dump holes, 3 feet (0.9 meters) in diameter by 30 feet (9.1 meters) deep, around the experimental area. At least four dump holes were drilled in Area 2B. Similar holes may exist in other areas (LANL 1992b).

Large concrete shields were used to minimize radiation exposure from a pulsing neutron source. The shields may have been activated with short-lived radionuclides. Monitoring with routine field instrumentation has found no detectable levels of surface contamination. Approximately 10 of these shields remain (LANL 1992b).

[20] *Containment experiments characterized the extent to which the detonations would fracture the tuff in the vicinity of the detonation points (LANL 1992b).*

The most significant contamination incident occurred in 1960 during the drilling of Hole 2-M in Area 2. After contamination was found, equipment that could not be decontaminated, or was of little value was placed in Hole 2-M along with contaminated surface soil. Other contaminated items were disposed of (LANL 1992b).

In January 1961, all open holes were filled with sand and crushed tuff, and the surface of Area 2 was capped with compacted clay and gravel. Historical estimates of the fill thickness in Area 2 range from 1 to 6 feet (0.3 to 1.8 meters), and a field inspection suggested a maximum fill thickness of 6 feet (1.8 meters). The cap was extended 12.5 feet (3.8 meters) beyond the outermost shafts and, in September 1961, paved with asphalt. Near-surface contamination was left beneath the asphalt. In 1977, the La Mesa forest fire burned over most of TA-49, destroying essentially all remaining combustible structures at the site (LANL 1992b).

In March 1975, collapse of asphalt over backfilled Hole 2-M left a hole 6 by 3 by 4 feet deep (1.8 by 0.9 by 1.2 meters deep) in the asphalt and underlying fill. This opening may have caused the 50 feet (15 meters) of standing water seen in 1975 in Core Hole 2. In September 1976, the opening over Hole 2-M was filled and the pad covering Area 2 was repaved with additional asphalt. Samples of water bailed from Core Hole 2 in 1977 and 1978 showed plutonium-239 in concentrations of 1.7 to 3.1 picocuries per gram, indicating that water in Core Hole 2 had contacted contamination beneath Area 2. The contaminated water presumably moved through fractures to the Core Hole 2 borehole and traveled down the annular spacing between the casing and the borehole. Alternatively, the enhanced infiltration caused by the collapsed hole created saturated soil conditions that extended laterally to the Core Hole 2 borehole and then traveled down the annular spacing between the casing and the borehole.

About 150 feet (46 meters) of standing water was measured in Core Hole 2 on several occasions in 1979 and 1980. Water from several levels was bailed from Core Hole 2 and plutonium was found in concentrations of from 0.1 to 5.5 picocuries per liter in filtered water samples, and from 0.54 to 0.72 picocuries per gram in suspended sediment samples. Core Hole 2 was bailed dry in June 1980 and from 1980 through 1987, Core Holes 1 through 4 were checked annually for standing water. No standing water was found. In 1981, the upper 2 feet (0.6 meters) of sand in the sand-filled shafts in Areas 2A and 2B was replaced with concrete. In May 1991, when vegetation was seen growing through cracks in the asphalt, Core Hole 2 contained 100 feet (30 meters) of standing water. In November 1991, cracks in the asphalt were resealed, and through the summer and fall of 1991 and spring of 1992, the water level in Core Hole 2 was measured on about a monthly basis. The water level during this time remained fairly stable. In December 1991, a transducer was installed in Core Hole 2 for continuous monitoring of the water level, which remained stable through April 1992. This water level stability suggested that the response to the summer 1991 rainfall and spring 1992 snowmelt was sluggish. Water analyses for a bailed sample from Core Hole 2 in May 1991 showed low but measurable concentrations of plutonium (LANL 1992b).

In 1998 and 1999, LANL performed an interim action at Areas 2, 2A, and 2B to: (1) plug and abandon Core Hole 2 and two other boreholes; (2) remove asphalt from Area 2; (3) install an evapotranspiration cover consisting of a layer of clean, crushed tuff, topsoil, shallow-rooted grass, and gravel for erosion protection; (4) cover part of the site and vicinity with a biointrusion barrier; (5) install a silt fence surrounding the new evapotranspiration cover; and (6) install a run-on diversion channel (LANL 1998a, 1999a, 1999c). In February 2000, a moisture monitoring system was installed to monitor the new evapotranspiration cover at Area 2. Moisture monitoring continues as required by the Consent Order.

In May 2000, the Cerro Grande forest fire burned the western and northern edges of TA-49, but did not burn vegetation or structures at MDA AB or Area 11.

Area 5. As the main control area, Area 5 contained several structures that were removed or destroyed between 1961 and 1984, including the tower. Other structures were destroyed in June 1977 by the La Mesa forest fire (LANL 1992b). Some of the debris collected during the 1984 cleanup of Area 5 was likely disposed of in a pit 10 by 10 by 10 feet deep (3 by 3 by 3 meters deep) in Area 5 (SWMU 49-005(b)) (LANL 2005c).

Area 6. Area 6 occupies a 150- by 700-foot (46- by 213-meter) area. Area 6 included storage and office structures, although all structures were removed by 1977. In addition, a 400-square-foot (37-square-meter) "boneyard" stored lumber, fencing, and steel. Some materials may have been radioactively contaminated. AOC 49-008(b) consists of contaminated surface soil (LANL 2005c).

The landfill in Area 6 (SWMU 49-004) was used from late 1959 to mid-1961 to burn construction wastes and to bury uncontaminated residues. The landfill was reopened in 1971 and 1984. A trench 30 by 100 by 15 feet deep (9.1 by 30 by 4.5 meters deep) was dug for burial of uncontaminated debris. Assessments of surface contamination in the landfill have found transuranic isotopes as well as lead and beryllium. A 1991 geophysical survey indicated a landfill surface area of 35 by 200 feet (11 by 61 meters). The survey found several magnetic and electromagnetic anomalies. The survey suggested that the buried objects were covered by 4 feet (1.2 meters) of overburden (LANL 1992b).

Area 10. Used for calibration tests, Area 10 contains an inactive underground experimental chamber and two shafts (AOC 49-002), each 6 to 7 feet (1.8 to 21 meters) in diameter and 64 feet (20 meters) deep and connected at the bottom by a tunnel. One shaft contains an elevator. In the other shaft, a pulsed neutron source irradiated calibration samples placed within a 14-foot (4.3 meter-diameter) by 10-foot high (3.0-meter-high) room lined with reinforced concrete faced with steel plate. A hydraulic lift platform at the bottom of the calibration room connects to a hydraulic oil reservoir at the surface. A concrete pad at the tops of both shafts provides a foundation for the elevator building and shielding wall (LANL 2005c).

East of Area 10 is an inactive landfill (SWMU 49-005(a)). The landfill is 50 to 100 feet (15 to 30 meters) northeast of the Area 10 experimental chamber and shafts. The landfill was built in 1984 as a disposal area for debris from the 1984 general surface cleanup of TA-49. The wastes were primarily wood and small pieces of metal (LANL 2005c).

Area 11. Area 11 is a 220- by 300-foot (67- by 91-meter) area, 700 feet (213 meters) west of the main MDA AB shafts, where radiochemistry and small-scale containment experiments took place (LANL 2005c). Containment experiments took place at the bottoms of thirteen 10-inch (25-centimeter-diameter) by 12-foot-deep (3.7-meter-deep) vertical holes encased in steel and backfilled with sand. Some of the shots used irradiated uranium-238 as a tracer. A maximum of

10.5 grams (0.4 ounces) of uranium was used, and the irradiated samples contained microcurie levels of neptunium-239. Some holes may have contained lead and some holes were partially backfilled with concrete. Ten-inch-diameter (25-centimeter-diameter) casing from two capped holes extends above the ground surface (LANL 1992b).

Area 12. Area 12 historically featured confinement experiments where high explosive was detonated in sealed metal "bottles" (up to 5 feet [1.5 meters] in diameter by 16 feet [4.9 meters] long) placed in a shaft 30 feet (9.1 meters) deep. The Bottle House, one of two remaining surface structures, surrounded the shaft. Roughly 26 experiments used a few kilograms of uranium-238. Six used a few microcuries of irradiated uranium tracer. Area 12 then supported operations at the nearby Cable Pull Test Facility, built in the early 1960s. The Bottle House shaft was backfilled with crushed tuff (LANL 1992b).

Waste Inventory

Areas 1, 2, 2A, 2B, 3, and 4. Inventories of plutonium and uranium in each of the experimental areas (as of 1992) are summarized in **Table I–10**. The experimental areas may also contain small quantities of fission products (less than 10 millicuries) and ingrown americium-241 (about 0.33 pounds [0.15 kilograms] in 1992). The experimental shafts contain approximately 24 pounds (11 kilograms) of beryllium and possibly more than 198,000 pounds (90,000 kilograms) of lead (LANL 1992b).

Table I–10 Material Disposal Area AB Principal Radionuclides Inventories

MDA AB Area	*SWMU Number* [a]	*Plutonium* [b] *(kilograms)*	*Uranium-235 (kilograms)*	*Uranium-238 (kilograms)*
Area 1	49-001(a)	1.06	0.00	62.3
Area 2	49-001(b)	12.62	47.4	52.5
Area 2A	49-001(c)	3.75	9.8	10.6
Area 2B	49-001(d)	5.67	6.4	14.7
Area 3	49-001(e)	0.00	0.005	0.030
Area 4	49-001(f)	17.04	29.4	29.0
Total		40.14	93.0	169.1

MDA = material disposal area, SWMU = solid waste management unit.
[a] SWMU 49-001(g) comprises surface contamination at the experimental areas.
[b] Plutonium isotopic composition in weight-percent: plutonium-239 (93.5 - 94.2 percent); plutonium-240 (5.30 - 6.05 percent); plutonium-241 (0.458 - 0.563 percent). Plutonium-241 decays to americium-241.
Note: To convert kilograms to pounds, multiply by 2.2046.
Source: LANL 1992b.

The Hole 2-M incident probably caused the radionuclides seen in surface soils around the Area 2 pad and just outside the Area 2 exclusionary fence (SWMU 49-001(g)). About 0.8 acre (0.3 hectare) may be contaminated with plutonium and americium (LANL 1992b).

Area 5. Only small amounts of hazardous or radioactive materials could have been released to soil. A few hundred gallons of photographic solutions may have been released to sumps or nearby soil (LANL 1992b).

Area 6. The landfill may contain lead or beryllium but probably contains little radioactive material (LANL 2002g).

Area 10. Materials used in calibration tests included uranium, beryllium, and lead shielding. Milligram quantities of enriched uranium were occasionally released, albeit generally recovered. The pulsed neutron source may have activated surrounding soils and structures, but activation products should be significantly decayed. The hydraulic oil in the lift system was not reported to contain PCBs. After 1961, hazardous materials were not used. Materials disposed of in the nearby landfill (SWMU 49-005(a)) were mainly wood and metal (LANL 2005c).

Area 11. Elevated levels of radioactivity have been measured near the east end of the former radiochemistry building. Small levels of radioactivity may be in the vicinity of the leach field. A 1991 geophysical survey suggested near-surface piping and electrically conductive areas possibly related to subsurface chemical contamination or elevated moisture levels. Buried metal was found in the small-shot area (LANL 1992b).

Area 12. Surface contaminants are at low levels and have discontinuous distributions (LANL 1992b).

Current Configuration

Areas 1, 2, 2A, 2B, 3, and 4. All six areas are covered with native soil and vegetation. Few aboveground structures remain. All areas except Area 3 are fenced. Aboveground pipes exist in Area 3, as do exposed patches of concrete. Piping to a gas expansion hole remains in Area 4 (LANL 1992b). Pipe interiors are contaminated (LANL 1992b).

Depths of MDA AB test and support shafts are shown in **Table I–11**. The shafts include shot holes, pipe dump holes, gas expression holes, and unused holes (either backfilled or proposed, but not excavated). This table does not list all possible subsurface contamination such as pipe dump holes, buried pipes, and sampling boxes. The individual down-hole assemblies in the experimental shafts weighed as much as 8 tons (7.3 metric tons) and consisted of cable, steel, iron, aluminum, and other structural materials (LANL 1992b).

A crushed-tuff evapotranspiration cover has been installed at Areas 2, 2A, and 2B. During February and March 2000, the LANL environmental restoration project installed three new shallow neutron access holes and two time-domain-reflectometry arrays in the cover and initiated monthly moisture monitoring to track the cover performance (LANL 2000a).

Area 5. The only surface structures now in Area 5 are the observation well enclosure and the concrete pads from the former transformer station and the photographic tower. Small amounts of metallic debris and lead bricks remain (LANL 1992b).

Area 6. A 1991 geophysical survey showed the footprint of the landfill trench to be 35 by 330 feet (11 by 101 meters). The RFI Work Plan describes four open trenches that are west and southwest of the landfill trench (SWMU 49-004). These previously undocumented trenches may predate activities at TA-49. The trenches are 10 feet wide by 4 to 6 feet deep by 50 to 100 feet long (3.0 by 1.2 to 1.8 by 15 to 30 meters). One trench had been backfilled and one passes through prehistoric ruins (LANL 2005c). Area 6 currently supports microwave research.

Table I–11 Material Disposal Area AB Test and Support Shaft Depths

Area 1	*Area 2*	*Area 2A*	*Area 2B*	*Area 3*	*Area 4*
1-A 58 [a]	2-A 54	2A-E 58	2B-A 58	3-A 87	4-A 88
1-B 31	2-B 54	2A-J 58	2B-B 58	3-B 57	4-B 101
1-C 51	2-C 30	2A-O 58	2B-C 57	3-C 88	4-C 58
1-D 31	2-D 57	2A-T 58	2B-D	3-D 88	4-D 108
1-E 50	2-E 53	2A-Y 58	2B-E	3-E 88	4-E 78
1-F 50	2-F 57	2A-Z 57	2B-F	3-F 88	4-F 78
1-G 31	2-G	–	2B-G	3-G 142	4-G
1-H	2-H 57	–	2B-H 58	3-H	4-H 88
1-I 31	2-I 57	–	2B-I	3-I	4-I
1-J 58	2-J 57	–	2B-J 57	3-J 142	4-J 88
1-K 85	2-K 68	–	2B-K	3-K 142	4-K 88
1-L 31	2-L 57	–	2B-L 58	3-L	4-L
1-M 31	2-M 58	–	2B-M	3-M	4-M 88
1-N 31	2-N 57	–	2B-N	3-N	4-N
1-O 85	2-O 57	–	2B-O	3-O	4-O 84
1-P 58	2-P 57	–	2B-P	3-P	4-P 88
1-Q 31	2-Q 57	–	2B-Q	3-Q	4-Q
1-R 31	2-R	–	2B-R	3-R	4-R 78
1-S 31	2-S 57	–	2B-S	3-S	4-S
1-T 58	2-T 57	–	2B-T 78	3-T	4-T 78
1-U 58	2-U 52	–	2B-U	3-U 88	4-U 108
1-V	2-V 57	–	2B-V 58	3-V 88	4-V
1-W 58	2-W 57	–	2B-W	3-W	4-W 78
1-X	2-X 57	–	2B-X 78	3-X	4-X
1-Y 80	2-Y 78	–	2B-Y 58	3-Y 108	4-Y 78
–	–	–	2B-Z 60	–	4-Z 70

[a] Notation: The first set (1-A) identifies the shaft. The second set is the nominal shaft depth in feet.
Note: To convert feet to meters, multiply by 0.3048.

Area 10. The elevator building has been removed. The concrete pad remains, as do concrete radiation shields at the top of the calibration shaft. The entrances to both shafts are covered with concrete blocks. The elevator shaft is open and the calibration shaft has been backfilled. The hydraulic oil reservoir has been removed (LANL 2005c).

Area 11. In 1970 and 1971, radiochemistry structures were decontaminated, demolished, and removed. The subsurface leach field and drain line remain (LANL 1992b).

Area 12. All structures have been removed except for the Bottle House and the Cable Pull Test Facility. Current use of Area 12 is limited to air monitoring and occasional use of portable microwave experimental equipment in the roadway between Areas 10 and 12 (LANL 1992b).

Site Investigations. Site characterization and monitoring began in 1959. Early studies analyzed information from boreholes drilled in and near the experimental areas and from the three observation holes. A 1987 survey found surface contamination at Areas 1, 3, and 4 and in the northeast corner of the Area 2 pad. The contamination was apparently caused by exhumation of contaminated soil by gophers. A 1991 geophysical study in Area 4 was limited by interference from the chain-link perimeter fence and from buried metallic debris. Additional site investigations have been conducted for Areas 5, 6, 11, and 12 up to the early 1990s as summarized in the RFI Work Plan for Operable Unit 1144 (LANL 1992b).

More recent site investigations are summarized below.

Areas 1, 2, 2A, 2B, 3, and 4. The Phase I RFIs in 1993 and 1994 included installation and sampling of four shallow and three deep boreholes and collection of surface samples at Area 2. In 1999, an interim measure and best management practices program was conducted at Areas 2, 2A, and 2B and the contaminated area northeast of Area 2 (LANL 2005c).

Area 5. A 1995 Phase I RFI was conducted at AOC 49-008(a). The RFI report recommended no further action, although it indicated that the site would be evaluated for ecological risks. In 1997, EPA Region 6 nonconcurred with the recommendation and recommended additional characterization. During 1995, a Phase I RFI was conducted at the Area 5 sump (SWMU 49-006). Based on a human health risk-based screening assessment, the RFI report recommended no further action, although it indicated that the site would be evaluated for ecological risks. EPA concurred with the recommendation. In 2002, a Supplemental Sampling and Analysis Plan for Areas 5, 6, and 10 was prepared (LANL 2005c).

Area 6. In 1995, a Phase I RFI was conducted at the open burning/landfill area (SWMU 49-004). The RFI report recommended no further action, although it indicated that the site would be evaluated for ecological risks. EPA Region 6 nonconcurred with the recommendation and called for Phase II sampling. In 1996, a Phase I RFI was conducted for AOC 49-008(b) (LANL 2005c).

Area 10. In 1995, a Phase I RFI was conducted at the experimental chamber and shaft (AOC 49-002). The RFI report recommended no further action, although it indicated that the site would be evaluated for ecological risks. EPA Region 6 concurred with the recommendation (LANL 2005c). Regarding the nearby landfill (SWMU 49-005(a)), a Phase I RFI was conducted during 1995 and 1996 (LANL 2005c).

Area 11. A 1995 Phase I RFI for the area of soil contamination (AOC 49-008(c)) performed radiation surveys and collected surface and subsurface samples. No further action was recommended, although the RFI report indicated that the site would be evaluated for ecological risks. EPA Region 6 nonconcurred with the recommendation (LANL 2005c). Regarding the leach field (SWMU 49-003), 13 shallow subsurface samples were collected during a 1995 Phase I RFI (LANL 2005c).

Area 12. In 1995, Phase I RFI sampling found radiation levels above background values at four survey points around the Bottle House. Copper and silver were found above background values in soil samples. Radionuclides were found above background values and uranium was present above screening action levels. Five organic chemicals were found. In 1997, a voluntary corrective action was conducted to remove the soils around the Bottle House. Additional soil removal occurred in 1998 (LANL 2005c).

I.2.5.4 Technical Area 50: Material Disposal Area C

TA-50 is on Mesita del Buey. TA-50 was developed for waste management activities because of limitations in disposal capacity in other areas, because of a plan to develop LANL to the south, and because of the 1948 fire in MDA B (see Section I.2.5.2.2). TA-50 includes inactive MDA C (**Figure I–13**) (DOE 1999a, LANL 1999b, 2006k).

History of MDA C. MDA C is adjacent to waste management facilities to the north, while Ten Site Canyon is to the northeast.

MDA C was used from 1948 to 1965. In 1963, the Radioactive Liquid Waste Treatment Facility (Building 50-1) was built to the north of MDA C. Additional facilities near MDA C include the Waste Characterization, Reduction, and Repackaging Facility (Building 50-69), built in 1983.[21] Liquid wastes from these facilities are piped to the Radioactive Liquid Waste Treatment Facility (LANL 1992c).

MDA C (SWMU 50-009) comprises seven pits, including one chemical pit, and 108 shafts. The disposal units are within a site covering 11.8 acres (4.8 hectares) (LANL 1999b). All pits and shafts were dug into the overlying soil and the Tshirege Member of the Bandelier Tuff (LANL 2003k). The MDA C disposal unit dimensions and periods of operation are shown in **Table I–12** (LANL 2003k). Except for 10 shafts, all disposal units are unlined. The shafts were placed in three groups. The first group of 12 shafts was dug between and parallel to Pits 4 and 5; the second group of 55 shafts was dug between and parallel to Pits 1 and 3; the third group of 40 shafts was dug in two lines perpendicular to the western ends of Pits 1 through 5. The strontium-90 disposal shaft was dug at the southwest corner of Pit 1 (LANL 2003k). (Shaft designation numbers do not reflect their sequence of use.)

Limited disposals may have been made following 1966. The last mention of MDA C in quarterly and annual waste disposal reports was in 1968. The last shaft (Shaft 89) was plugged on April 8, 1974 (Rogers 1977).

The pits were filled with wastes arriving in a variety of containers (Rogers 1977). Routine radioactive trash consisted of cardboard boxes, 5-mil plastic bags from chemistry laboratories, and 55-gallon (0.21-cubic-meter) barrels of sludge from wastewater treatment plants in TA-21 and TA-45 (LANL 2003k). Nonroutine waste included debris from the demolition of the Bayo Site and TA-1, classified materials, and tuballoy (a uranium alloy) chips (LANL 2003k). Hazardous constituents and uncontaminated classified material were buried with radioactive waste. A 1959 memorandum complains that much of the waste in one of the pits (probably Pit 6) was outdated technical badges and safety film. Chemicals were commonly burned in the chemical pit (Rogers 1977).

[21] *Not shown in Figure I–13 is the Radioactive Materials Research, Operations, and Demonstration Facility (Building 50-37), built in 1975. The facility is now called the Actinide Research and Teaching Integration Center.*

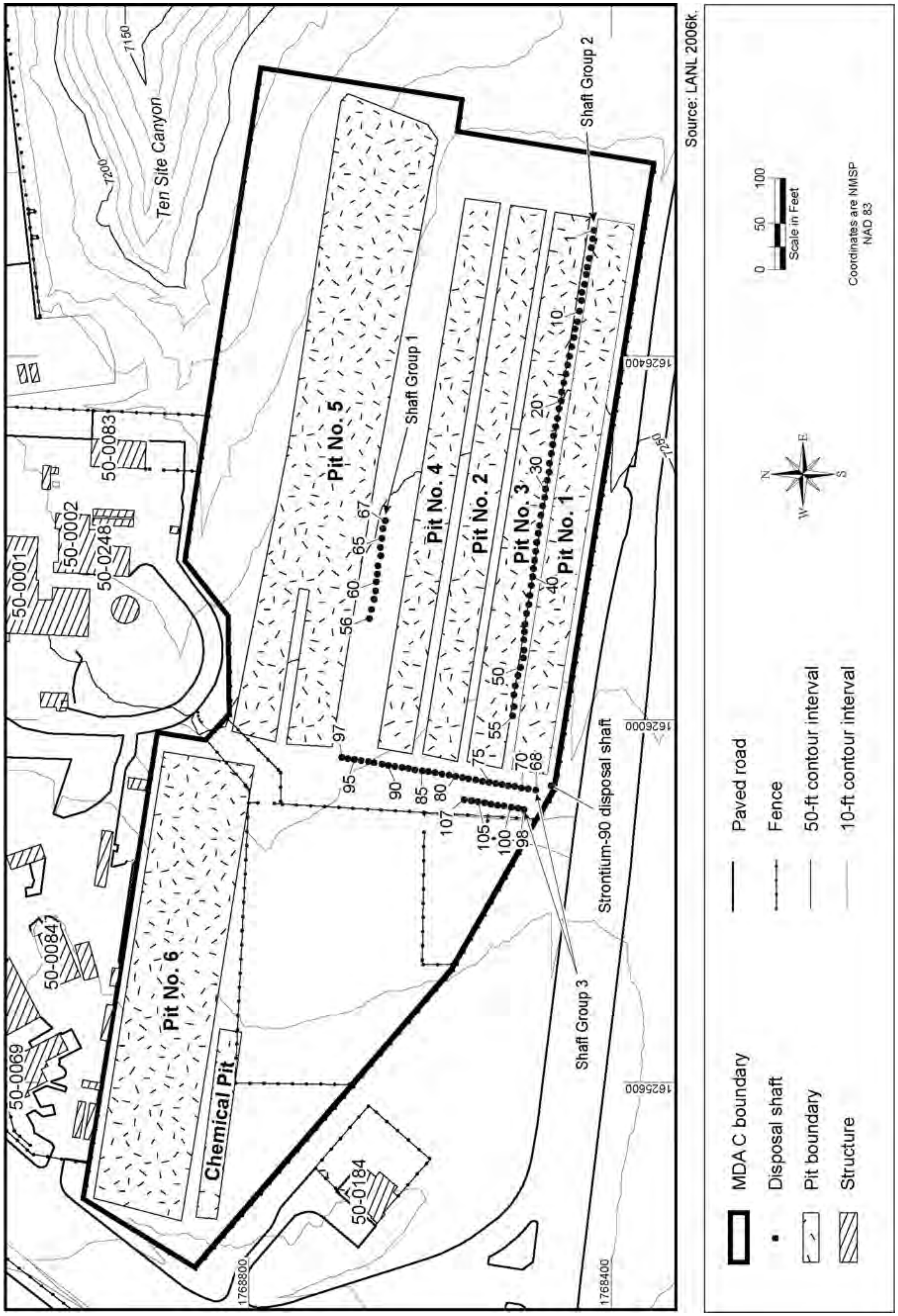


Figure I–13 Locations of Pits and Shafts at Material Disposal Area C

Table I–12 Approximate Dimensions of Material Disposal Area C Disposal Units

Disposal Unit	*Dimensions (feet)* [a]	*Period of Operation*
Pit 1	610 × 40 × 25	1948 to 1951
Pit 2	610 × 40 × 25	1950 to 1951
Pit 3	610 × 40 × 25	1951 to 1953
Pit 4	610 × 40 × 25	1951 to 1955
Pit 5	705 × 110 × 18	1953 to 1959
Pit 6	505 × 100 × 25	1956 to 1959
Chemical Pit	180 × 25 × 12	1960 to 1964
Shaft Group 1 (12 shafts; numbers 56-67)	2 × 10	1959
Shaft Group 2 (55 shafts; numbers 1-55)	2 × 15	1959 to 1967
Shaft Group 3 (40 shafts; numbers 68-107)	1-2 × 20-25 [b]	1962 to 1966
Shaft 108 (strontium-90 disposal shaft)	Unknown	1950s or 1960s

[a] Pit dimensions are length by width by depth; shaft dimensions are diameter by depth. Dimensions are approximate.
[b] Shafts 98-107 are 1 foot in diameter and are lined with 12-inch thick concrete. Shafts 68-97 are 2 feet in diameter and are unlined.
Note: To convert feet to meters, multiply by 0.3048.
Source: LANL 2003k.

At first, the waste was covered once a week to reduce the danger of fire, but operating practices were changed in 1957. Wastes were then backfilled when a single layer of waste covered about half the width of the pit, reducing the risk of fire as well as the amount of waste that could be placed in a pit (Rogers 1977). The MDA C Investigation Work Plan references a 1959 memorandum stating that Pit 6 received 10,000 cubic yards (7,645 cubic meters) of waste and 24,000 cubic yards (18,300 cubic meters) of fill, for an approximate ratio of 2.5 cubic yards (1.9 cubic meters) of fill to 1 cubic yard (0.76 cubic meters) of waste (LANL 2003k).

The shafts were used for disposal of "beta-gamma waste," mostly from the Chemical Metallurgy Research Building at TA-3 (Rogers 1977, LANL 2003k). Before February 1958, when the first shafts were drilled, beta-gamma waste was taken to a disposal pit where the waste was placed in a hole dug into the bottom of the pit and covered. After the shafts were opened, containers of waste were transported to the disposal area in lead transfer casks and dropped into the disposal shafts. By 1967, filled disposal shafts were routinely topped with concrete (Rogers 1977).

Five fires occurred at MDA C between 1950 and 1958. The first, in November 1950, involved material that had been placed in one of the pits. The second, in June 1952, involved one box as it was being unloaded. The third, in March 1953, involved containers that had been placed in the pit prior to being covered with backfill. The fourth, in April 1953, involved a single, smoking box from Sigma Building. The final fire, in November 1958 involved two boxes; the suspected cause was the presence of a volatile, flammable chemical such as acetone (Rogers 1977).

In 1974, most of the MDA C surface was covered with crushed tuff and fill, and the new surface was recontoured and seeded with grass. Localized surface subsidence on the north boundary of Pit 6 was seen in 2002. The subsidence produced a hole along an asphalt drainage carrying runoff to Ten Site Canyon and may have promoted infiltration of stormwater into Pit 6. The subsidence was mitigated (LANL 2003k).

Waste Inventory. Table I–13 lists the wastes that were placed into each of the pits and three shaft groups, based—except for the chemical pit—on Los Alamos Scientific Laboratory logbooks (LANL 2003k). No information is available for the strontium-90 shaft.

Table I–13 Los Alamos Scientific Laboratory Logbook Citations of Wastes Placed in Pits and Shafts

Pit 1	Trichloroethylene, boron, sulfuric acid, graphite, medical laboratory solutions, contaminated materials and trash, tritium, americium-241, uranium, classified material, plutonium, cyanide, radium-226, acids, lead, and waste oil.
Pit 2	Trichloroethylene and contaminated materials and trash, boron, tritium, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, plutonium, cyanide, mercury, radium-226, acids, lead, and waste oil.
Pit 3	Mercury teplers, tritium-contaminated glassware, cyanide solutions, contaminated materials and trash, trichloroethylene, boron, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, plutonium, radium-226, acids, lead, waste oil, and beryllium.
Pit 4	Tritium-contaminated glassware and boxes, tritium contaminated urine samples, mercury teplers, actinium-227, vials of radium-226, cyanide and cyanide solutions, a 5-gallon can of actinium waste, empty bottles, contaminated materials and trash, trichloroethylene; boron, americium-241, uranium, sulfuric acid, biological waste, graphite, classified material, plutonium, acids, lead, waste oil, silver, and beryllium.
Pit 5	Batteries (acids and lead), a 5-gallon can of actinium-227 waste, lead bricks, vials of radium-226, zirconium shavings, cyanide and cyanide solutions, radionuclide-contaminated boxes and urine samples, contaminated materials and trash, trichloroethylene, boron, americium-241, uranium, sulfuric acid, biological waste; graphite, classified material, and plutonium.
Pit 6	Radionuclide-contaminated oil, tritium-contaminated oil, copper sheets, cobalt chips, bottles of cadmium-boron tungstate, tritium-contaminated boxes and cans, a can of oil, about 100 curies of cobalt-60, a lanthanum source, 10 bottles of platinum chloride, beryllium chips, carbon-14-contaminated graphite, a plutonium slug, contaminated materials and trash, classified material, mercury, actinium-227, radium-226, acids, and lead.
Chemical Pit	No logbook entries were made. A 1964 memorandum provides this summary: "…A variety of chemicals, pyrophoric metals, hydrides and powders, sealed vessels containing sodium-potassium alloy or compressed gasses, and equipment not suitable for salvage, public dump or the contaminated dump have been placed in the pit. No high explosives have ever been disposed of in this pit. Natural uranium powders and hydrides have been disposed of in this pit. Inadvertently, some plutonium-contaminated objects were placed in the pit but have long since been covered. Because of the uranium disposed it should be assumed that the pit is mildly alpha contaminated" (Rogers 1977).
Shaft Group 1 (Shafts 56-67)	Barium, tritium, radium, lanthanum-140, strontium-89 and -90, tantalum, cerium waste, two cerium sources, fission products, one lanthanum-140 static source, phosphoric acid, depleted uranium, a charcoal trap, and polonium-beryllium-fluorine compounds.
Shaft Group 2 (Shafts 1-55)	Barium-140, lanthanum-140, fission products from the Omega reactor, uranyl phosphate, graphite slugs, a cobalt-60 capsule, radioactive graphite, radioactive tantalum, 1 gram of irradiated plutonium, thallium, irradiated uranium, graphite, lead-beryllium sources, thorium, cesium, strontium, plasma thermocouples, fuel elements (rods), cobalt-60 slugs and sources, sulfuric acid solution, zirconium carbide, a copper sphere, two "rabbit" tubes [a] of beryllium, reactor seals, alpha emitters in solution, acid solutions, actinium components, various uranium isotopes, depleted uranium, cerium-141, yttrium, silver-110, sodium-22, cesium-137, cesium-144, plutonium waste, oralloy (enriched uranium from Oak Ridge), benzene, isopropyl alcohol, neptunium-237, contaminated materials and trash, americium-241, biological waste, classified material, radium-226, lead, silver, and "induced activity" (activation products, usually from a linear accelerator).
Shaft Group 3 (Shafts 68-107)	Plutonium-contaminated trash, fission products, aluminum sheets and tubes, acids, cesium-137, sodium, cobalt-60, antimony, lanthanum-140, cobalt-60 sources, polonium, beryllium, vacuum pump oil, empty glass bottles, graphite, plutonium, boron, fuel element end caps, thermocouples, acetone, uranium, zirconium carbide, zinc and aluminum residues, barium, irradiated tantalum, tuballoy (a uranium alloy), shell waste, yttrium-91, radioactive chemicals and organic solutions, hydrochloric acid waste, plutonium in ether solution, zinc and mercury solutions, depleted uranium chips, miscellaneous sources, oralloy solution, iridium-192, tantalum, indium-114, animal tissues, solvents, a LAMPRE (Los Alamos Molten Plutonium Reactor Experiment) rod assembly, waste oil, detonator components, NRX (Navy experiment) reactor parts, trinitrotoluene (TNT) element samples, americium-242, aluminum-105 (sic), zinc-65, neptunium-237, contaminated materials and trash, americium-241, classified material, actinium-227, radium-226, lead, silver, strontium-90, and "induced activity."

[a] Rabbits are containers placed in a reactor neutron flux to irradiate the contents.

Note: To convert gallons to liters, multiply by 3.7854; grams to ounces, multiply by 0.03527.
Data are as stated in the source document.

Source: LANL 2003k.

Radionuclide inventories estimated for the pits and shafts, decay corrected to January 1989, are listed in **Table I–14** (LANL 1992c). These inventories are derived from information in (Rogers 1977). Table I–14 (LANL 1992c) does not list any citation for transuranic isotopes in the MDA C shafts, although a 1999 DOE database on buried transuranic waste (DOE 1999g) estimates 57 curies of plutonium-239 in MDA C shafts.

Table I–14 Material Disposal Area C Estimated Radionuclide Inventories as of January 1989

Disposal Unit	*Radionuclide*	*Activity (curies)*
Pits	Uranium-234, -235, -236, -238	25
	Plutonium-239	26
	Americium-241	145
	Total	**196**
Shafts	Tritium	20,000
	Sodium-22	0.58
	Cobalt-60	2.4
	Strontium-90/Yttrium-90	21
	Radium-226	1
	Uranium-233	5
	Uranium-234, -235, -236, -238	<0.1
	Fission products [a]	50
	Activation products [a]	200
	Total	**20,280**

[a] Uncorrected because exact compositions are unknown.
Source: LANL 1992c.

Current Configuration. The topography slopes from west to northeast, becoming steeper across the northeast quadrant of the site toward Ten Site Canyon. The site is vegetated by grass established after the 1984 addition of fill and topsoil over the disposal units (LANL 2003k).

The area south of Pit 6 and west of Pits 1 through 6 is covered with asphalt, as is much of the ground north of the MDA not occupied by buildings. The MDA is fenced. Many of the buildings and structures north of MDA C are SWMUs. Underground utilities run along and outside the fence line (LANL 2003k), including a water line along Pajarito Road and a radioactive liquid waste line along the west half of the northern site boundary. A new pump house and effluent storage facility is being built 30 feet (9.1 meters) north of the MDA boundary between TA-50 and TA-35 (Stephens 2005).

Geophysical surveys were conducted in 1994, 2001, and 2002. All seven pits probably extend beyond the boundaries shown on historical maps. Pits 1 through 4 extends farther to the east, and Pit 6 possibly extends to the fence on the north side of MDA C.[22] Shafts 98 through 107 were found to correlate with historical data. Neither the other two shaft fields nor the strontium-90 shaft were identified (LANL 2003k).

The 2001 geophysical survey found east-west trending conductivity anomalies that generally coincided with expected pit locations. No anomalies could be positively attributed to the shafts. The cover thicknesses over Pits 1 through 6 ranged from about 2.5 feet (0.8 meters) to about 8 feet (2.4 meters). The depth of cover over Shaft Groups 2 and 3, the western ends of Pits 1 through 4, and the chemical pit was less than 1 foot (0.3 meters)[23] (LANL 2003k).

Site Investigations. Radiation surveys of site soils and vegetation occurred from 1976 through 1984. Additional field surveys and laboratory analyses followed the 1984 placement of crushed tuff and cover material (LANL 1992c, 2003k). The Phase I RFI (1995 through 2003) sampled surface soil, subsurface tuff, and pore gas. A 2003 study obtained samples from 29 ant mounds and small-mammal burrow spoils and from 16 trees growing on the site. All trees were removed. The Phase I site investigations concluded (LANL 2003k):

- Historical releases of radionuclides to surface soils had been largely covered with crushed tuff. Elevated concentrations of americium-241 and isotopic plutonium in surface soils in the northeast area of MDA C were likely from releases from MDA C before placement of the crushed tuff in 1984.
- The only metals detected in concentrations above their respective background values in surface soil were lead and silver. There were sporadic detections of semivolatile organic compounds and Aroclor-1254 and -1260, but no defined pattern was found nor evidence for widespread release of organic chemicals.
- Specific metals (including barium, copper, and lead) and radionuclides (strontium-90 and americium-241) were found in tuff beneath the disposal pits. The extent of this subsurface contamination was not sufficiently defined.
- Subsurface pore gas contains tritium and volatile organic compounds (mainly trichloroethylene, tetrachloroethene, and 1,1,1-trichloroethane). The vertical and horizontal extent of contamination was not sufficiently defined.
- Surface flux of volatile organic compounds and near-surface tritium soil gas concentrations indicated localized areas where releases to the atmosphere were occurring.

[22] The 1994 survey indicated that Pit 6 may possibly extend beyond the fence at the east end of the pit (LANL 2003a). However, a photograph confirms the proximity of the northern edge of Pit 6 to the north perimeter fence (Rogers 1977).
[23] A map showing the variable thickness of cover across MDA C is available in the Investigation Work Plan for MDA C (LANL 2003a) and in a survey of source materials for capping the MDAs (Stephens 2005).

Further work was proposed in the 2003 MDA C Investigative Work Plan to determine: (1) the extent of metals, cyanide, and radionuclide contamination in tuff beneath Pit 6; (2) the concentrations and spatial extent of volatile organic compounds and vapor phase tritium in the subsurface tuff; (3) the nature and extent of potential releases of metals, cyanide, and radionuclides beneath pits and shafts; (4) the extent of radionuclide contamination in surface soil on the eastern boundary of MDA C; (5) the presence of perchlorate, nitrate, dioxin, and furan in tuff; (6) the presence of perched groundwater beneath MDA C; and (7) information on hydrogeologic properties and fracture characteristics (LANL 2003k). The MDA C Investigation Report (LANL 2006k) was completed and submitted to NMED on December 6, 2006. Additional work is ongoing.

I.2.5.5 Technical Area 54: Material Disposal Areas G, H, and L

TA-54 is on Mesita del Buey, which spans the boundary of the Cañada del Buey and Pajarito Canyon Watersheds. The northern border is the boundary between LANL and the San Ildefonso Pueblo; its southeastern boundary borders White Rock (LANL 1999b). The primary function of TA-54 is management of radioactive and hazardous chemical wastes. It contains more than 100 structures (DOE 1999a). The facilities at TA-54 are grouped in different areas according to the types of waste managed (see **Figure I–14**). Areas and MDAs in TA-54 include:

- *Area G*. The current Area G footprint comprises a 63-acre (25.5-hectare) site used since 1957 (LANL 2005h). It includes MDA G, a site having numerous subsurface disposal pits and shafts that are the subject to Consent Order investigations, as well as active low-level radioactive waste disposal operations. It includes above- and belowground transuranic waste storage areas; a facility for decontaminating radioactive waste containers; compactors for transuranic and low-level radioactive waste; an administrative support building; and numerous other structures. Because of space and regulatory consideration, low-level waste disposal operations will be expanded into Zones 4 and 6 at Area G (64 *Federal Register* [FR] 50797); other waste management activities will be transferred to other LANL locations.
- *TA-54 West*. TA-54-West is the site of the Radioassay and Nondestructive Testing Facility, used to determine characteristics of containerized transuranic waste and to prepare the containers for shipment to WIPP.
- *Area L*. This 2.6-acre (1.1-hectare) area is LANL's chemical waste management area. Area L includes MDA L, a site formerly used for subsurface disposal of chemical wastes, and currently subject to Consent Order investigations.
- *MDA H*. This MDA consists of nine inactive shafts used until 1986 for disposal of classified radioactive wastes. The area is being remediated pursuant to the Consent Order.
- *MDA J*. This 2.65-acre (1.1-hectare) MDA was used from 1961 until 2001 for disposal of solid wastes. The six pits at MDA J are covered with clean fill and all four shafts are capped. An asbestos transfer station has been removed. MDA J has undergone closure under the New Mexico Solid Waste Act of 1990, and is under postclosure monitoring.

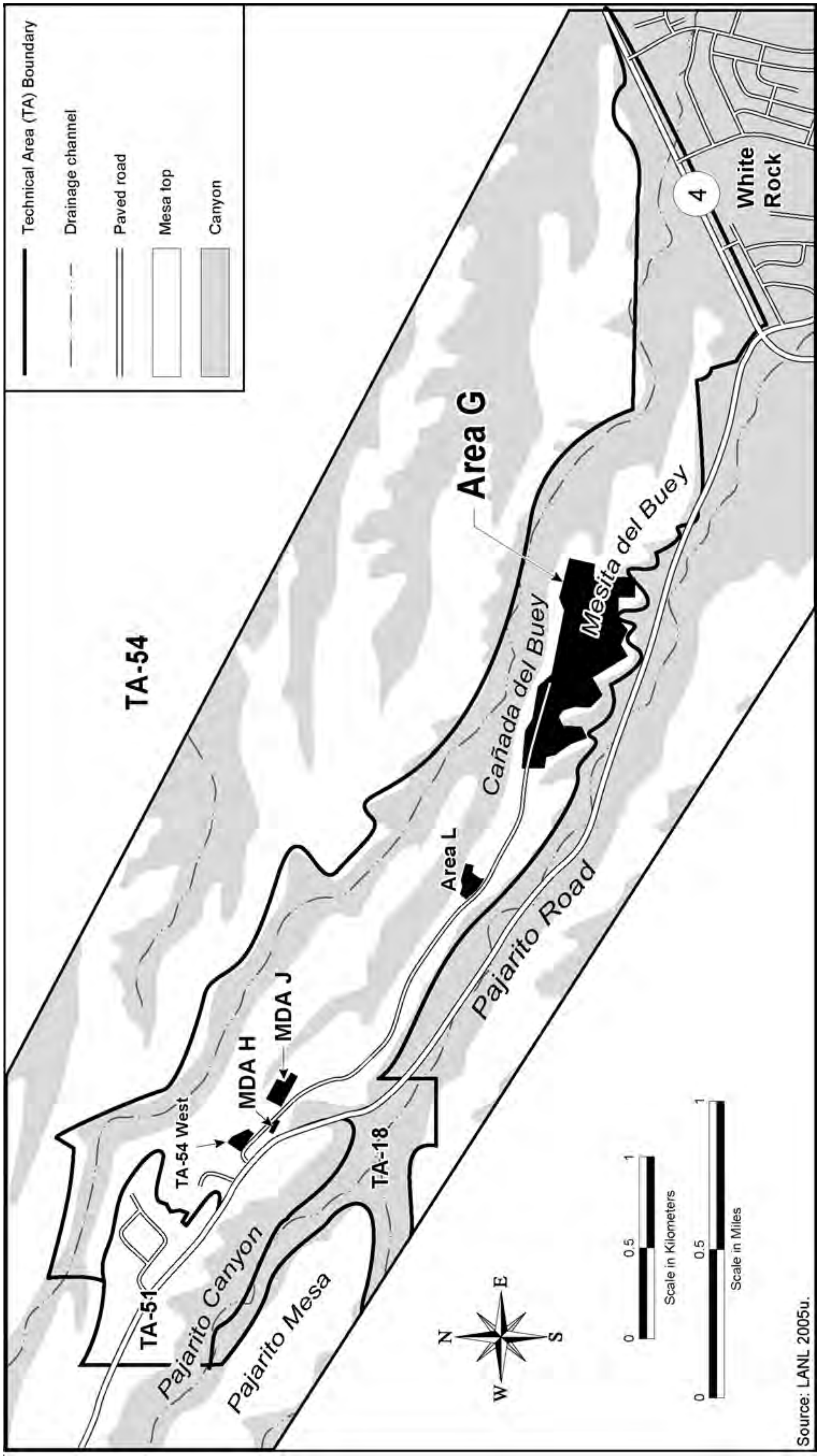


Figure I–14 Area and Material Disposal Area Locations of Technical Area 54

I.2.5.5.1 Material Disposal Area G

Within Area G, MDA G includes subsurface disposal units containing radionuclides and hazardous constituents under RCRA, and subsurface storage units for transuranic waste. The Investigation Work Plan for MDA G identified 32 pits, four trenches, and 194 shafts having depths ranging from 10 to 65 feet (3 to 20 meters) below the ground surface (LANL 2004c). **Figure I–15** shows existing waste areas within the existing Area G footprint (LANL 2005h).

Figure I–15 Waste Management Areas within the Existing Area G Footprint in Technical Area 54

History of MDA G. Disposal began during the 1950s. Up until the early 1970s, some of the waste disposed of at Area G contained transuranic isotopes in concentrations exceeding 10 nanocuries per gram, and some contained nonradioactive hazardous constituents. After DOE began retrievably storing wastes suspected of containing transuranic isotopes exceeding 10 nanocuries per gram, low-level radioactive waste disposed of in Area G contained significantly smaller quantities of transuranic isotopes,[24] but, until July 1986, still contained nonradioactive hazardous constituents (LANL 1997). Thereafter, disposal of mixed low-level radioactive waste was discontinued, but low-level radioactive waste and radioactively contaminated PCB waste continued to be disposed of in Area G (LANL 2004c). MDA G comprises those disposal units of Area G that are subject to corrective action under the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act.

---

[24] The transuranic limit for DOE disposal of low-level radioactive waste was revised in the early 1980s from 10 to 100 nanocuries per gram.

Tables I–15 and **I–16** describe the dimensions, operational periods, and wastes placed into MDA G pits and trenches (LANL 2004c). **Table I–17** summarizes information about the shafts (LANL 1992a).[25] The trenches are used for retrievable storage of contact-handled transuranic waste. The shaft diameters range from 1 to 6 feet (0.3 to 1.8 meters) (LANL 2004c).

Table I–15 Material Disposal Area G Pits

Pit Number	*Operational Period*	*Dimensions (feet) (length by width by depth)*	*Pit Volume [a] (cubic yards)*	*Waste Volume [a] (cubic yards)*	*Waste Description*
1	1/59-4/61	616 × 113 × 20	37,080	5,529	Wing tanks from Kirtland Air Force Base, dry boxes, "normal trash." Pit used to burn combustibles.
2	4/61-7/63	618 × 104 × 26	42,911	6,407	Classified Bendix waste, 55-gallon drums, property numbers, D-38, hot dirt.
3	6/63-3/66	655 × 115 × 33	56,759	9,473	Misc. material, lumber, pipe, 55-gallon drums, D&D, D-38, Bendix classified waste, soil from TA-10/Bayo Canyon.
4	1/66-12/67	600 × 110 × 34	44,950	8,212	D&D, graphite, wooden boxes, D-38, 55-gallon drums, classified Bendix waste, property numbers. Burning trench along south wall of pit.
5	1/67-3/74	600 × 100 × 29	41,258	6,624	Scrap material, D&D, graphite hoppers, sludge drums (possibly aqueous solution from TA-50), property numbers.
6	1/70-8/72	600 × 113 × 26	43,933	6,696	Misc. scrap, wood, D&D. Covered with topsoil from TA-1 with up to 20 picocuries per gram plutonium contamination.
7	3/74-10/75	600 × 50 × 30	17,101	4,343	Low-level transuranic waste. Replaced Pit 17 for low-level transuranic waste in 1974. Covered with topsoil from TA-1 with up to 20 picocuries per gram plutonium contamination.
8	9/71-5/74	400 × 25 × 25	6,528	2,311	55-gallon drums of sludge from H-7 and nonretrievable transuranic waste. Also drums from TA-50 (aqueous and nonretrievable transuranic waste).
9 [b]	11/74-11/79	400 × 30 × 20	9,027	(b)	Drums and fiberglassed crates containing retrievable transuranic wastes (>10 nanocuries per gram plutonium-239 or uranium-233 or >100 nanocuries per gram plutonium-238).
10	5/79-3/80	380 × 57 × 27	15,549	4,016	Building debris, lab wastes, sludge drums (from TA-50 dewatering, possibly aqueous).
12	9/71-12/75	400 × 25 × 25	7,303	2,363	Transuranic-contaminated residual material. Originally contained retrievable transuranic waste that was transferred to Pit 9.
13	11/76- 9/77	400 × 42 × 28	12,107	1,931	Uranium, mixed fission and activation products. Uranium fission products and induced-activity wastes.
16	9/71-8/75	400 × 25 × 25	8,081	2,235	Crates and drums containing uranium-contaminated wastes.
17	8/72-3/74	600 × 46 × 24	17,399	4,962	Low-level plutonium transuranic waste, <10 microcuries per gram. Miscellaneous scrap wastes, crates, filter plenums.
18	2/78-8/79	600 × 75 × 40	46,685	12,358	Contaminated dirt, lab wastes, noncompactible waste, D&D, drums.

[25] *Additional shaft information is available in Table B-3 in the Investigation Work Plan for MDA G (LANL 2004c).*

Pit Number	***Operational Period***	***Dimensions (feet) (length by width by depth)***	***Pit Volume [a] (cubic yards)***	***Waste Volume [a] (cubic yards)***	***Waste Description***
19	11/75-8/79	153 × 30 × 18	1,371	(c)	Asbestos and carcinogens, plastic layer placed in bottom.
20	11/75-10/77	600 × 71 × 36	37,454	14,899	Lab waste, oil, sludge drums, trash, contaminated dirt.
21	8/72-12/74	402 × 56 × 26	13,328	3,607	Uranium, classified material, boxes, drums, scrap metal.
22	9/76-3/78	413 × 56 × 33	17,690	3,744	Filter plenum, sludge drums (possibly aqueous from TA-50), lab waste, graphite fuel rods, contaminated dirt.
24	5/75-11/76	600 × 58 × 30	23,388	7,327	Graphite, lab wastes, 22 truck loads of soil. Uranium, tritium, mixed fission and activation products.
25	1/80-5/81	395 × 103 × 39	47,000	6,530	Reactor control rods, D&D, scrap drums, lab wastes, test drums, PCB-contaminated waste forms.
26	2/84-2/85	310 × 100 × 36	22,209	4,312	Building debris, transuranic waste culverts, asbestos, alpha box soil, lumber, PCBs.
27	5/81-/82	400 × 80 × 46	26,946	7,441	Lab waste, contaminated soil and pipe, D&D, PCBs, and unknown chemical waste.
28	12/81-4/83	330 × 83 × 40	21,381	4,422	Barium nitrate, PCB soil, lab waste, property numbers, transformers, clay pipes, building debris, uranium graphite.
29 [d]	10/84-10/86	658 × 80 × 50	45,795	9,784	Retrievable transuranic-waste-contaminated cement paste, D&D soil, gloveboxes, plywood boxes, asbestos, PCBs, and unknown chemical waste.
30	10/88-6/90	568 × 39 × 35	42,843	13,464	Asbestos, PCBs, and unknown chemical waste.
31	6/90-3/03	280 × 52 × 25	(c)	2,702	Asbestos, mixed fission and activation products.
32	11/85-8/87	518 × 74 × 51	36,364	5,367	PCB asphalt, transformers, building debris, contaminated soil, gloveboxes, plywood boxes, capacitors.
33	11/82-7/84	425 × 115 × 40	59,930	7,776	Beryllium in stainless steel, lab waste, building debris, asbestos, noncompactible trash, PCBs, and unknown chemical waste.
35	6/87-2/88	363 × 83 × 40	20,957	3,361	Trash, plywood boxes, asbestos, lab waste, PCBs, and unknown chemical waste.
36	1/88-12/88	435 × 83 × 43	28,057	4,491	Plywood boxes, compactible N.N. trash, rubble, building waste, beryllium, and PCB-contaminated soil (less than 200 parts per million).
37	4/90-4/97	731 × 83 × 61	57,213	24,299	UHTREX reactor vessel and stack, asbestos, PCBs, and unknown chemical waste.
Total			902,668	200,997	–

D-38 = depleted uranium, D&D = decontamination and decommissioning, TA = technical area, PCB = polychlorinated biphenyl, UHTREX = ultra-high-temperature reactor experiment.

[a] Pit Volume = pit volume as field measured; Waste Volume = approximate volume of waste placed in pit.

[b] Pit 9 contains disposed waste and 55,090 cubic feet of contact-handled transuranic waste stored above the pit under a soil cover.

[c] No information available.

[d] Stored above Pit 29 under a soil cover is contact-handled transuranic waste.

Note: To convert cubic feet to cubic meters, multiply by 0.028317, cubic yards to cubic meters, multiply by 0.76456; feet to meters, multiply by 0.3048; gallons to liters, multiply by 3.7854.

Source: LANL 2004c.

Table I–16 Material Disposal Area G Trench Information

Trench Number	Operational Period	Dimensions (feet) (length by width by depth)	Waste Description
A	1974	262.5 × 12.75 × 8	Heat sources containing plutonium (80 percent plutonium-238) and disposed of in casks. Average of 18 grams plutonium-238 per cask, with a maximum of 40 grams.
B	1974 to 1976	218.75 × 12.75 × 8	
C	No information	218.75 × 12.75 × 10 (estimate)	
D	No information	250 × 12.75 × 10 (estimate)	

Note: To convert feet to meters, multiply by 0.3048; grams to ounces, multiply by 0.035274.
Source: LANL 2004c.

Table I–17 Material Disposal Area G Summary Shaft Information

Data Status	Shaft Number
High tritium	6, 7, 15, 16, 39, 50, 59, 61, 136, 137, 150-159
Unknown tritium inventory	3, 4, 8-11, 22, 30, 32, 60, 81, 104, 121, 132
High cobalt-60 inventory	22, 23, 97, 102, 108, 122
Unknown cobalt-60 inventory	95, 128
High MAP-MFP [a] inventory	1, 2, 28, 58, 94, 98, 100, 107, 110, 114, 120, 126, 139, 141, 189-192, 196
Generally unknown values of radionuclides	34, 37, 39, 56, 57, 70, 82, 84, 85, 118, 135, 138, 140
Generally high radionuclide activity	129, 133
Generally unknown activity (less than 150 curies)	12, 13, 14, 24, 25, 27, 36, 40-42, 45, 47, 52-55, 68, 69, 72, 74, 75, 77, 78, 79, 80, 83, 87, 93, 103, 106, 112, 115, 124, 134
Activity generally known (less than 20 curies)	5, 17-21, 26, 29, 31, 33, 35, 38, 43, 44, 46, 48, 49, 51, 62-67, 71, 76, 86, 88-92, 96, 99, 101, 105, 109, 111, 119, 123, 125, 127, 130, 131, 160, 206
Polychlorinated-biphenyl-contaminated oil	C1-C13
Transuranic waste storage	200-232, 235-243, 246-253, 262-266, 302-306

[a] MAP-MFP: mixed activation products or mixed fission products.
Source: LANL 1992a.

Table I–18 organizes the disposal units by their SWMU groupings (LANL 2004c).

Table I–18 Material Disposal Area G Solid Waste Management Unit Groupings

Subsurface Disposal and Storage Units	SWMU	Description
Pit 9	54-014(b)	Pit with retrievably placed transuranic waste
19 pits	54-017	Pits 1-8, 10, 12, 13, 16-22, 24
12 pits	54-018	Pits 25-33, 35-37
Above Pit 19	54-013(b)	Truck decontamination operations that occurred on surface of Pit 19
4 trenches	54-014(d)	Trenches A, B, C, D with retrievably stored transuranic waste
68 shafts	54-020	Shafts C1-C10, C12, C13, 22, 35-37, 93-95, 99-108, 114, 115, 118-136, 138-140, 151-160, 189-192, 196
92 shafts	54-019	Shafts 1-20, 24-34, 38-92, 96, 109-112, 150
34 shafts	54-014(c)	Shafts 200-233
Above Pit 29	54-015(k)	Transuranic waste mound

SWMU = solid waste management unit.
Source: LANL 2004c.

SWMU 54-014(b) is Pit 9. It received retrievable transuranic and mixed transuranic waste from 1974 to 1978. The filled pit was covered with 3.3 feet (1 meter) of crushed and compacted tuff and 4 inches (10 centimeters) of topsoil and reseeded with native grass (LANL 2004c).

SWMU 54-017 and SWMU 54-018 are two sets of pits. Pits comprising SWMU 54-017 are inactive. All but Pit 29 in SWMU 54-018 are inactive. (Although no longer in use, Pit 29 is an active regulated unit until RCRA closure is certified by NMED.) Both sets of pits received a variety of wastes. The filled pits were covered with 3.3 feet (1 meter) of crushed, compacted tuff, covered with 4 inches (10 centimeters) of topsoil, and reseeded with grass (LANL 2004c). Portions of several pits have been covered with concrete and used for purposes such as aboveground transuranic waste storage.

SWMU 54-13(b) was a vehicle monitoring and decontamination area on the surface of Pit 19 in the center of Area G. The area is no longer used (LANL 2004c).

SWMU 54-014(d) consists of four transuranic waste storage trenches. Beginning in 1974, the trenches received transuranic wastes in 30-gallon (0.11-cubic-meter) containers inside concrete casks. The trenches were backfilled with 3.3 feet (1 meter) of crushed tuff, covered with 4 inches (10 centimeters) of topsoil, and reseeded with grass (LANL 2004c).

SWMU 54-020 consists of 68 disposal shafts. Shaft 124 is an active regulated unit pending RCRA closure certification and NMED approval. The shafts contain PCB residues, low-level radioactive waste, and hazardous and mixed wastes. The shafts were filled with waste to within 3 feet (0.9 meters) of the ground surface, backfilled with crushed tuff, and capped with concrete (LANL 2004c).

SWMU 54-019 consists of 92 disposal shafts. The shafts received low-level radioactive waste, chemical and mixed wastes. Disposal shafts were filled with waste to within 3 feet (0.9 meters) of the ground surface, backfilled with crushed tuff, and covered with concrete domes (LANL 2004c).

SWMU 54-014(c) comprises 34 1-foot-diameter (0.3-meter-diameter), 18-foot-deep (5.5-meters-deep), shafts lined with concrete. The SWMU 54-014(c) shafts, now inactive, were used from 1979 to 1987 for transuranic waste. The shafts contain wastes requiring special packaging (mainly tritium), special handling (e.g., high surface-exposure rates), or segregation by activity. The shafts were filled with waste to within 3 feet (0.9 meters) of the ground surface, backfilled, and covered with concrete domes (LANL 2004c).

SWMU 54-015(k) is a layer of retrievable transuranic waste in cement-filled sections of corrugated metal pipes inside a mound of fill above Pit 29 (LANL 2004c). This waste was once stored in MDA T, as discussed in Section I.2.5.2.3.

Disposal units were generally dug, filled, and capped sequentially from the east end of the site to the west. Temporary spring-dome structures on concrete or asphalt pads have been placed over many of the disposal units to support waste operations (LANL 2004c).

Waste Inventory. The performance assessment and composite analysis for Area G contains disposed radionuclide inventories on a pit-by-pit basis and also inventories for groups of shafts in Area G (LANL 1997). **Table I–19** summarizes the hazardous chemical inventories within MDA G as summarized in the MDA G Investigation Work Plan (LANL 2004c).

Table I–19 Material Disposal Area G Hazardous Chemical Inventories

Hazardous Constituent	*Pre-1971 Waste (kilograms)*	*1971 to 1990 Waste (kilograms)*
Aluminum	0	480,000
Arsenic	2.2	380
Barium	520	430
Beryllium	0	19,000
Cadmium	12	1,900
Chromium	96	1,900
Lead	16	230,000
Mercury	1.3	380
Nickel	850	690
Selenium	3.6	3.0
Silver	22	18
Acoclor-1260	0	200

Note: To convert kilograms to pounds, multiply by 2.2046.
Source: LANL 2004c.

Current Configuration. MDA G is within Area G, which, in addition to being the only active low-level radioactive waste disposal facility at LANL, is the focus of several other operations involving radioactive waste, including storage, characterization, and processing by compaction or repackaging of transuranic waste destined for disposal at WIPP; characterization and compaction of low-level radioactive waste before disposal; and storage of mixed low-level radioactive waste destined for offsite treatment or disposal. Portions of the MDA G disposal units are covered with concrete to support Area G waste management activities. Surface runoff from the site is controlled, discharging into drainages to the north to Cañada del Buey, and to the south to Pajarito Canyon. Stormwater and sediment monitoring stations are distributed throughout Area G and in the drainages around Area G (LANL 2006h).

The 63-acre portion of Area G shown in Figure I-15 will be closed to meet the Consent Order deadline for closure of MDA G. The closure approach must integrate and accommodate all applicable regulatory requirements. All storage and disposal units are subject to DOE requirements under the Atomic Energy Act. Many disposal units in Area G are SWMUs and AOCs that comprise MDA G and are subject to corrective action under the Consent Order. Other disposal units are RCRA-regulated disposal units subject to RCRA closure and postclosure care requirements. Low-level waste disposal operations will continue in Zones 4 and 6 at Area G. As analyzed in Appendix H, Section H.3, other waste management activities would be transferred to other LANL locations.

Site Investigations. Early investigations determined the soil moisture characteristic curves; intrinsic permeability and unsaturated hydraulic conductivity of the tuff; infiltration and redistribution of meteoric water in the tuff; presence of core and pore gas in the vadose zone; and presence of perched water. Volatile organic compounds were found in pore gas beneath the MDA. The primary volatile organic compound pore gas constituent was 1,1,1-trichloroethane, present to at least 153 feet (47 meters) below ground surface (LANL 2004c).

MDA G Phase I RFI fieldwork was conducted from 1993 through 2003. The results of these investigations are summarized below (LANL 2004c).

- There were infrequent detections of radionuclides in samples of tuff beneath pits, trenches, and shafts. No pattern of detections was seen from borehole samples.
- There were infrequent detections of inorganic chemicals in samples of tuff beneath the pits, trenches, and shafts. It could not be determined whether inorganic chemicals had been released from the disposal units.
- Tritium had been released into the tuff beneath the disposal units.
- Volatile organic compounds, mainly trichloroethane, were detected in subsurface pore gas.
- Drainage channel sediments contained low concentrations of methoxychlor, americium-241, cobalt-60, plutonium-238, plutonium-239, and tritium. Beryllium, cobalt, mercury, selenium, and silver were not found above background values; however, detection limits for some samples were elevated above background values. Cadmium was found above its background value.
- Volatile organic compounds and tritium were being released into the atmosphere from the subsurface.

The required Investigation Report for MDA G was submitted in September 2005 (LANL 2005q). Thirty-nine boreholes were drilled alongside MDA G disposal units, including two to depths of 556 to 700 feet (169 and 213 meters), respectively. Organic and inorganic chemicals were found beneath the disposal units at trace levels that were generally consistent with results from the Phase I RFI. Naturally-occurring and anthropogenic radionuclides were found above background values in soils and rock samples from beneath MDA G. Generally sporadic detections of americium-241, plutonium-238, plutonium-239, and strontium-90 occurred across the site. Thorium isotopes, uranium,-234, uranium-235, and uranium-238 were found at concentrations within their natural variability in the subsurface. Volatile organic compounds were found in pore-gas samples from 38 of the boreholes, and tritium in pore-gas samples from 35 of the boreholes. The highest concentrations of volatile organic compounds and tritium were from boreholes in the eastern and south-central portions of MDA G. Perched groundwater was not found in any of the boreholes, including the one drilled to 700 feet (213 meters) (LANL 2005q). On July 26, 2006, NMED issued a notice of disapproval for the MDA G Investigation Report (NMED 2006a). On August 31, 2006, LANL staff sent a response to the notice of disapproval agreeing to deepen four existing boreholes to further characterize the vertical extent of organic vapor contamination (LANL 2006e). The results of the pore-gas sampling from boreholes confirmed the results of the Phase I RCRA facility investigations, previous quarterly monitoring, and the 2005 site investigation (LANL 2007a).

In response to a September 13, 2006 letter from NMED about vapor-phase tritium found in increased concentrations with depth in a borehole down-gradient of the active tritium disposal shafts, DOE directed LANL staff to determine whether the trend extends to the basalt layer. The LANL management and operating contractor agreed to increase the depth of a nearby borehole, install equipment to monitor for tritium, and report the results of monitoring to NMED (LANL 2006j). Monitoring results showed that tritium concentrations peaked at 50 feet (15 meters) below ground surface near the base of the nearby 60-foot (18-meter) deep tritium shafts. The concentrations decreased as the sampling depth increased to about 240 feet (73 meters) below ground surface (LANL 2007a).

In July 2007, DOE issued a plan that describes the regulatory basis and the technical approach for performing a Corrective Measures Evaluation at MDA G. The plan identifies specific corrective measure alternatives to be evaluated including source containment or stabilization, source removal, contaminant extraction, or combinations of these alternatives (LANL 2007b). In July 2007, DOE also issued a work plan for implementing an *in situ* soil vapor extraction pilot study at MDA G (LANL 2007c).

I.2.5.5.2 Material Disposal Area H

MDA H (SWMU 54-004) is within a fenced 0.3-acre (0.1-hectare) area of TA-54. Nine shafts were used for disposal of classified waste from 1960 to 1986. A RCRA investigation program was completed and submitted to NMED in 2001, along with an addendum in 2002. A Corrective Measures Study Report for this MDA was completed in May 2003 (LANL 2003b), and an environmental assessment was issued in June 2004 (DOE 2004d).

NMED selected a corrective remedy for MDA H requiring complete encapsulation of the disposal shafts, a soil vapor extraction system, and construction of an engineered evapotranspiration cover (NMED 2007a). The Consent Order also requires collection and analysis of subsurface vapor samples and monitoring of groundwater in canyons potentially affected by MDA H (NMED 2005).

I.2.5.5.3 Material Disposal Area L

MDA L (SWMU 54-006) is within a 2.58-acre (1.0-hectare) site (Area L) north of Mesita del Buey Road between MDA G and MDAs H and J. The land north of MDA L drops steeply away to Cañada del Buey. Pajarito Canyon is to the south. Between about 1959 and 1985, chemical wastes were disposed of within unlined pits and shafts. Since 1986, Area L has stored RCRA waste, PCB waste, and mixed waste such as contaminated lead (LANL 1999b).

History of MDA L. MDA L was used from the late 1950s to 1986 for disposal of containerized and non-containerized nonradiological liquid wastes; bulk quantities of aqueous wastes; treated salt solutions and electroplating wastes, including precipitated heavy metals; and treated lithium hydride. The MDA consists of Pit A; Impoundments B, C, and D for liquids; and 34 shafts (**Figure I–16**). All disposal units are unlined (LANL 1992a, LANL 2003m). The dimensions and operation periods of each of the disposal units are summarized in **Tables I–20** and **I–21** (LANL 2003m). The pit, impoundments, and shafts are collectively identified as SWMU 54-006. Since 1986, Area L has stored RCRA waste, PCB waste, and mixed waste such as contaminated lead (LANL 1999b).

Pit and Impoundments. Pit A had three near-vertical walls on the north, south, and west sides and a ramp on the east side leading to a flat bottom. After being filled to within 3 feet (0.9 meters) of the surface, the pit was covered with crushed tuff in 1978. Impoundments B, C, and D had near-vertical walls on the east and west sides, and ramps on the north and south sides leading to flat bottoms. After Impoundments B and C were decommissioned, residual waste was covered with at least 3 feet (0.9 meters) of crushed tuff (LANL 2003m).

Impoundment D was used for treating small quantities of lithium hydride by reaction with water. The neutralized solutions were evaporated. Treatment was discontinued in 1984. Impoundment D was partially filled with crushed tuff in 1985 and completely filled in 1989. Between 1984 and 1989, aboveground used-oil storage tanks were placed next to Impoundment D (LANL 1992a). The waste oil storage tanks were emptied in 1985 and, in 1989, taken to Area G in TA-54 [26] (LANL 2003m).

Shafts. The 34 shafts range from 3 to 8 feet (0.9 to 2.4 meters) in diameter and from 15 to 65 feet (4.6 to 20 meters) deep. (The depth of most is 60 feet [18 meters].) After layering the bottom 3 feet (0.9 meters) of each shaft with crushed tuff, the shafts were filled with waste to within 3 feet (0.9 meters) of the surface; the remaining void was filled with concrete. Before 1982, liquids were disposed of in containers without adding absorbents. Small containers were often dropped into the shafts. Larger drums were lowered by cranes. Spaces around the drums were filled with crushed tuff, and a 6-inch (15-centimeter) layer of tuff placed between each layer of drums. In early years, uncontainerized liquid wastes were dumped into the shafts. Between 1982 and 1985, only containerized wastes were emplaced. When MDA L was decommissioned in 1986, its surface was partially paved with asphalt for permitted storage of hazardous and mixed wastes (LANL 2003m).

Waste Inventory. Estimates of the waste types and quantities disposed of in MDA L are summarized in the Historical Investigation Report for MDA L (LANL 2003m). Waste disposal records for MDA L are found in un-numbered logbooks. Records before 1974 are incomplete, and many logbooks contain only brief descriptions. Residuals from treatment of wastes in the impoundments may have been left in place (LANL 2003m).

---

[26] *The tanks were closed in 1990 under RCRA regulations.*

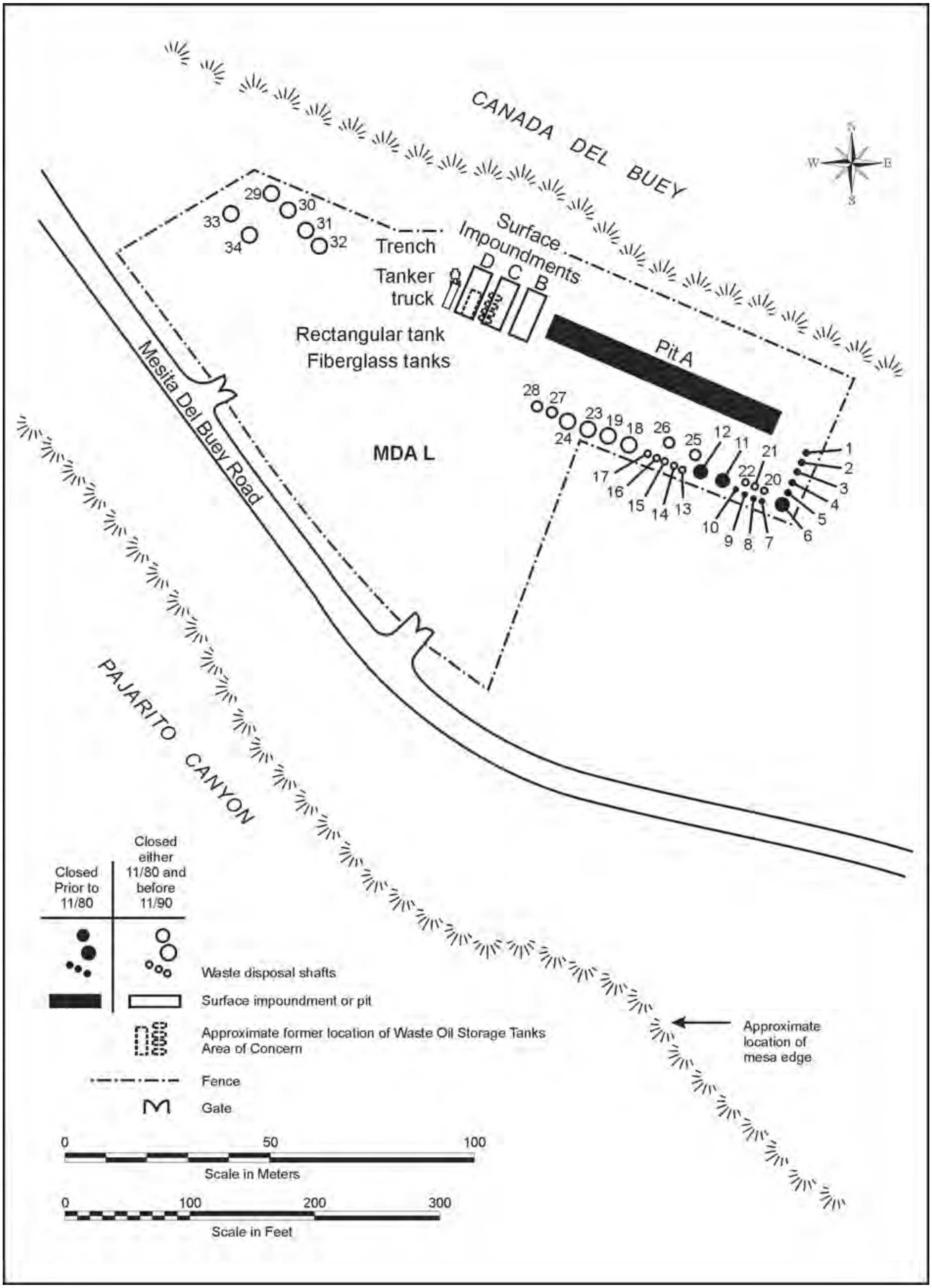


Figure I–16 Material Disposal Area L Inactive Waste Unit Locations

Table I–20 Material Disposal Area L Pit and Impoundment Dimensions and Operation Dates

Pit or Impoundment	Dimensions (feet) (length by width by depth)	Period of Use
A	200 × 12 × 10	1950s - 12/1978
B	60 × 18 × 10	1/1979 - 6/1985
C	35 × 12 × 10	1964 - 1978
D	75 × 18 × 10	1972 - 1984

Note: To convert feet to meters, multiply by 0.3048.
Source: LANL 2003m.

Table I–21 Material Disposal Area L Shaft Dimensions and Operation Dates

Shaft	Diameter/Depth (feet)/(feet)	Period of Use	Shaft	Diameter/Depth (feet)/(feet)	Period of Use
1	3/60	4/80 - 8/83	18	8/60	6/79 - 5/80
2	3/60	2/75 - 6/79	19	8/60	4/80 - 4/82
3	3/60	2/75 - 10/78	20	3/60	3/82 - 8/83
4	3/60	2/75 - 4/80	21	3/60	3/82 - 12/84
5	3/60	2/75 - 5/77	22	3/60	3/82 - 8/83
6	4/60	6/75 - 5/79	23	4/60	4/82 - 2/84
7	3/60	6/75 - 5/79	24	4/60	4/82 - 3/84
8	3/60	6/75 - 5/79	25	6/60	9/82 - 4/85
9	3/60	6/75 - 5/79	26	6/60	9/82 - 2/84
10	3/60	6/75 - 5/79	27	4/60	1/83 - 1/85
11	8/60	1/78 - 6/79	28	4/60	1/82 - 4/85
12	4/60	1/78 - 6/79	29	6/65	12/83 - 7/84
13	8/60	6/79 - 4/82	30	6/65	12/83 - 4/84
14	3/60	6/79 - 4/82	31	6/61	12/83 - 8/84
15	3/60	6/79 - 4/82	32	4/15	3/84 - 8/84
16	3/60	6/79 - 4/82	33	6/65	3/84 - 1/85
17	3/60	6/79 - 4/82	34	6/63	2/85 - 4/85

Note: To convert feet to meters, multiply by 0.3048.
Source: LANL 2003m.

Pit and Impoundments. Pit A received containerized and uncontainerized liquid chemical wastes. About 5,123 cubic feet (145 cubic meters) of liquid waste was discharged to Pit A. A salt layer remained on the pit floor after the aqueous phase evaporated. Impoundments B and C evaporated treated salt solutions and electroplating wastes. Treated wastes placed in Pit A and Impoundments B and C were generated from the following processes (LANL 2003m):

- Ammonium bifluoride waste was neutralized with calcium chloride and calcium hydroxide, yielding an aqueous solution of ammonium chloride, calcium, fluoride, and water.
- Acids and caustics in quantities larger than 55 gallons (208 liters) were diluted and neutralized. Acids were neutralized with sodium hydroxide; bases with mineral acids. Heavy metals were precipitated and removed before disposal in shafts.

- Cyanide solutions were treated with calcium hypochlorite or calcium chloride and calcium hydroxide, resulting in cyanate, carbon dioxide, and nitrogen. After treatment, the aqueous solution was discharged to the pit or the impoundment. Solids from the process were mixed with cement in metal drums and disposed of in MDA L shafts.

- Chromium waste was treated with sodium hydroxide and a reducing agent (sulfur dioxide or sodium bisulfate). End products were sodium sulfate and chromium hydroxide. Treated chromium waste was disposed of in MDA L shafts.

Shafts. Shafts 1 through 34 were used for disposal of containerized and uncontainerized liquid wastes and precipitated solids from treatment of aqueous wastes. Heavy metals precipitated from acid or caustic solutions were packaged in 15-gallon (57-liter) drums and disposed of in the same shafts as the neutralized acid or caustic solutions. Shafts used for disposal of neutralized acid solutions were also used for disposal of treated chromium waste (LANL 2003m).

Current Configuration. A 3- to 4-foot-high (0.9- to 1.2-meters-high) vertical retaining wall bounds the north and east sides of the site, and a stormwater diversion channel runs outside this retaining wall, immediately above the escarpment. An electrical line is buried outside of the northern boundary of the site (Stephens 2005).

Figure I–17 shows the location of the MDA L disposal units along with important structures (LANL 2003d). Stormwater is directed to an outfall at the northeast corner of the liquid low-level radioactive waste storage dome discharging into Cañada del Buey. The area is surrounded by a security fence and is covered with asphalt. Administrative offices are outside of the security fence adjoining Mesita del Buey Road. The area has water, electricity, and telephone services (LANL 1992a, 2003m).

Site Investigations. Early investigations determined the soil moisture characteristic curves; intrinsic permeability and unsaturated hydraulic conductivity of the tuff; infiltration and redistribution of meteoric water in the tuff; presence of core and pore gas in the vadose zone; and the possible presence of perched water. Early investigations documented a subsurface vapor-phase volatile organic compound plume extending beneath the site and beyond the boundary of MDA L. The primary constituents were 1,1,1-trichloroethane, present to a depth of at least 200 feet (61 meters) below ground surface, and trichloroethene. Other organic vapor-phase compounds included carbon tetrachloride, chloroform, tetrachloroethene (also known as tetrachloroethylene or perchlorethylene), toluene, chlorobenzene, xylene, and 1,2,4-trimethylbenzene (LANL 2003m). Investigations also identified moist-to-wet conditions at multiple depths within basalt beneath MDA L (see below) (LANL 2003m).

Phase I RFI fieldwork was conducted from 1993 through 2003 (LANL 2003m). Channel sediment samples contained inorganic chemicals, methoxylchlor, and a single instance of plutonium-238. Inorganic materials, organic chemicals, and tritium were detected in tuff, and tritium was detected in ambient air. Pore gas samples showed detectable levels of volatile organic compounds. The primary volatile organic compound was trichloroethane, followed by trichloroethene (LANL 2003m).

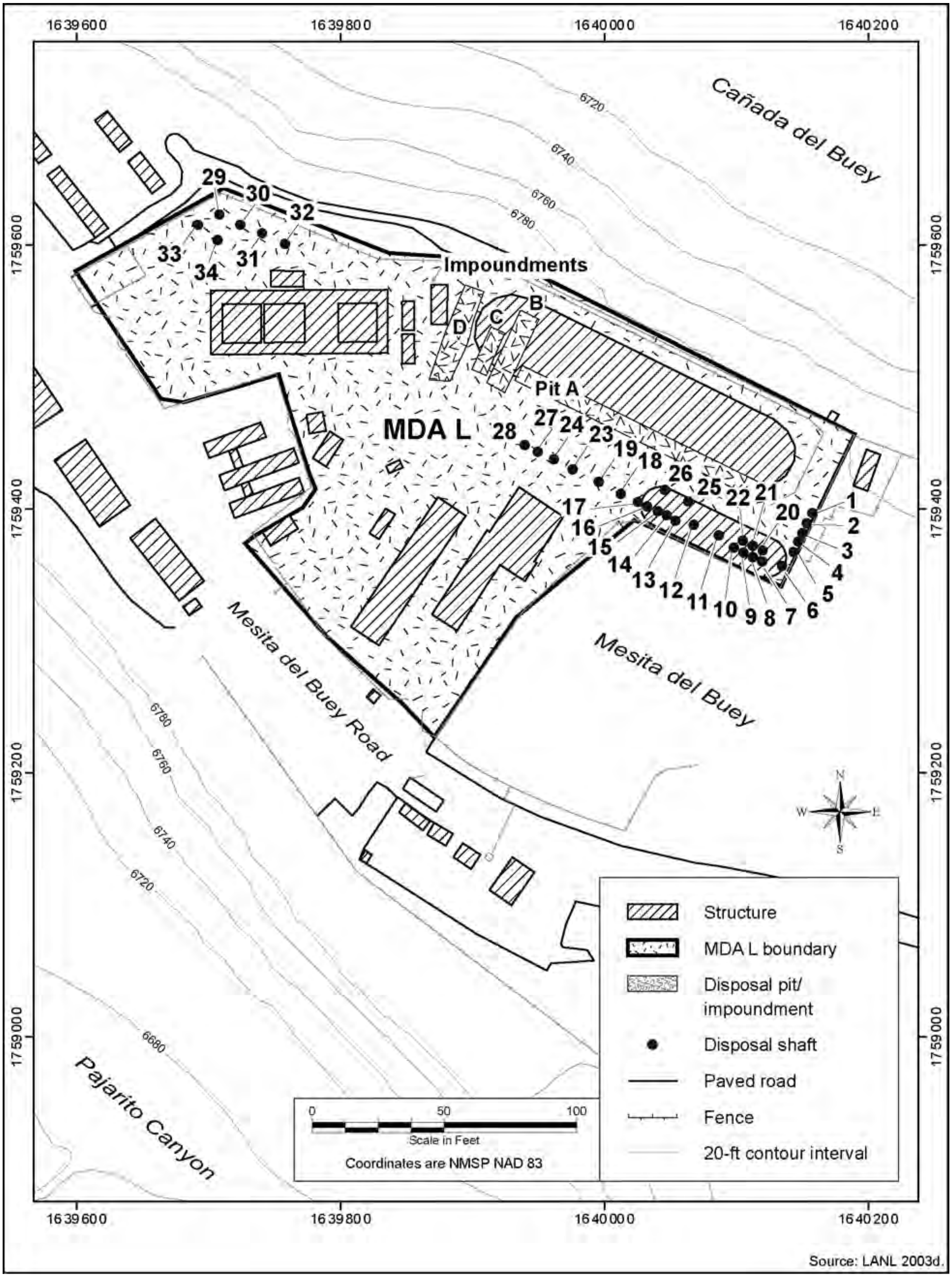


Figure I–17 Location of Subsurface Disposal Units at MDA L

Samples of surface flux were measured for tritium and for volatile organic compounds. All samples were obtained from areas of MDA L not covered by asphalt. Six samples had measured tritium emission fluxes of 2 to 5.5 picocuries per minute per square meter; one had a flux of 20,000 picocuries per minute per square meter; and one had a flux of 29,000 picocuries per minute per square meter. Twenty volatile organic compounds were detected, the most prevalent being trichloroethane, trichloroethene, and perchlorethylene (LANL 2003m).

The required Investigation Report for MDA L was submitted to NMED in September 2005 (LANL 2005r). Subsurface samples collected to evaluate moisture properties did not identify any perched groundwater zones to a depth of 660 feet (201 meters) beneath MDA L. Volatile organic compounds and tritium were found in pore-gas samples collected from 8 boreholes, each drilled to a minimum depth of 150 feet (46 meters). Among other points, the Investigation Report recommended using the results of a soil vapor extraction pilot study to evaluate this method as a potential remediation strategy (LANL 2005r). The workplan for this pilot study was submitted to NMED in May 2005 (LANL 2006h). Results of the study were addressed in a November 2006 Summary Report (LANL 2006m). In 2007, DOE issued an addendum to the Investigation Report for MDA L describing the results of supplemental drilling and sampling activities conducted to complete the investigation of MDA L (LANL 2007d) and issued a revision to the interim subsurface vapor monitoring plan for MDA L (LANL 2007e). In January 2008, DOE submitted a Corrective Measures Evaluation Report for MDA L to NMED recommending a corrective remedy that would feature an engineered evapotranspiration cover, a soil vapor extraction system, monitoring, and maintenance (LANL 2008a).

I.2.6 Other Solid Waste Management Units and Areas of Concern, Including Aggregate Areas

Section V of the Consent Order addresses requirements for all SWMUs and AOCs that are not addressed in Sections IV and VI of the Consent Order. (Section IV is discussed in Section I.2.5 of this appendix; Section VI is discussed in Section I.2.7.) The Consent Order sets forth requirements for identifying, investigating, and taking corrective action (if necessary) at any SWMU or AOC discovered after the effective date of the Consent Order, or any newly discovered releases from existing SWMUs or AOCs. Furthermore, the Consent Order presents requirements for addressing SWMUs and AOCs located in aggregate areas[27] (NMED 2005).

As required by the Consent Order, a list has been submitted to NMED identifying all aggregate areas and the SWMUs and AOCs within each aggregate area. Investigative work plans must be prepared for these aggregate areas. Following completion and submittal of the investigations, NMED may require corrective measure evaluations for any SWMU or AOC in any aggregate area. Investigation work plans for each aggregate area must be submitted in accordance with Consent Order schedules. Aggregate-area-specific investigation reports must be submitted by the dates specified in approved investigation work plans (NMED 2005).

[27] *The Consent Order defines an aggregate area as an area within a single watershed or canyon made up of one or more solid waste management units (SWMUs) or Areas of Concern (AOCs) and the media affected or potentially affected by releases from those SWMUs or AOCs, and for which investigation or remediation, in part or in entirety, is conducted for the area as a whole to address areawide contamination, ecological risk assessment, and other factors.*

The required list of aggregate areas was submitted in 2005 (LANL 2005n). All SWMUs and AOCs, except for canyons identified as AOCs,[28] were assigned to an aggregate area to ensure addressing cumulative impacts of all potentially collocated releases in the corrective action process. The SWMUs and AOCs were assigned to the aggregate areas based on factors such as operational history, potential historical risk, and physical location. Aggregate area boundaries were based mainly on boundaries of grouped subwatersheds, but were adjusted to maximize integration, consistency, and efficiency. The 29 aggregate areas within the eight major watersheds of the Rio Grande River and one watershed of the Jemez Mountains, are listed in **Table I–22** (LANL 2005n). The 29 aggregate areas contain hundreds of PRSs, many of which are described in other sections of this analysis.

Several work plans for these aggregate areas have been submitted to NMED, including those addressing the DP Site Aggregate Area at TA-21 (LANL 2004e); the Guaje, Barrancas, Rendija Canyons Aggregate Area at TA-00 (LANL 2005j); and the Pueblo Canyon Aggregate Area (LANL 2005g). In addition, the Bayo Canyon Aggregate Area Investigation Work Plan and the Middle Mortandad-Ten Site Canyon Aggregate Area Investigation Report have been submitted to NMED (LANL 2005m). Aggregate area Investigation Work Plans have also been submitted for Middle Los Alamos Canyon Aggregate Area, Upper Los Alamos Canyon Aggregate Area, and Cañon de Valle Aggregate Area.

Table I–22 Aggregate Areas and Watersheds

Watershed	***Aggregate Area***	***Watershed***	***Aggregate Area***
Los Alamos	Guaje, Barrancas, Rendija Canyons	Pajarito	Twomile Canyon
	Bayo Canyon		Starmer, Upper Pajarito Canyon
	Pueblo Canyon		Lower Pajarito Canyon
	Upper Los Alamos Canyon		Threemile Canyon
	Middle Los Alamos Canyon	Water	Cañon de Valle
	DP Site		Potrillo, Fence Canyons
	Lower Los Alamos Canyon		S-Site
Sandia	Upper Sandia Canyon		Upper Water Canyon
	Lower Sandia Canyon		Lower Water, Indio Canyons
Mortandad	Upper Mortandad Canyon	Ancho	North Ancho Canyon
	Middle Mortandad, Ten Site Canyons		South Ancho Canyon
	Lower Mortandad, Cedro Canyons	Chaquehui	Chaquehui Canyon
	Upper Cañada del Buey	Frijoles	Frijoles Canyon
	Middle Cañada del Buey	Lake Fork	TA-57 (Fenton Hill)
	Lower Mortandad, Cañada del Buey		

TA = technical area.
Source: LANL 2005n.

I.2.7 Continuing Investigations

Section VI of the Consent Order requires continued investigation of the SWMUs listed in **Table I–23**. Investigations of these sites were planned or ongoing at the time the Compliance Order was originally issued in November 2002. Hence, many Consent Order requirements for the listed SWMUs have already been met.

[28] AOCs that are canyons were not assigned an aggregate area and are being investigated pursuant to Section IV.B of the Consent Order.

Table I–23 Solid Waste Management Units Requiring Continuing Investigation

SWMU	Description
3-010(a)	Used for disposal of vacuum oil from Building TA-3-30 pump repair area
16-003(o)	Known as the fish ladder, the former outfall from Building TA-16-340
16-008(a)	Inactive, unlined pond 200 feet (61 meters) in diameter
16-018 (MDA P) and TA-16-387	SWMUs included with MDA P closure, including a former barium nitrate pile, the TA-16-386 and TA-16-387 and the septic tank drain field and outfall
16-021(c) and 16-003(k)	Collectively the outfall, drainage, and associated sumps and drain lines from the active explosives machining building, TA-16-260
21-011(k)	Outfall for industrial wastewater from Buildings TA-21-35 and TA-21-257
TA-35	The Middle Mortandad-Ten Site Aggregate Area
TA-49, Areas 5, 6, and 10	SWMUs associated with historic hydrodynamic studies at MDA AB
53-002(a and b)	Impoundments that have received sanitary, radioactive, and industrial wastewater from several TA-53 facilities
73-001(a-d) and 73-004(d)	Airport landfill, comprising five SWMUs: main landfill, waste oil pit, bunker debris pits, debris disposal area, and a septic system
73-002	Ash pile from a former incinerator next to the Los Alamos County Airport

SWMU = solid waste management unit, TA = technical area, MDA = material disposal area.
Source: NMED 2005.

I.2.7.1 Solid Waste Management Unit 3-010(a): Vacuum Oil Disposal Area

SWMU 3-010(a) within TA-3 (South Mesa Site) was used between 1950 and 1957 for disposal of vacuum oil from the pump repair area within Building TA-3-30. The disposal site is 40 feet (12 meters) long by 15 feet (4.6 meters) wide and is on a hillside on the west side of Building TA-3-30. Consent Order investigations are meant to determine the extent of groundwater contamination, determine sources and flow directions, any connection between the shallow groundwater and deeper zones, and other contaminants (NMED 2005). The Groundwater Investigation Report for SWMU 03-010(a) was submitted to NMED on 31 August 2005. The report defined the nature and extent of chemicals of potential concern in soil and tuff, and concluded that the shallow groundwater body beneath this site and SWMU 03-001(e) (a former waste storage area) was of limited extent, and most likely recharged from stormwater runoff. Among other studies, quarterly groundwater monitoring will be conducted at the sites for two years to better understand the sources of the groundwater and to determine temporal trends of the contaminants of potential concern and their potential for natural attenuation (LANL 2006h).

I.2.7.2 Solid Waste Management Unit 16-003(O): Fish Ladder Site

Covering 2,410 acres (975 hectares), TA-16 is in the southwest corner of LANL. TA-16 is bordered by Bandelier National Monument south of New Mexico (NM) 4 and by Santa Fe National Forest west of NM 501. TA-16 is bordered to the north and east by TA-8, -9, -11, -15, -37, and -49. The northern border of TA-16 is Cañon de Valle (LANL 2003l). TA-16 was established to develop explosives, cast and machine explosives, and assemble and test explosives for nuclear weapons. This mission continues (LANL 2003l).

SWMU 16-003(o) comprises six inactive high explosive sumps and an outfall associated with the explosives synthetics building (Building 16-340), the largest of five structures that produced plastic-bonded explosive powders from the early 1950s until October 1999. Between 1951 and 1988, explosive-contaminated wastewater was untreated before discharge. Starting in the early 1980s and lasting through 1998, various methods were used to reduce volatile organic compound concentrations in effluent. Although most volatile organic compounds were distilled during processing, the remaining solvents were discharged. The effluent historically discharged to a permitted outfall that was removed from the LANL National Pollutant Discharge Elimination System (NPDES) permit effective July 20, 1998 (LANL 2005c, NMED 2005).

The Consent Order requires continuing investigation to fully characterize the vertical and lateral extent of sediment and groundwater contamination by these contaminants and other metals (NMED 2005). The investigation report for the Fish Ladder Site was submitted to NMED on January 31, 2006, and was approved on October 25, 2006. Phase II investigations are ongoing.

I.2.7.3 Solid Waste Management Unit 16-008(a): Inactive Pond

Consolidated Unit 16-008(a)-99 comprises the footprints of former high explosive process buildings; former materials storage buildings; and sumps, drain lines, and outfall systems. Most structures were built in 1950 for machining high explosive. After 1970, the buildings were used for storage until, by 1991, they were all removed from service. The structures were removed in 1996 (LANL 2005c).

One SWMU (16-008(a)) is an inactive, unlined pond 200 feet (61 meters) in diameter. The pond received liquids from sumps and drain lines from process buildings. The discharge began as early as 1949; lasted until the mid-1950s; and contained explosives, barium, uranium, volatile organic compounds, machining oils, nickel, and cadmium. The area contains runoff and occasionally dries up in the summer (LANL 2005c, NMED 2005). The Consent Order requires continued investigation to fully characterize the vertical and lateral extent of surface, vadose, and groundwater contamination (NMED 2005).

The Investigation Work Plan for SWMU 16-008(a) and associated sites was submitted to NMED on March 31, 2004, and approved by NMED on June 28, 2004.

I.2.7.4 Solid Waste Management Unit 16-018 (Material Disposal Area P) and Technical Area 16-387

SWMUs incorporated into NMED-required closure activities for MDA P (SWMU 16-018) include the former barium nitrate pile (SWMU 16-016(c)); the TA-16-386 flash pad (SWMU 16-010(a)); the TA-36-387 flash pad (SWMU 16-019(b)); and the septic tank drain field and outfall (SWMU 16-006(e)) (NMED 2005).

MDA P was a 1.4-acre (0.57-hectare) waste pile near the south rim of Cañon de Valle. In 1995, LANL submitted a closure plan to NMED proposing to clean-close MDA P. NMED approved the closure plan for MDA P on February 20, 1997, and approved the closure plan for the TA-16-387 flash pad on April 28, 2000 (NMED 2005). Contamination was removed as described in Section I.3.3.1.3.1. A closure certification report for MDA P and the TA-16-387 flash pad was submitted to NMED on January 31, 2003. On April 30, 2003, NMED requested its reformatting and resubmittal. One of the four documents composing the reformatted closure report was submitted to NMED on July 9, 2003 (NMED 2005).

The Consent Order requires submittal of the remaining three documents composing the closure report for MDA P (NMED 2005). All three documents were submitted in 2003. The MDA P closure certification report was approved by NMED, and no further actions are required under the Consent Order.

I.2.7.5 Solid Waste Management Units 16-021(c) and 16-003(k): 260 Outfall

Operating since 1951, Building 16-260 processed and machined HE (LANL 2002c). Machine turnings and HE washwater were flushed to building sumps and routed to the TA-16-260 outfall. Liquids from the outfall drained to a settling pond 40 feet (12 meters) away (**Figure I–18**) (LANL 2003l). The settling pond was 50 feet (15 meters) long and 20 feet (6.1 meters) wide. Pond overflow flowed through the drainage channel for 300 feet (91 meters) before dropping to a lower drainage channel that continued to the bottom of Cañon de Valle (LANL 2003l). EPA permitted the outfall in the late 1970s. The last NPDES permitting effort occurred in 1994, the outfall was deactivated in November 1996, and the outfall was removed from LANL's NPDES permit in January 1998. Liquids once routed to the outfall are now treated in the TA-16 wastewater plant that was completed in 1997 (LANL 2003l).

Consolidated SWMU 16-021(c)-99 includes:

- SWMU 16-003(k), comprising 13 sumps in the HE machining building (TA-16-260) plus 1,200 feet (366 meters) of associated drain lines (concrete troughs) that ran 200 feet (61 meters) to the outfall east of the HE machining building

- SWMU 16-021(c), comprising the upper draining channel fed directly by the outfall, the settling pond and associated surge beds beneath the settling pond (see below), and the lower drainage channel leading to the bottom of Cañon de Valle

During 2000 and 2001, an interim measure removed contaminated soil from the settling pond and channel (LANL 2003l).

The 260 Outfall has three areas of contamination (LANL 2003l): an outfall source area (excluding the settling pond and surge beds); outfall settling pond and surge beds; and canyon springs and alluvial system. The outfall source area refers to the drainage channels. Fewer than 100 cubic yards (76 cubic meters) of residual contaminated soil remains within the outfall source area (LANL 2003l). The settling pond has underlying surge beds at depths below ground surface of 17 and 45 feet (5.2 and 14 meters). The canyon springs and alluvial system refers to sediments, springs, surface water, and alluvial groundwater in Cañon de Valle and in Martin Spring Canyon (LANL 2003l).

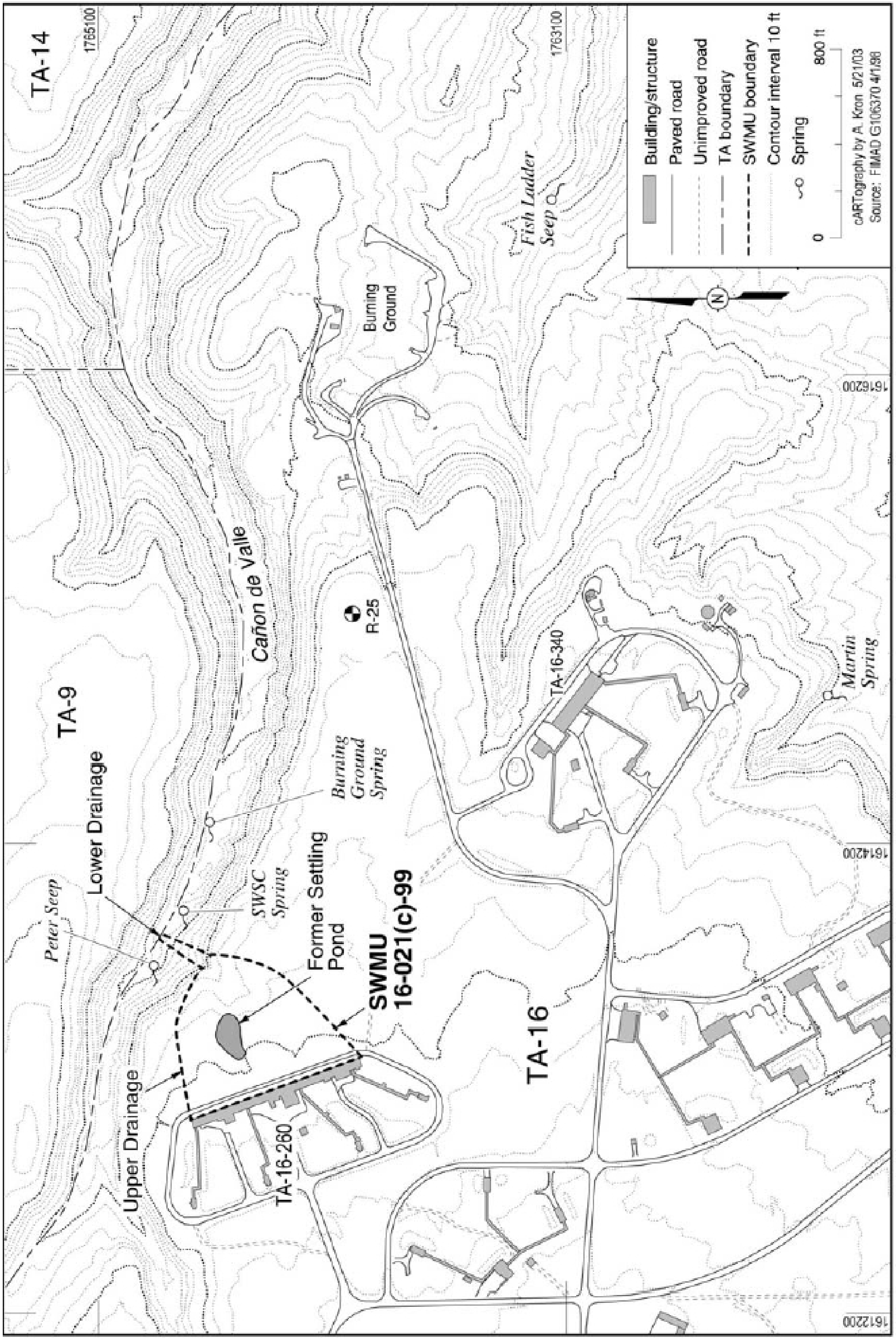


Figure I–18 260 Outfall Within Technical Area 16

Both the outfall and the drainage channel below the outfall are contaminated with high explosive and barium. Known contaminants include barium, RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine), TNT (2,4,6-trinitrotoluene), and HMX (octahydro-1,3,5,7-tetranitro-3,5,7-tetrazocine). Suspected contaminants include other high explosive compounds, inorganic chemicals, volatile organic compounds, semivolatile organic compounds, and uranium. The 17-foot (5.2-meter) surge bed beneath the settling pond contains detectable levels of RDX, HMX, and TNT. The 45-foot (24-meter) surge bed contains detectable levels of RDX and HMX (LANL 2003l).

Several site investigations have been conducted as summarized in the Corrective Measures Study Report (LANL 2003l) and the Phase III RFI Report, issued in September 2003 (LANL 2003g) and revised in September 2004 (LANL 2004g).

NMED selected a final remedy for the surface and alluvial system on October 13, 2006. The investigation report for intermediate and regional groundwater was approved by NMED on November 29, 2006; and additional groundwater investigations are ongoing to support the intermediate and groundwater corrective measure evaluation.

The land adjacent to the outfall is dedicated to continued LANL operations (LANL 2003l).

I.2.7.6 Solid Waste Management Unit 21-001(k): Technical Area 21 Outfall

SWMU 21-011(k) was an NPDES-permitted outfall. The SWMU includes a drainage pipe and an outfall ditch that routed wastewater north over the south rim of DP Canyon and into the canyon itself. The outfall received industrial effluent from the wastewater treatment plant in Building 21-35 from 1952 until 1967 and from the wastewater treatment plant in Building 21-257 from 1967 until the early 1990s (LANL 2002f).

SWMU 21-011(k) was investigated in 1988, 1992, and 1993. A 1996 interim action removed the contaminated soil from the hillside (LANL 2002f). A November 2000 gamma spectrometry for the site was followed in March 2001 by collection of samples that identified remaining hotspots (LANL 2002f). A voluntary corrective measure was prepared that included the following actions: (1) excavate and dispose of the outfall drain line and other waste; (2) excavate and solidify contaminated tuff and sediment; (3) place solidified material in a cell excavated near the center of the SWMU; (4) place and compact clean fill over the entire site; and (5) conduct site inspections and radiation surveys (LANL 2002f). However, plans for the voluntary corrective measure were modified to eliminate the onsite solidification of waste. The remedy was implemented in 2003 (LANL 2003i). The Voluntary Corrective Measure Report for SWMU 21-011(k) was submitted to NMED on October 31, 2003, and approved by NMED on August 9, 2005.

I.2.7.7 Technical Area 35 (Middle Mortandad–Ten Site Canyon Aggregate Area)

TA-35 (Ten Site) is used for nuclear safeguards research and development; reactor safety research; optical science and pulsed-power system research; and metallurgy, ceramic technology, and chemical plating activities. TA-35 is on a finger mesa between Mortandad Canyon and Ten Site Canyon within the Mortandad Canyon Watershed.

Contaminants have been released from outfalls, air stack emissions, and cooling water and septic system discharges. From 1951 until 1963, the wastewater treatment facility discharged effluent into Ten Site Canyon. Spills occurred from leaks in pipelines, structures, and container storage areas. Potential contaminants include metals, PCBs, volatile organic compounds, and radionuclides (NMED 2005).

On March 29, 2002, a Sampling and Analysis Plan (LANL 2002e) was submitted that integrated most of the PRSs into one aggregate. Originally 102 PRSs were within TA-35. Fifty-four PRSs were SWMUs and 48 were AOCs. Of the 102 PRSs, 32 have been recommended or approved for no further action, leaving 70 PRSs, of which 65 will be investigated.[29] The PRSs addressed in the Sampling and Analysis Plan are listed in **Table I–24**, where the first column indicates whether the PRS is part of a consolidated unit and the second column indicates the PRS number. The third column describes the PRS, while the fourth column describes the subarea within TA-35 within which the PRS is located (LANL 2002e).

Table I–24 Potential Release Sites Considered in the Middle Mortandad–Ten Site Aggregate Sampling and Analysis Plan

Consolidated Unit	*Potential Release Site*	*Potential Release Site Description*	*Subarea within the Aggregate*
	35-002	MDA X	Mesa top
35-003(a)-99	35-003(a)	Wastewater Treatment Facility	Mesa top
	35-003(b)	Wastewater Treatment Facility	Mesa top
	35-003(c)	Wastewater Treatment Facility	Mesa top
35-003(d)-00	35-003(d)[a]	Wastewater Treatment Facility	Pratt Canyon
35-003(a)-99	35-003(e)[a]	Wastewater Treatment Facility	Pratt Canyon
	35-003(f)	Wastewater Treatment Facility	Mesa top
	35-003(g)	Wastewater Treatment Facility	Mesa top
	35-003(h)	Wastewater Treatment Facility	Mesa top
35-003(j)-99	35-003(j)	Wastewater Treatment Facility	Mesa top
	35-003(k)	Wastewater Treatment Facility	Mesa top
35-003(d)-00	35-003(l)[a]	Wastewater Treatment Facility	Pratt Canyon
35-003(a)-99	35-003(m)	Wastewater Treatment Facility	Mesa top
	35-003(misc)	Industrial waste lines	Mesa top
	35-003(n)	Wastewater Treatment Facility	Mesa top
	35-003(o)	Wastewater Treatment Facility	Mesa top
	35-003(p)	Wastewater Treatment Facility	Mesa top
35-003(d)-00	35-003(q) [a]	Wastewater Treatment Facility	Pratt Canyon
	35-003(r)	Outfall	Pratt Canyon
	35-004(a)	Storage areas	Mesa top
	35-004(b)	Storage areas	Mortandad slope
25-004(g)-00	35-004(g)	Container storage area	Ten Site slope
	35-004(h)	Container storage area	Mesa top
35-014(g)-00	35-004(m)	Container storage area	Ten Site slope
35-008-00	35-008	Surface disposal and landfill	Mortandad Slope

[29] PRSs 35-013(a), 35-013(b), 35-013(c), 35-006(g), and 35-016(h) are not being investigated in the Sampling and Analysis Plan because they are outside the watershed aggregate boundary or are within active buildings and have been deferred until decommissioning occurs (LANL 2002e).

Consolidated Unit	*Potential Release Site*	*Potential Release Site Description*	*Subarea within the Aggregate*
	35-009(a)	Septic system	Ten Site slope, mesa top
35-004(g)-00	35-009(b)	Septic system	Ten Site slope, Ten Site Canyon
	35-009(c)	Septic system	Mortandad slope
	35-009(d)	Septic system	Pratt Canyon
	35-009(e)	Septic system	Ten Site slope
35-010(a)-99	35-010(a)	Sanitary lagoon	Ten Site Canyon
	35-010(b)	Sanitary lagoon	Ten Site Canyon
	35-010(c)	Sanitary lagoon	Ten Site Canyon
	35-010(d)	Sand filters	Ten Site Canyon
	35-010(e)	Release from sand filter	Ten Site Canyon
	35-011(d)	Underground storage tank	Mesa top
	35-014(a)	Operational release	Mesa top
35-003(j)-99	35-014(b)	Leaking drum	Mesa top
	35-014(d)	Operational release	Mesa top
35-008-00	35-014(e)	Oil spill	Mortandad slope
35-016(i)-00	35-014(e2)	Oil spill	Mortandad slope
	35-014(f)	Soil contamination	Mesa top
35-014(g)-00	35-014(g)	Soil contamination	Ten Site slope
	35-014(g2)	Soil contamination	Ten Site slope
	35-014(g3)	Soil contamination	Ten Site slope
	35-015(a)	Soil contamination	Mesa top
35-003(j)-99	35-015(b)	Waste oil treatment	Mesa top
35-016(a)-00	35-016(a)	Drains and outfalls	Ten Site slope
	35-016(b)	Outfall	Ten Site slope
335-016(c)-00	35-016(c)	Outfall	Ten site slope
	35-016(d)	Outfall	Ten site slope
	35-016(e)	Outfall	Mortandad slope
	35-016(f)	Storm drain	Mortandad slope
35-016(i)-00	35-016(i)	Drains and outfalls	Mortandad slope
	35-016(j)	Storm drain	Ten Site slope
35-016(k)-00	35-016(k)	Drains and outfalls	Pratt Canyon
	35-016(l)	Storm drain	Pratt Canyon
	35-016(m)	Drains and outfalls	Pratt Canyon
35-014(g)-00	35-016(n)	Storm drain	Ten Site slope
	35-016(o)	Drains and outfalls	Mortandad slope
	35-016(p)	Outfall	Mortandad slope
35-016(a)-00	35-016(q)	Drains and outfalls	Ten Site slope
	35-017	Steam blowoff outfall from reactor	Ten Site slope
	35-018(a)	Transformer	Mesa top
	C-35-007	Soil contamination	Ten Site Canyon

MDA = material disposal area.
[a] These potential release sites are consolidated with mesa top potential release sites but also have a canyon component.

Among the PRSs in Table I–24 is MDA X (PRS 35-002) near the southeast corner of Building TA-35-2 on the south side of Ten Site Mesa. MDA X is the former site of the reactor from the Los Alamos Power Reactor Experiment No. 2 (LAPRE-II). After being decommissioned in 1959, the reactor was buried in place. But in 1991, MDA X was remediated as an interim action. MDA X was recommended for no further action in the Addendum to the Operable Unit 1129 RFI Work Plan (LANL 1999b).

NMED approved the sampling and analysis plan on June 9, 2003. A supplemental sampling and analysis plan addressing the remaining sites in the Middle Mortandad-Ten Site Canyon Aggregate Area was submitted to NMED on March 31, 2004, and approved on June 29, 2004. The sampling and analysis plan, and supplement, was implemented and the Investigation Report for the Middle Mortandad-Ten Site Canyon Aggregate Area was submitted to NMED in September 2005. Additional investigations for the Middle Mortandad-Ten Site Canyon Aggregate Area are ongoing.

I.2.7.8 Technical Area 49: Areas 5, 6, and 10

The Consent Order requires additional investigation of potential contamination at Areas 5, 6, and 10 within TA-49. Details about the activities conducted in these areas, the likely contamination present, their current configurations, and past investigations are discussed in Section I.2.5.3.

I.2.7.9 Solid Waste Management Unit 53-002 (a and b): Impoundments

SWMU 53-002(a) includes two impoundments (northeast and northwest), each 210 by 210 by 6 feet deep (64 by 64 by 1.8 meters deep), that were built in 1969 and received sanitary, radioactive, and industrial wastewater from TA-53 facilities. The impoundments occasionally overflowed to a channel draining east into a tributary of Los Alamos Canyon. A third impoundment (southern impoundment, SWMU 53-002(b)) was built in 1985 and measured 305 by 148 by 6 feet deep (98 by 45 by 1.8 meters deep). In 1989, the southern impoundment was restricted to radioactive liquids, while the other two impoundments received sanitary wastewater. All three impoundments are now inactive. As part of an interim action, the sludge and liners were removed from all three impoundments, and characterization samples were collected from the perimeter around each impoundment and from drainage channels leading from the southern impoundment (NMED 2005). The investigation and remediation report for the impoundments was submitted to NMED on January 29, 2004, and approved on July 25, 2006. NMED issued a Certificate of Completion on September 13, 2006.

I.2.7.10 Solid Waste Management Unit 73-001 (a-d) and 73-004 (d): Airport Landfill

The Airport Landfill consists of 5 SWMUs: a main landfill (73-001(a)), a waste oil pit (73-001-b)), bunker debris pits (73-001(c)), a debris disposal pit (73-001(d)), and a septic system (73-04(d)). DOE began operations in 1943. Trash collected from the townsite and from other locations was burned on the edge of a hanging valley. Burning continued until 1965, when Los Alamos County assumed operation. Operation ceased on June 30, 1973. From 1984 to 1986, the western portion of the landfill was removed and taken to the debris disposal pit. This allowed construction of airport hangers and tie-down areas (LANL 2001b, NMED 2005). RFI activities occurred between 1994 and 1997 (LANL 1992e). An RFI report was submitted to NMED, and NMED agreed with the proposed remedy on December 8, 1999 (NMED 2005).

The Sampling and Analysis Plan for the Airport Landfill disposal areas describes the main landfill as covering 12 acres (4.9 hectares) and having a volume of 489,500 cubic yards (374,000 cubic meters). The west and south sides of the main landfill coincide with the edges of the asphalt tie-down area and the asphalt taxiway. The north site extends roughly to the chain-link security fence along the north side of the airport, and the east side extends to the end of the hanging valley. The debris disposal area consists of two, roughly parallel trenches dug to a maximum depth of 35 feet (11 meters). The debris disposal area covers 5 acres (2.0 hectares) and has a volume of 126,000 cubic yards (96,000 cubic meters) (LANL 2001e).

Subsequently, data needed to design a final cover for the landfill were collected, and an interim measure removed debris from landfill drainages. A closure recommendation was issued in June 2005. The preferred alternative is to leave the waste in place and install a MatCon (Modified Asphalt Technology for Waste Containment) asphalt cover and retaining wall at the main landfill and an evapotranspiration cover at the debris disposal area (LANL 2005i, DOE 2005b).

I.2.7.11 Solid Waste Management Unit 73-002: Incinerator Ash Pile

SWMU 73-002 is an ash pile from a former incinerator at TA-73. The ash pile is next to the Los Alamos County Airport. The incinerator equipment and stack were removed before 1973. An ash and surface disposal area is on the north-facing slope below the canyon rim (NMED 2005). The pile is several hundred feet northwest of the airport. The pile is 150 feet (46 meters) wide and 150 feet (46 meters) below the mesa top (LANL 2005e). RFI activities were conducted in 1996 and 1997. The RFI results were submitted in 1997 to NMED in a Phase II sampling and analysis plan. The plan was approved on February 28, 2000 (NMED 2005).

The Consent Order requires investigations to fully characterize the extent of contamination and the potential for migration of contaminants through fractures (NMED 2005). The investigation and corrective action work plan for SWMU 73-002 was submitted to NMED in May 2005 and approved in September 2005. Remediation of the ashpile is now complete and the Investigation Report for Consolidated Unit 73-002-099 and Corrective Action of Solid Waste Management Unit 73-002 at Technical Area 73 was submitted to and approved by NMED (LANL 2008a).

I.2.8 Additional Material Disposal Areas

MDAs in this section will be addressed as part of the aggregate area investigations.

I.2.8.1 Technical Area 8: Material Disposal Area Q

Also known as the GT or Anchor West Site, TA-8 is at the western end of LANL and is used for dynamic tests. MDA Q is within a 0.2-acre (0.8-hectare) site on Pajarito Mesa, in an area called the Gun-Firing Site (PRS 8-002), which once contained naval guns used to develop the Little Boy atomic weapon. Two concrete anchor pads for the gun mounts and two target sand butts remain (LANL 1999b).

MDA Q is a burial ground (SWMU 8-006(a)) that received waste in 1946 from the naval gun experiments, possibly including parts from Little Boy tests (LANL 2005c). The MDA occupies an irregularly shaped area having dimensions of 270 by 260 feet (81 by 78 meters) (LANL 1999b). Within this area, burial occurred in a pit of uncertain size. Investigations in the early 1990s suggested a size of 30 by 30 feet (9.1 by 9.1 meters) (LANL 1993d). Later investigations indicated that the disposal area covered a larger area (LANL 1993d). The MDA Core Document cites a 0.2-acre (0.8-hectare) area (LANL 1999b).

Radioactive contamination was absent in a gun mount unearthed in 1947. In 1994, copper and lead were found above background values in surface soil samples. No radioactive contamination was found (LANL 2005c).

I.2.8.2 Technical Area 9: Material Disposal Area M

TA-9 (Anchor East Site) is on the western edge of LANL. The site is used for explosives research. MDA M is on Pajarito Mesa southwest of Pajarito Canyon. MDA M (SWMU 09-013) consists of a 3.2-acre (1.3-hectare) circular surface MDA and a small disposal area 750 feet (229 meters) northwest. The main disposal area is surrounded by an earth berm that is eroded from surface runoff. MDA M was a dump for construction debris and other wastes. From 1960 through 1965, the site received nonhazardous wastes from construction at other sites. MDA M has been inactive since 1965 (LANL 2005c).

In 1996, all wastes were removed and the site surveyed. Twenty-six verification samples were analyzed for organic and inorganic chemicals, radionuclides, PCBs, and asbestos. All contaminants were either not detected or were below recommended cleanup levels. The site access road was regraded and revegetated, and the main disposal area was scarified, graded, tiered, and seeded to control soil movement and erosion. The report for the 1996 expedited cleanup recommended no further action (LANL 2005c).

I.2.8.3 Technical Area 15: Material Disposal Area N

MDA N (SWMU 15-007(a)) is within a 0.28-acre (0.11-hectare) site within TA-15. MDA N is a pit containing remnants of structures from R Site that had been exposed to explosive or chemical contamination. (If radioactive contamination is present, it is probably at a low level given nearby office buildings.) The MDA is shown in the RFI Work Plan for Operable Unit 1086 work plan as a 30- by 290-foot (9.1- by 88-meter) rectangle (LANL 1993c). A later report estimated the size as 300 by 100 feet (91 by 30 meters) (LANL 2005c). Opened in 1962, MDA N may have received waste from demolishing the control room and darkroom (Building 15-7) used to support Firing Point C (and probably D) (LANL 1993c). A 1965 aerial photograph showed it to be closed (LANL 2005c). The pit is covered and vegetated (LANL 1999b).

Little is known about use of hazardous materials. A 1989 aerial survey did not find radioactive materials. Neither high explosives nor uranium were handled. It is unknown how photographic chemicals were disposed (LANL 1993c).

I.2.8.4 Technical Area 16: Material Disposal Area R

TA-16 is described in Section I.2.7.2.

MDA R (SWMU 16-019) is an 11.5-acre (4.7-hectare) site on the edge of the mesa on the south side of Cañon de Valle. It is north of the explosives processing facility (Building 260). MDA R is an high explosive burning ground and disposal area that was used from 1945 until 1951. The MDA covers an area of 600 by 900 feet (180 by 270 meters), although the contaminated area is probably smaller (LANL 1999b).

A later document (LANL 2005c) reports an area of 2.27 acres (0.92 hectare). The MDA consists of three U-shaped, 75-square-foot (7.0-square-meter) bermed pits that were fenced and encircled by a road (LANL 1993f). During construction of the 260 Line, the berms and surface soil were graded northward into Cañon de Valle. Debris was pushed northward over the edge of the burning ground toward the canyon floor. Debris was held back by a natural barrier of wood and tress created by clearing the area for Building 16-260 in 1951. The area was covered with grasses and pine trees before the 2000 Cerro Grande Fire. Suspected contaminants are barium, high explosive, lead, asbestos, and organic chemicals (LANL 2005c). A geophysical survey suggests that the depth of waste at MDA R is shallow (LANL 1999b).

After the Cerro Grande Fire, 800 cubic yards (611 cubic meters) of clean soil was excavated and staged, as well as 1,500 cubic yards (1,147 cubic meters) of contaminated soil and debris. A runon diversion channel was built and erosion-control materials installed. The MDA was sampled in September 2000 to determine the nature and extent of contamination (LANL 2005c).

I.2.8.5 Technical Area 33: Material Disposal Areas D, E, and K

TA-33 (Hot Point Site) is near the southeast boundary of LANL. It spans the boundary of the Chaquehui Canyon and Ancho Canyon Watersheds. TA-33 was used from 1947 to perform experiments in underground chambers, on surface firing pads, and at firing sites where guns shot projectiles into berms. Weapons experiments ceased in 1972. A high-pressure tritium facility operated from 1955 until late 1990 (LANL 1999b). The TA is used for experiments that require isolation or do not need daily oversight.

I.2.8.5.1 Material Disposal Area D

MDA D (SWMUs 33-003(a) and (b)) is on the east end of the TA. MDA D consists of two underground chambers: TA-33-4 (SWMU 33-003(a)) and TA-33-6 (SWMU 33-003(b)). Built in 1948, the chambers were octagonal (18 by 18 by 11 feet high [5.5 by 5.5 by 3.4 meters high]), with the tops of the chambers 30 feet (9.1 meters) below grade. Access was via a 46-foot-deep (14-meter-deep) elevator shaft (Rogers 1977). The chambers were used for initiator tests using polonium-210 (138-day half-life), milligram quantities of beryllium, and large quantities of high explosive. Chamber TA-33-4 was used once in 1948. Chamber TA-33-6 was used in 1948 and April 1952. The second test destroyed the chamber. Debris ejected into the air spread over the mesa. The crater around the chamber was filled with recovered debris and covered with soil (LANL 1999b).

The Rogers report summarizes information indicating that the underground chambers may be contaminated with explosive residue, uranium-235, and possibly trace amounts of other uranium isotopes, polonium, and cobalt-60 (Rogers 1977).

A 1995 Phase I RFI report for the MDA recommended no further action for SWMU 33-003(a) because no release to the environment was apparent. A 1997 Phase I report recommended no further action for SWMU 33-003(b). The report recommended deferring evaluating ecological risks until a risk method had been developed (LANL 2005c).

I.2.8.5.2 Material Disposal Area E

On the south edge of the TA, MDA E is on a point formed by Chaquehui Canyon and one of its tributaries. Consolidated Unit 33-001(a)-99 (MDA E) consists of four waste disposal pits (SWMUs 33-001(a) through (d)) and an underground test chamber and shaft (SWMU 33-001(e)). The test chamber and shaft were last used in 1950, and the disposal pits ceased receiving waste in 1963. The consolidated unit covers 140 by 220 feet (43 by 67 meters) and is fenced (LANL 2005c). The four pits[30] have the following dimensions, based on contemporary engineering drawings (LANL 2005c):

- 33-001(a): 20 by 60 feet (6.1 by 18 meters);
- 33-001(b): 20 by 50 feet (6.1 by 15 meters);
- 33-001(c): not determined; and
- 33-001(d): 20 by 100 feet (6.1 by 30 meters).

The pits are probably shallow, each about 6 to 7 feet (1.8 to 2.1 meters) deep (Rogers 1977).

All four pits contain beryllium and uranium. A report by the U.S. Geological Survey referenced by Rogers (Rogers 1977) states that the area contains several hundred kilograms of depleted uranium. Pits 1 and 2 were reported to contain 240 curies and 60 curies, respectively. Pits 1 and 2 may contain hazardous wastes (LANL 1999b). Pit 3 contains a can of beryllium dust immersed in kerosene. Dates of construction cannot be confirmed. When disposal ceased in 1963, the pits were filled and compacted (LANL 2005c).

The underground chamber and shaft were built from November 1949 to February 1950. The octagonal chamber was 14 feet (4.3 meters) wide and 11 feet (3.4 meters) high and had concrete walls, floor, and ceiling. The adjacent shaft was 48 feet (15 meters deep). The chamber was used to conduct tests using explosives, beryllium, and tungsten. The chamber collapsed during an April 1950 experiment and was abandoned (LANL 2005c).

Sampling programs in 1982 and 1983 found tritium, cesium-137, and uranium. The RFI work plan indicated that subsurface contaminants were not being released from the pits and chamber (LANL 2005c).

I.2.8.5.3 Material Disposal Area K

MDA K (Consolidated Unit 33-002(a)-99) is in the northern part of the TA. The consolidated unit is in an unfenced area comprising a 3-acre (1.2-hectare) footprint (LANL 2005c). The six SWMUs composing the consolidated unit have a smaller footprint. The RFI Work Plan for Operable Unit 1122 estimates a size of 1 acre (0.4 hectare) (LANL 1992f). All former SWMUs

[30] Two additional pits were constructed but were backfilled, apparently without being used for waste disposal. Rogers (Rogers 1977) reports slightly different dimensions for the pits, based on a contemporary engineering drawing: Pit 1 = 15 by 75 feet (4.6 by 23 meters); Pit 2 = 15 by 45 feet (4.6 by 14 meters); Pit 3 = 5 feet (1.5 meters) in diameter; Pit 4 = 15 by 100 feet (4.6 by 30 meters).

are associated with the Tritium Facility (Building 33-86), which operated from June 1955 until 1990. The former SWMUs consist of a septic system (SWMU 33-002(a)), two sumps (SWMUs 33-002(b) and -002(c)), an outfall (SWUM 33-002(d)), a roof drain (SWMU 33-002(e)), and a surface disposal area (SWMU 33-002(f)) (LANL 2005c). SWMUs (33-002(a-e)) were remediated in 2005 as part of an accelerated corrective action at TA-33. The remedy completion report for this accelerated corrective action was submitted to NMED on March 2, 2006, and was approved with a Certificate of Completion on August 31, 2006.

The history and origins of waste within the surface disposal area (33-010(f)) are unknown. The surface disposal area comprises two groups of debris at the southeast corner of the MDA. One group of debris is 15 feet (4.6 meters) square, and it is 50 feet (15 meters) from a second 10- by 20-foot (3.0- by 6.1-meter) group of debris. Materials include pieces of concrete and concrete culvert, piles of tuff and cured asphalt, rusted metal cans, rebar, strapping bands, and other debris (LANL 2005c).

I.3 Description of Options

I.3.1 Overview of Options

To predict the impacts of carrying out future corrective measure decisions, three broad-scope options are considered for purposes of NEPA:

1. **No Action Option**. Environmental investigations and restoration efforts are assumed not to be carried out in accordance with the Consent Order. The LANL environmental restoration project would continue at a pre-Consent Order level, but no extensive corrective measures would be conducted for major PRSs.

> The No Action Option is considered in this appendix because such an action is required by NEPA. DOE is legally required to carry out the provisions of the Consent Order.

2. **Capping Option**. The Consent Order would be implemented. For this appendix it was assumed that environmental investigations would take place in accordance with the Consent Order, LANL MDAs would be stabilized in place, and several other PRSs would be remediated annually.

   Stabilizing MDAs in place means placing final covers over them and conducting certain other environmental restoration activities such as remediating the volatile organic compound plumes existing in soil at some MDAs. The General’s Tanks within MDA A would be stabilized in place using a grout mixture. Transuranic waste in subsurface storage at MDA G would be removed, processed, and shipped to WIPP. Because a small volume of the stored transuranic waste in subsurface shafts within MDA G may be difficult to retrieve, an option to leave this stored waste in place would be considered. If this option were pursued, a performance assessment pursuant to 40 CFR Part 191 may be required. If such an assessment is required, the assessment results may indicate the need for additional waste stabilization or MDA final cover modification.

   Remediating additional PRSs would include contamination removal at sites such as Firing Sites E-F and R-44 and the 260 Outfall. Other remediation activities could include surge bed grouting, contaminated sediment natural flushing, use of permeable reactive barriers, pump and treat system installation, or other measures.

For MDAs A, B, T, U, C, L, G, and AB, it was assumed that remediation would be completed by the dates presented in Table I–2. For other MDAs and PRSs, it was assumed that remediation would be completed in compliance with appropriate Consent Order schedules, including those for aggregate areas. It was assumed that remediation of these MDAs and PRSs would occur from FY 2007 through FY 2016.

3. **Removal Option**. The Consent Order would be implemented. For this appendix it was assumed that environmental investigations would take place as they would for the Capping Option. In addition, LANL MDA waste and contamination would be removed. All transuranic waste stored at MDA G would be removed and shipped to WIPP along with all other transuranic-contaminated material disposed of before 1970. Remediation of additional PRSs would again occur by various methods as discussed for the Capping Option. Remediation of MDAs or PRSs was assumed to be completed by the same dates assumed for the Capping Option.

   The projected annual waste volumes and other environmental impacts are conservative. If extensive removal of waste and contamination from the MDAs were required, then for a variety of programmatic, funding, safety, and regulatory compliance reasons, the remediation process may extend beyond FY 2016, provided that a revised schedule is approved by NMED. If this were to occur, annual waste volumes and other impacts associated with the Removal Option would be smaller.

Environmental impacts associated with these three options are expected to bound those that could result from eventual implementation of MDA and PRS corrective actions. Remediation decisions will be made for specific MDAs and PRSs rather than groups, and may prescribe a combination of corrective measures. For example, some waste within an MDA may be removed and the remainder may be stabilized in place.

For all options, appropriate safety and environmental surveillance and maintenance would continue at LANL to maintain compliance with DOE and external criteria and standards, including those for nuclear environmental sites (Section I.3.2.3).

I.3.2 Continuing Environmental Restoration Work

Since LANL's environmental restoration project was established in 1989, progress has been made in characterizing and remediating LANL PRSs. Some of the numerous environmental investigations conducted by LANL have generated solid and liquid wastes. Additional wastes have resulted from implementing corrective measures. Projections of future waste generation are difficult. One reason is that waste generation rates depend on regulatory decisions yet to be made that would establish the scope of specific environmental restoration activities. Because the kinds of investigations conducted under the Consent Order will be basically the same as those previously performed (for example, well drilling), it was assumed that waste from environmental investigations would be encompassed by those in existing LANL forecasts (see Section I.3.2.1).

I.3.2.1 Existing Waste Forecasts

Estimates of waste generation from LANL's environmental restoration project were presented in the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, New Mexico (1999 SWEIS)* (DOE 1999a). Updated projections are in the August 17, 2004, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)* (LANL 2004f). The 2004 LANL information document provides 10-year forecasts of radioactive and nonradioactive waste generation at LANL. These forecasts are in two parts:

- Forecasts of wastes from several LANL sources, including the environmental restoration project and LANL operations. The forecasts are derived from a June 2003 report (LANL 2003c) that was attached to the 2004 LANL information document (LANL 2004f) as Appendix G.
- Forecasts of waste from a separate decontamination, decommissioning, and demolition (DD&D) project that would generate wastes from demolishing several LANL structures (LANL 2004f).

The focus of this appendix is on waste that could be generated from LANL's environmental restoration project.[31] Projections of environmental restoration project waste from the June 2003 report (LANL 2003c) as updated for years 2006 through 2008 by a subsequent report (LANL 2004i), are presented in **Table I–25** for FYs 2006 through 2012. For transuranic waste and mixed transuranic waste, the revised forecast projected an annual minimum of 52 cubic yards (40 cubic meters) of transuranic waste and an annual maximum of 105 cubic yards (80 cubic meters) of transuranic waste (LANL 2004i). The larger estimate is reflected in the table.

Table I–25 Projections of Los Alamos National Laboratory Environmental Restoration Project Wastes from Fiscal Year 2006 through Fiscal Year 2012

Waste	Fiscal Year						
	2006	2007	2008	2009	2010	2011	2012
Chemical - hazardous waste [a] (tons)	7,591	1,644	1,165	162.7	0	38.4	27.6
Low-level radioactive waste (cubic yards)	1,295	989	3,640	4,175	31	0	0
Mixed low-level radioactive waste (cubic yards)	6.5	129	196	20	0	303	89
Transuranic waste (cubic yards)	100	100	100	0	0	0	0

[a] Resource Conservation and Recovery Act (RCRA) waste, Toxic Substances Control Act (TSCA) waste, New Mexico State special solid waste, and waste not otherwise suitable for sanitary landfill disposal.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; tons to metric tons, multiply by 0.90718.
Sources: LANL 2003c, 2004i.

The Consent Order requires the investigation and remediation of numerous potential release sites and areas of concern. Implementing the Consent Order may cause generation of larger quantities

[31] *Wastes potentially generated from DD&D of LANL structures are addressed in Appendix H, Section H.1, for structures in TA-18 and in Section H.2 for structures in TA-21. Waste estimates from recovery and shipment of stored transuranic waste at Area G of TA-54 are addressed in Section H.3. Waste estimates from combined LANL sources are addressed in the main body of this SWEIS.*

of environmental restoration waste than previously projected. Because investigations are ongoing and many corrective action decisions remain to be made, it is not possible to precisely define the types and quantities of wastes that would be generated from actions taken under the Consent Order. Bounding estimates were therefore made.

It was assumed that MDAs A, B, T, U, AB, C, G, and L would be remediated in conformance with their remedy completion report due dates.[32] For other MDAs, it was assumed that their remediation would start in FY 2007 and continue through FY 2016. Total quantities of wastes that may be generated under each option (capping or removal) were estimated and averaged from FY 2007 through FY 2016. For the remaining PRSs, waste generation rates from some representative PRSs were estimated, and an average annual waste generation rate was assumed starting in FY 2007 and continuing through FY 2016. This waste was added to that projected in Table I–25.

The waste types assumed for this appendix are listed in **Table I–26**. Nonliquid wastes are grouped into four types: solid waste, chemical waste, low-level radioactive waste, and transuranic waste. Solid waste refers to solid waste suitable for disposal into a solid waste landfill. Chemical waste is meant to be a general description for chemical or hazardous wastes that contain hazardous constituents regulated under RCRA or TSCA, are regulated as a special waste by the State of New Mexico pursuant to the New Mexico Solid Waste Act of 1990, or otherwise fail to meet waste acceptance criteria for sanitary landfill burial.

Table I–26 Waste Types Considered

Waste Types	*Waste Subtypes*
Nonliquid Wastes	
Solid waste	–
Chemical waste	–
Low-level radioactive waste	Low-activity
	Mixed low-activity
	Alpha
	Mixed alpha
	Remote-handled
	Mixed remote-handled
Transuranic waste and mixed transuranic waste	Contact-handled
	Remote-handled
Liquid Wastes	
Industrial	–
Hazardous	–
Radioactive	Low-level
	Mixed low-level

Low-level radioactive waste was assumed to be radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring

[32] *This assumption is conservative for MDA U because NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (see Section I.2.5.2.4 of this appendix).*

radioactive material. Low-level radioactive waste was divided among six subtypes. This distinction was made to enable assessment for transportation impacts in this appendix and was not meant to represent official DOE waste classifications.

Low-activity low-level radioactive waste contains radionuclides in concentrations that do not exceed the Class A limits of 10 CFR Part 61 and have surface radiation levels smaller than 200 millirem per hour. Mixed low-activity low-level radioactive waste has similar radioactive properties but also meets the definition of RCRA hazardous waste. Alpha low-level radioactive waste contains alpha-emitting transuranic isotopes in concentrations between 10 and 100 nanocuries per gram; this waste is assumed to be contact-handled. Mixed alpha low-level radioactive waste is similar radiologically but also meets the definition of RCRA hazardous waste. Mixed remote-handled low-level radioactive waste has surface radiation levels that exceed 200 millirem per hour. Much of this waste may also exceed Part 61 Class A limits. Mixed remote-handled low-level radioactive waste is similar material but also meets the definition of RCRA hazardous waste.[33]

Transuranic waste is not separated into mixed and nonmixed subgroups. Both mixed and nonmixed transuranic waste can be shipped directly to WIPP, provided that wastes having the RCRA characteristics of ignitability, corrosivity, or reactivity are treated. Transuranic waste is separated into contact-handled and remote-handled transuranic waste, where remote-handled transuranic waste containers have surface radiation levels exceeding 200 millirem per hour.

Liquid wastes would be generated in small volumes; for example, from equipment decontamination. Liquid low-level radioactive waste contains small concentrations of radioactive isotopes regulated by DOE under the Atomic Energy Act of 1954. Mixed low-level radioactive liquid waste is similar in radioactive properties but also meets the definition of RCRA hazardous waste. Hazardous liquid waste meets the definition of RCRA hazardous waste. Industrial liquid waste is process water that does not meet the definition of hazardous waste.

I.3.2.2 Investigations

The Consent Order requires investigations to fully characterize the nature, extent, fate, and transport of contaminants that have been released to air, soil, sediment, surface water, and groundwater. For example, the investigations of the canyon watersheds must address canyon alluvial sediments, surface water monitoring and sampling, and groundwater monitoring and sampling, focusing on the fate and transport of contaminants from the point of origin to each canyon watershed drainage system, and, if necessary, to the regional aquifer and the Rio Grande. The Consent Order requires the construction of new wells, the abandonment of some existing wells, and environmental sampling. Newly constructed wells include alluvial wells, intermediate wells, and regional aquifer wells. Requirements for specific LANL TAs are often prescribed in terms of individual MDAs. The investigations for each MDA must typically include a survey of disposal units, drilling explorations, soil and rock sampling, sediment sampling, vapor monitoring and sampling, intermediate and regional aquifer groundwater well installation, and

---

[33] *This grouping of different low-level radioactive waste subtypes contains simplifications. For example, some alpha-low-level radioactive wastes may require remote handling. However, there is insufficient information for further meaningful subgroupings.*

groundwater monitoring (NMED 2005). These investigations would involve similar if not identical technologies that have long been used at LANL.

Investigations of PRSs must be conducted in accordance with work plans to be submitted to and approved by NMED. Investigations for most PRSs will be conducted in accordance with work plans for the aggregate areas containing these PRSs, and the details of the work plans will depend on the known and inferred characteristics of the PRSs within each aggregate area. Three example work plans are those addressing the DP Site Aggregate Area at TA-21 (LANL 2004e); the Guaje, Barrancas, Rendija Canyons Aggregate Area at the townsite (LANL 2005j); and the Pueblo Canyon Aggregate Area (LANL 2005g). The objectives of the work plans are to characterize the nature and extent of contamination, if any, and to determine the need for corrective action. Investigations may include (but are not necessarily limited to) geodetic and geophysical surveys, radiological surveys, surface and near-surface soil sampling, sampling soil and tuff from boreholes, and confirmation sampling of soil or tuff after conducting a remedial action. A phased approach will be used that will be tailored to each PRS, including site reconnaissance, screening, characterization, excavation, confirmation sampling, and evaluation of survey screening and sample data. This approach allows for acquisition of confirmation data and review of results before demobilizing the investigation program for that PRS.

In May 2005, LANL staff submitted an Interim Facility-Wide Groundwater Monitoring Plan to NMED. Four modes of water will be monitored: base flow, alluvial groundwater, intermediate perched groundwater, and regional aquifer groundwater. Monitoring within LANL boundaries will take place in seven major watersheds or water shed groupings. Monitoring outside LANL boundaries will be conducted in areas that LANL operations have affected, and, to provide baseline information, areas that LANL operations have not affected. Monitoring data will be reported in accordance with Consent Order schedules (LANL 2006h).

Any investigation-derived waste generated during the site investigation process will be managed in accordance with all applicable EPA and NMED regulations, DOE orders, and LANL implementation requirements. Investigation-derived waste may include drill cuttings, contaminated personal protective equipment, sampling supplies, plastic, and decontamination fluids. Some field investigations may also displace environmental media such as groundwater, surface water, surface and subsurface soils, rocks, bedrock, and gravel.

I.3.2.2.1 Well Installation

Exploratory and monitoring well borings must be drilled using the most effective, proven, and practicable method for recovery of undisturbed samples and potential contaminants. Methods to be used must be approved by NMED (NMED 2005). Monitoring wells are typically constructed by advancing a boring with a drilling rig, installing a well casing and screen, and backfilling the annulus between the casing and the wall of the borehole (Hudak 1996). Based on drilling conditions, the borings may be advanced using one of the following methods: hollow-stem auger, air rotary, mud rotary, percussion hammer, sonic, dual-wall air rotary, direct-push technology, cryogenic, and cable tool. Drilling techniques will be selected and used that minimize collateral disturbance and investigation-derived waste. NMED prefers hollow-stem auger or direct-push technology drilling methods if vapor-phase or volatile organic compound contamination is known or suspected. Air rotary drilling is preferred for borings intersecting the regional aquifer. The type of drilling fluid used must be approved by NMED (NMED 2005).

Each of these drilling methods are summarized below.

Hollow-stem auger. A hollow-tem auger may be used to install monitoring wells in unconsolidated or poorly consolidated materials, but is inappropriate for solid rock. No drilling fluids are required (Hudak 1996).

Air rotary. Rotary drilling uses circulating fluids to remove drill cuttings and maintain an open hole as drilling progresses. In the air rotary method, air is forced down the drill pipe and back up the borehole to remove drill cuttings. Air rotary is often discouraged for environmental investigations because of the difficulty of yielding representative samples (Hudak 1996).

Mud rotary. Mud rotary drilling, like water rotating drilling, requires the introduction of fluids through the drill pipe to maintain an open hole, to provide drill bit lubrication, and to remove drill cuttings. Mud rotary drilling is often used instead of water drilling when the subsurface properties make it difficult to maintain an open borehole (Hudak 1996).

Dual-wall air rotary. The dual-wall reverse-circulation rotary method employs a double-walled drill pipe. Air (or water) is forced down the outer casing and circulated up through the inner pipe. Cuttings are forced to the surface through the pipe (Hudak 1996).

Percussion hammer. This drilling technique uses compressed air to hammer a series of short, rapid blows to the drill rods or bits and also simultaneously applies a rotating motion. Drill cuttings are flushed to the surface by compressed air (TH 2005).

Sonic. Resonant sonic drilling uses a combination of mechanically generated vibrations and limited rotary power to penetrate soil. The drill head, attached to the drill pipe, uses two counter-rotating, out-of-balance rollers, causing the drill pipe to vibrate in resonance. The vibration and weight of the drill pipe, along with the downward thrust of the drill head, permit penetration of the geologic formation without adding drilling mud or lubricating fluid. The technique is adaptable to any slant angle and virtually any geologic formation and typically produces no cuttings or secondary waste streams (NCDENR 2005, CPEO 2005).

Direct-push technology. Direct-push technologies use hydraulically powered machines that drive small-diameter tools directly into the surface. This technology generates little to no investigation-derived wastes and can be mounted on relatively small vehicles, allowing for use at sites that are difficult to access and minimizing collateral disturbance to surrounding soil and vegetation (ICON 2005, Fugro 2005).

Cryogenic. Cryogenic drilling replaces ambient air with cold nitrogen liquid or gas—as cold as 320 ^{o}F (degrees Fahrenheit) (-196 ^{o}C [degrees Celsius])—as the circulating medium. The nitrogen stream freezes moisture in the ground surrounding the borehole, thus stabilizing it (DOE 1998b).

Cable tool. The cable tool drilling method uses a heavy string of drilling tools that are repeatedly lifted and dropped within a borehole. The drill bit breaks and crushes consolidated rock into small fragments and loosens unconsolidated material. The reciprocating action of the tools mixes the crushed and loosened rock particles with water to form a slurry. A sand pump or bailer removes the slurry (Hudak 1996).

I.3.2.2.2 Well Purging

Procedures for purging monitoring wells before sampling must be approved by NMED. The Consent Order requires temporary storage of purged groundwater and decontamination water until proper characterization and disposal can be arranged. Disposal methods must be approved by NMED (NMED 2005).

I.3.2.2.3 Test Excavations

Site investigations may include test excavations, including trenches and test pits in areas of contamination. Test excavation programs have been conducted at LANL PRSs. Future test excavation programs should cause small areas of temporary surface disturbance, generally in areas such as MDAs that have already been changed from natural conditions. Test excavations will result in temporary removal, stockpiling, and return of uncontaminated soil and material, as well as generation of small volumes of waste.

I.3.2.3 Maintenance of Nuclear Environmental Sites

Some of the PRSs addressed in this appendix are nuclear environmental sites, which are inactive waste handling or disposal areas that contain sufficient radioactive material to be classified as hazard category 2 or 3 according to DOE Standard thresholds (DOE 1997b). These nuclear environmental sites are listed in **Table I–27**. LANL staff perform routine inspections and maintenance at these sites to maintain compliance with 10 CFR Part 830. LANL staff has developed a documented safety analysis for surveillance and maintenance of the sites (LANL 2004l).

Consistent with the surveillance and maintenance documented safety analysis implementation plan, all nuclear environmental sites have been initially inspected. Results of those inspections indicated the need for several actions, which are ongoing. The work elements required to address these findings fall into several distinct categories of similar actions:

- General maintenance
- Boundary marking
- Baseline radiological survey
- Erosion control studies and maintenance efforts
- New fencing

Table I–27 Hazard Categories and Descriptions of Nuclear Environmental Sites

Nuclear Environmental Site [a]	*Associated PRS*	*Description*	*Hazard Category*
TA-21 MDA A	21-014	Subsurface tanks and pits associated with historical liquid and solid waste disposal	2
TA-21 MDA B	21-015	Undifferentiated subsurface areas associated with historical waste disposal	3
TA-21 MDA T	21-016(a)-99	Shafts and absorption beds associated with liquid wastes	2
TA-35 MDA W	35-001	Subsurface tanks used for disposal of sodium coolant from reactor experiments	3
TA-35 Wastewater Treatment Plant	35-003(a)-99	Areas of residual contamination associated with leakage from, and removal of, components of former Wastewater Treatment Plant	3
TA-35 Pratt Canyon	35-003(d)-00	Areas of residual contamination associated with discharge from former Wastewater Treatment Plant	3
TA-49 MDA AB	49-001(a)-00	Shaft areas associated with historical subcritical experiments involving nuclear materials	2
TA-50 MDA C	50-009	Complex of pits and shafts used for disposal of combustible and noncombustible debris and sludge-filled drums	2
TA-53 Resin Tank	53-006(b)-99	Subsurface tank that received contaminated ion exchange resins from an accelerator facility	2
TA-54 MDA H	54-004	Shafts formerly used for disposal of classified waste	3

PRS = potential release site, TA = technical area, MDA = material disposal area.
[a] An additional site is outside the LANL boundary in Bayo Canyon.
Source: LANL 2004l.

General Maintenance. Activities may include mowing, debris clearing, foliage removal, and fence repair. Tasks such as mowing, clearing brush, removing debris, and removing small trees are performed to maintain site surface characteristics and to limit combustible materials. Equipment used includes miscellaneous hand tools and cutters, chain saws, tractors with fixed or adjustable cutting attachments, weed-line or blade trimmers, push mowers, tractors with fixed or adjustable (hydraulic) mower decks, and trucks and transport vehicles, including cherry picker hydraulic lifts. Repairing existing fences involves minor site preparation, such as light scraping and removal of vegetation. Small hand- and power tools may be used.

Boundary Marking. The disposal units that comprise the inventory driving the nuclear facility categorization are being demarcated. Activities may include general surveying, placement of posts, and placement of temporary barriers such as orange construction fencing. General surveying is usually conducted by a surveyor and assistant. Some surveying equipment (for example, tripods, survey rods) slightly intrudes into the subsurface to provide a firm base for instruments. The depth of penetration in typical soils is less than 3 inches (7.6 centimeters). Personnel use pin flags, flagging, and wooden or metal stakes to mark locations and may pound stakes 1 foot (0.3 meter) or deeper into the subsurface. General surveying may require the installation of permanent benchmarks using hand- or battery-operated rock drills to make small holes in bedrock and cementing the benchmarks in the drilled holes. To provide a clean line of sight for instrument readings, personnel may use small saws, axes, or clippers to clear brush and thin branches in areas of vegetation.

Baseline Radiological Survey. Baseline radiological surveys are being performed at several sites. The goal of a baseline survey is to establish surface radiological conditions at a specific point in time. If future inspections indicate significant physical changes such as biodegradation, erosion, or burrowing animals, the impacts of these changes can be evaluated by performing radiological surveys in the areas of changed condition. Survey equipment includes a wide array of devices that are generally small, handheld, and self-contained. To conduct a survey, personnel may require access to radioactive storage areas; waste lagoons; areas downwind of stack release points or exhaust vents; areas near storm, septic, sanitary, or drainage systems; and areas where runoff may collect. These areas may be within or outside of nuclear environmental site boundaries. Survey personnel may work in areas of dense vegetation or rough terrain and along parking lots and roadways near traffic. Survey instruments may be mounted on all-terrain vehicles.

Erosion Control Studies and Maintenance. Erosion control measures may include installation and maintenance of check dams, straw wattles, or surface basecoarse or earthen berms.

New Fencing. New fence construction can include digging holes, placing concrete, setting posts, and using a “come along” or other light equipment to stretch fencing. Personnel performing these tasks may use trucks and transport vehicles with mounted hydraulic lifts and pole drivers to install posts and lift materials; vehicle-mounted, power, or manual augers to excavate post holes; hand tools to support post and fence placement; cutting torches to cut fencing or signage materials; radiological and industrial-hygiene survey equipment; oxy-acetylene or arc welding units; or electric or pneumatic cutting drills and saws.

I.3.3 Remediation of Material Disposal Areas

The MDAs contain a variety of radionuclides or hazardous constituents within wastes that have been disposed of in pits, trenches, and shafts. To evaluate alternative corrective measures, potential corrective measure technologies would be screened to eliminate those that prove infeasible to implement, rely on technologies unlikely to perform satisfactorily or reliably, or do not achieve corrective action objectives within a reasonable time. Conceptual models would be established and the likely performance of the MDAs would be evaluated against the corrective measure objectives established for the corrective measure process.

The purpose of this section is not to preclude this screening process, but to identify a range of corrective measure technologies that might be suitable. At any MDA, a number of corrective measure technologies may be used. For example, portions of MDAs may be removed and portions may be stabilized in place. Some MDAs may require treatment of volatile organic compound plumes.

I.3.3.1 Corrective Measure Technologies Possibly Suitable for Material Disposal Areas

Corrective measure technologies continue to be developed, for example as part of DOE’s Environmental Remediation Science Program. One information source of environmental remediation technologies is the Federal Remediation Technologies Roundtables Remediation Technologies Screening Matrix and Reference Guide (FRTR 2005). Each of the MDAs presents a unique mix of challenges for remediation. Nonetheless, possible treatment technologies can be grouped as follows:

- *Stabilization in place* – containment and in situ treatment technologies
- *Removal* – excavation/removal and ex situ treatment technologies

I.3.3.1.1 Possible Containment and in Situ Treatment Technologies Associated with the Stabilization in Place Option

Contamination would be treated in situ or contained in place by installing a final cover. Possible technologies are listed in **Table I–28.**

Table I–28 Possible Technologies for Containment and in Situ Treatment

Category	***Subcategory***	***Technology***
Containment	Vertical barriers	Slurry walls
		Rock-grout mixing
		Synthetic membrane
	Deep-surface horizontal barriers	Deep-surface horizontal barriers
	Near-surface horizontal barriers	Soil-grout mix
		Vitrification
	Surface barriers	Asphalt cover
		Compacted clay cover
		Multilayer cover
		Evapotranspiration cover
		Biotic barriers
In Situ Treatment	Biological treatment methods	Microorganisms
	Physical treatment methods	Soil gas venting
		Soil vapor extraction
		Pneumatic fracturing
		Electrokinetic soil treatment
		Vitrification
		Compaction with conventional equipment
		Dynamic compaction
		Waste stabilization
		Thermal treatment

Vertical Barriers

Vertical (lateral) barriers could be installed around the perimeters of the disposal units, including:

- *Slurry walls*. A slurry wall is formed by placing cement grout or similar materials into narrow, deep trenches or in a series of adjacent open boreholes surrounding the perimeter of a group of disposal units.

- *Rock-grout mixing*. Rock-grout barriers are formed by drilling adjacent deep shafts around the perimeter of a group of disposal units and then mixing the cut rock with injected grout as the shaft is drilled.

- *Synthetic membrane*. A geosynthetic liner or similar membrane can be placed in a vertical trench, thereby forming a barrier that impedes or restricts the lateral movement of contaminants.

These barriers are principally meant to prevent lateral movement of contaminants from disposal units. Assuming that vertical barriers were combined with an effective cap, the two technologies would act essentially as an upside-down box over the waste. This would reduce the potential for human or bio-intrusion.

Vertical barriers were considered as stabilization alternatives for the nine waste disposal shafts at MDA H. Under one alternative, a vertical sidewall barrier would be constructed at a predetermined depth and width around the entire perimeter of MDA H. Concrete caps would be placed above the shafts and the surface covered with an evapotranspiration cover. Under a second alternative, which was selected as a partial corrective remedy by NMED (NMED 2007a), interlocking boreholes filled with grout would surround each of the 6-foot shafts. A concrete cap would be installed (DOE 2004b). A third alternative was the deep-surface horizontal barrier discussed below.

Deep-Surface Horizontal Barrier

A horizontal barrier could be installed underneath disposed waste to reduce the downward aqueous-phase movement of contaminants. Such a barrier was selected by NMED for encapsulation of the nine disposal shafts at MDA H (LANL 2003b, NMED 2007a). A wall would be constructed around each disposal shaft by drilling interlocking shafts around each disposal shaft that would be filled with cement slurry. At the bottom of each disposal shaft a bottom seal would be constructed using a three-fluid (“Kajima”) system. An injector assembly would be lowered to the bottom of one or more shafts. As the injector assembly rotated, it would direct high-energy jets of water against the tuff. An air jet producing an aureole of compressed air concentric about the jet would augment the effectiveness of the water jet. At the same time, cement grout would be injected into the void and the surrounding soil through a second nozzle. A mixing radius of over 6 feet (1.8 meters) can be achieved (LANL 2003b).

The Kajima system may not be effective for all disposal units considered in this appendix. Most MDAs are much larger than MDA H, comprising pits and trenches covering large surface areas in addition to shafts.

Near-Surface Horizontal Barrier

These technologies provide horizontal barriers above disposed waste to reduce vertical infiltration of water into waste and to reduce the potential for intrusion by plants, animals, or humans. Technologies include a soil-grout mixture and vitrification:

- *Soil-grout mix*. A soil-grout mixture would be emplaced over the tops of the disposal units. The mixture could range in thickness up to several feet. After the mixture hardens, it would restrict infiltration or intrusion.

- *Vitrification*. Electrical resistance would heat several feet of soil above disposed waste to temperatures high enough to melt the soil. This melted area would cover the entire surface of a disposal unit.[34] When the melted soil or rock cools, a glasslike mixture would cover the tops of the disposal units. The glass mixture would be theoretically impenetratable against water infiltration and biological intrusion.

A soil-grout mix may be more generally suitable to the MDAs considered in this appendix. Vitrification would subject the top layers of waste within the MDAs to high levels of heat, possibly causing unsafe reactions.

Surface Barriers

These technologies comprise barriers placed over the tops of disposal units to restrict infiltration of water, erosion, or biointrusion. Possible barriers may include asphalt covers, compacted clay covers, multiple-layer covers, evapotranspiration covers, and biotic barriers.

Asphalt covers. A layer of asphalt would be placed over the tops of the disposal units. Asphalt layers have been placed over portions of disposal units at MDA AB (Area 2), MDA L, and MDA B. Investigations at Area 2 of MDA AB have shown that moisture has been trapped beneath its asphalt layer. Absent the asphalt, the moisture may have evapotranspired. Also, if portions of the asphalt collapse from settling or subsidence of the underlying waste and backfill, the holes produced in the asphalt can act as a funnel for infiltration.[35]

Compacted clay cover. A 1- to 3-foot (0.3- to 0.9-meter) layer of compacted clay would be placed over the tops of disposal units. Because clay, when effective, has a very low permeability and therefore resists water infiltration, a clay cap has been recommended or used at numerous waste disposal sites. But in arid and semiarid environments the clay can dry and crack, leading to comparatively large rates of infiltration through the cracks. And to the extent that the underlying waste and soil is structurally unstable, leading to subsidence and differential settling, the barrier provided by the compacted clay may be disrupted.

Multiple-layer cover. Multiple-layer covers consist of layers of different geologic and synthetic materials. They have been proposed for several radioactive waste disposal sites and are being used at RCRA landfills. The Corrective Measures Study Report for MDA H cites cases where multiple-layer covers at RCRA landfills were damaged through settlement that compromised the continuity of the cover's discrete layers. The clay layer at the bottom of a differentially settled area at a landfill may be breached. Also, a geomembrane may tear if enough settlement occurs. The drainage layer above the barrier layer can funnel moisture to the low area where infiltration occurs at the breached portions of the clay layer (LANL 2003b).

Evapotranspiration cover. Evapotranspiration covers are designed to enhance soil water storage capacity by retaining infiltrated water until it can be evaporated by solar radiation and transpired by shallow-rooted plants. Two types of evapotranspiration covers have been investigated: monolithic evapotranspiration covers and evapotranspiration covers having capillary barriers. Monolithic evapotranspiration covers consist of a single, vegetated soil layer having a site-specific mix of soil texture, soil thickness, and vegetation. Evapotranspiration covers having

[34] *See the In Situ Physical Treatment section for a brief discussion on applying vitrification to waste in an entire disposal unit. In this case, vitrification is used for long-term waste stabilization.*
[35] *The asphalt layer at MDA AB was removed in 1999 and an evapotranspiration cap installed (LANL 1999a).*

capillary barriers include an interface between an upper fine-textured soil and lower coarse-textured material.[36] The capillary barriers are placed below the water storage zone to provide additional protection against downward water flow (INEEL 2000).

Unlike clay covers, evapotranspiration covers do not rely on low hydraulic conductivity. Mechanisms that increase the hydraulic conductivity of evapotranspiration covers (that is, drying out) do not significantly affect their performance. Hence, evapotranspiration covers—particularly monolithic covers—may be less susceptible to loss of function from subsidence and differential settlement than either a compacted clay cap or a multiple-layer cap. Evapotranspiration caps have been developed explicitly for landfills in arid and semiarid environments. Case studies addressing the use of evapotranspiration caps at landfills covering a range of climatic conditions have been summarized in a technology overview by the Interstate Technology and Regulatory Council (ITRC 2003a). Research has been ongoing about use of evapotranspiration caps at LANL disposal units since the early 1980s (Breshears, Nyhan, and Davenport 2005; Nyhan 2005).

Biotic barriers. These barriers control the intrusion of plants or animals into disposal units. One approach would be to place layers of hard, long-lasting natural materials such as cobble-sized rocks or pea gravel. These barriers discourage penetration by burrowing animals and, depending on design, can potentially discourage penetration by deep-rooting plants.

Research has been performed on burial of herbicides (or other plant poisons) within discharge units at depths below those associated with desirable types of local, shallow-rooted plants. Plants having roots that grow into the herbicide layer are killed. The efficacy of this technology is limited to the secretion period of the discharge units.

At MDA AB, chain-link fencing has been placed on the surface of a disposal cover. Although vegetation readily grows through the fencing, intrusion by burrowing animals is discouraged (LANL 1999b).

In Situ Biological Treatment

These technologies use processes that feed on organic material. The technologies have been effective in treating low-level concentrations of radionuclides in wastewater, but have not been demonstrated at radioactive waste disposal sites (LANL 2003b).

In Situ Physical Treatment

Several technologies may help remediate or physically stabilize waste disposal sites, including those described below.

Soil gas venting. Boreholes are drilled into the soil and left open, allowing release of subsurface vapors and gases to the atmosphere or a treatment system. Soil gas venting may be used to

[36] Under unsaturated conditions, water in the small pores of the fine-textured soil is held at high tension and will not flow into the large pores of the coarse-textured soil where the water tension is low. For the water to flow out of the soil and into the coarse-textured material, it must be at sufficiently low tension. Tension decreases as the soil approaches saturation. Once breakthrough occurs, water will drain into the coarse material at a rate largely controlled by the hydraulic conductivity of the overlying soil (INEEL 2000).

remove an underground source of volatile organic compounds or to reduce volatile organic migration. It is less effective when volatile organic compound concentrations are in the parts-per-billion range. It has been postulated for release of tritium in a gaseous or vapor form (LANL 2003b).

Soil vapor extraction. A force is applied to underground gases or vapors to accelerate their removal from soil. Forces have included: (1) air pressure injected into one or more wells; (2) a vacuum pulling the gas or vapor from one or more wells; or (3) a steep diffusion force that removes gas or vapor from an area. The extracted gas or vapor may be directed to a treatment system. The technology is less effective for volatile organic compounds when volatile organic compound concentrations are in the parts-per-billion range (LANL 2003b).

Pneumatic fracturing. A fluid is injected at high pressure to create open fractures in an area where a contaminant plume exists. The opened flow paths allow access to the contaminated media for removal or treatment. The technology injects large amounts of water, which may accelerate contaminant movement. If the contaminant includes explosives, the technology might promote their detonation (LANL 2003b).

Electrokinetic soil treatment. This technology continuously removes ionic or charged species from soils. A low-intensity direct current is produced between ceramic electrodes that are divided into a cathode array and an anode array. Charged species are mobilized toward the electrodes. Metal ions, ammonium ions, and positively charged organic compounds move toward the cathode. Chlorides, cyanides, fluorides, nitrates, negatively charged organic compounds, and other anions move toward the anode. Contaminants that migrate toward the polarized electrodes may be removed. If the contaminant includes explosives, the technology may promote their detonation. Effectiveness is reduced for waste having a moisture content smaller than 10 percent (LANL 2003b, FRTR 2005).

Vitrification. In situ vitrification uses an electric current to melt soil or waste at temperatures from 2,900 to 3,650 degrees F (1,600 to 2,000 degrees C). Most inorganics are immobilized within the vitrified glass and crystalline mass, and most organics are destroyed by pyrolysis. Water vapor and organic combustion products are captured and drawn into a treatment system. Vitrification leaves a chemically stable, leach-resistant crystalline material similar to obsidian or basalt (FRTR 2005). In situ vitrification has been demonstrated at LANL by treating a small portion of one absorption bed at MDA V (LANL 2003e, 2004j).

Compaction with conventional equipment. Decreased infiltration and percolation through a disposal unit cover (by reducing porosity and thus permeability) can be achieved using commercially available equipment. Equipment may include sheepsfoot rollers, rubbertire rollers, smoothwheel rollers, vibrating baseplate compactors, and crawler tractors. Soil to be compacted would be applied in 6- to 12-inch (15- to 30-centimeter) lifts and several passes made to compact each lift to the desired density. The depth of compaction can range from 0 to 6 feet (0 to 1.8 meters) (NRC 1981).

Dynamic compaction. This technology compacts and consolidates waste in place. It may greatly reduce settling and subsidence over time. It has potential use at pits and trenches where the surface area is large relative to the disposal unit depth. A heavy weight is raised above a disposal unit and dropped, compressing the area underneath the weight. The weight is lifted, moved to cover an adjoining area of the disposal unit, and dropped. This process is continued until all the area over the disposal unit is compressed. The voids created by the process are backfilled and compacted. The technology has drawbacks: for maximum effectiveness, compaction should extend to the bottom of the disposal units. If the compactor breaks through the cover placed over the waste, contamination may be ejected. (Significant ejection of material might be avoided by making repeated compacting runs over the same area, each time filling in voids after each compacting effort.) The physical shock may destroy the integrity of any buried waste container. It may drive moisture from the disposal unit into the surrounding soil matrix (NRC 1981).

Waste stabilization. Wastes can be stabilized using a lance to inject a grout mixture (or similar) into the waste zone. The process to be employed, and the grout formulation, would be developed through a test program. The grout could be mixed at a conveniently sited batch plant, delivered to the work site by truck, and fed into pumps that deliver the grout to an injection lance using high-pressure lines. The injection lance would be driven into the waste using technology such as a rotary percussion drill to the maximum depth of the waste, or until refusal. As grout is forced out of jet nozzles located in the tip of the lance, the lance is rotated as it is withdrawn. After the lance is retracted, it is decontaminated and moved to the next location. Care is needed to minimize the return of grout to the surface. Another concern is ground heaving. Properly performed, the technique can increase the density of the disposed waste without any increase in waste volume. In addition to waste stabilization, the technique reduces the permeability of the waste, and provides encapsulation and chemical buffering (INEEL 2002c).

In situ grouting has been analyzed and tested at several DOE sites as summarized in an Idaho National Laboratory report (INEEL 2002c). Grout consisting of Portland cement, epoxy, hematite grout, paraffin grout, and other proprietary formulations have been investigated or considered (INEEL 2002c). In situ grouting is an option for stabilization of the trenches, pits, and shafts at the Idaho National Laboratory surface disposal area (INEEL 2002a). A variation was considered for encapsulation of the LANL MDA H shafts (DOE 2004b).

Thermal treatment. Several techniques have been developed to decompose heat-sensitive contaminants into less-toxic or less-mobile forms. These techniques can be used to heat a contaminant into a vapor phase, and in so doing, enhance its extractability. Heat may be generated using microwave, radiofrequency, thermal radiation, or other methods. But if the contaminants include reactive or explosive materials, this technology might promote undesirable chemical reactions (LANL 2003b).

I.3.3.1.2 Possible Removal, Ex Situ Treatment, and Disposal Technologies

A decision to remove waste or contaminated soil results in an interlinked series of operations:

- Excavation;
- Material characterization;
- Material classification;
- Treatment and packaging; and
- Storage or disposal of the material.

The first three operations are addressed in Section I.3.3.1.2.1; the last two are addressed in Section I.3.3.1.2.2. Some case studies are summarized in Section I.3.3.1.2.3.

I.3.3.1.2.1 Removal Technologies and Operations

Removal activities must be conducted in a manner that ensures worker and public safety, minimizes the spread of contamination, and minimizes possible negative effects on biological, cultural, and operational resources. Typical removal activities are listed in **Table I–29.**

Table I–29 Typical Removal Activities

Activity	*Typical Subactivities*
Planning	Engineering and operations Material disposition Safety assessments and plans Biological and cultural assessments and resource protection plans Stormwater pollution prevention plans Best management practices for erosion control NEPA reviews Readiness reviews
Permits and authorizations	National Pollutant Discharge Elimination System General Permit Regulatory corrective action approval NEPA documentation Safety authorization Other authorization
Preliminary work	Site preparation (establish roads and equipment; material; and waste storage, handling, and decontamination areas and reroute utilities) Remove buried pipes or lines or overheads (ensure utilities, if needed) Establish environmental and safety monitoring networks Perform tests and further develop equipment and procedures (test excavations, etc.) Perform surface and subsurface tests and sample collections to determine the extent of contamination
Operations	Excavation Contamination control Sorting Media characterization Material characterization Material classification Packaging for transport Safety and environmental monitoring
Finish work	Backfilling Final cover, if needed Cleanup and remediation
Closeout	Final sampling and monitoring Regulatory approval

NEPA = National Environmental Policy Act.

After the planning, authorization, and site preparation phases are completed, excavation would commence and continue until the operational objectives are met. Overburden over the contaminated material, or uncontaminated material excavated near the contaminated material, would be stockpiled for return to the excavation when contamination removal is completed.

Removal operations can be differentiated into:

- *Standard removals*: Those that can be safely and relatively quickly conducted using standard construction equipment

- *Specialized removals*: Those requiring more extensive planning and effort and use of specialized procedures and equipment

Standard, usually small-scale, removals have taken place at several DOE sites. Procedures for radiation and industrial safety, contamination control, waste characterization, and classification are well established. Waste equipment commonly used for such removals is listed in **Table I–30** (INEEL 2002b).

Table I–30 Equipment Commonly Used for Standard Removals

Equipment	*Description*	*Comments*
Backhoe	Tracked or wheeled excavators used for digging small areas, having a typical bucket size of 2 cubic yards (1.5 cubic meters). Auxiliary equipment can include clamshell buckets, drum grapplers, dippers, loader buckets, and hammers.	Useful for trench digging and area excavation up to 45 feet (13.7 meters) deep. Linear reach less than 100 feet (30 meters).
Front-end loader	Tracked or wheeled excavators capable of digging, lifting, dumping, and hauling. Bucket size is up to 20 cubic yards (15 cubic meters).	Useful for excavating large areas having short travel distance needs (< roughly 300 feet [91 meters]).
Bulldozers	Tracked vehicle having a blade or bucket for surface work.	Useful for removing surface layers, clearing surface debris, and general earthmoving. Less useful for retrieval of buried waste.
Trencher	Wheeled excavator capable of excavating and grading. Commonly called a ditch witch, it can use auxiliary equipment such as a backhoe, backfill blade, or an auger.	Useful for small-scale digging.
Vacuum/soft trencher	Vacuum removes soil without disturbing large debris. Can use jetted air to loosen soil before vacuum removal.	Potentially useful for loose soil removal at dig face. Not useful for retrieving buried waste.
Soil skimmer	Removes thin layers of soil in a controlled manner.	
Skid-steer loader	Small excavator similar to a front-end loader. Often called a Bobcat.	

Source: INEEL 2002b.

Specialized removals require more extensive planning and effort and use of specialized procedures and equipment such as remote-control excavators or excavators designed to protect the operators from external radiation or airborne contamination hazards. An Idaho National Laboratory report (INEEL 2002b) provides 13 case histories of demonstrations where (mainly) DOE sites have: (1) used remote excavators and end-effectors; (2) modified standard equipment so a person in a sealed environment could operate the equipment; and (3) faced conditions similar to those at the Idaho National Laboratory subsurface disposal area. Another reference surveys commercially available remote-control machines for excavation and recovery of buried ordnance (LLNL 2002). Appendix G of the Sandia Mixed Waste Landfill Corrective Measures Study Final Report reviewed excavation of a portion of the landfill using robotics (SNL 2004). Examples of specialized excavators and ancillary equipment are listed in **Table I–31** (INEEL 2002b).

Example measures for controlling contamination during excavation are listed in **Table I–32** (adapted from INEEL 2002b).

Table I–31 Examples of Specialized Excavators and Other Equipment

Equipment	***Comments***
Remote Excavators	
Brokk	Remote controlled excavator with a telescoping arm. Available with several end-effectors for hammering, cutting, and scooping wastes. The largest BROKK can reach about 13 feet (4 meters) below ground surface (bgs). Used at Hanford for retrieval of high-dose debris and at Idaho National Laboratory for demolition.
Kiebler Thompson	Remote-controlled excavator with a telescopic boom capable of three-dimensional movement. Available with several end-effectors. The largest machine can reach about 16 feet (5 meters) below ground surface. Similar to the Brokk.
T-Rex	A tele-operated, heavy-lift, long-reach excavator used to retrieve boxes, drums, and containers using a front-shovel excavator. Controls can be operated up to 1,250 feet (381 meters) away. Developed at Idaho National Laboratory.
HERMES	A tracked computer controlled excavator with a hydraulic manipulator. The system (Hybrid Remote Robotic Manipulation and Excavation System [HERMES]) was developed by Boissiere Engineering and Applied Robotics (BEAR), Inc., and used for exhuming LANL's MDA P.
Modified Standard Equipment	
Sealed, pressurized cabins	Standard construction equipment with cabin modifications. Can supply air to the operator either using filtered air intakes or externally supplied air. Possibly useful for environments where the inhalation hazard is high.
Shielded cabins	Standard construction equipment with cabin modifications. The walls and cabin windshield would be shielded for use in high external radiation environments.
Remote Cranes	
Cooperative Telerobotics Retrieval System	System consists of a 80-foot-wide (24-meter-wide) girder, two trolley assemblies with vertically telescoping masts, two manipulators, and a 5-ton (4.5 metric ton) remotely operated hoist. Presently at Idaho National Laboratory.
RoboCrane	Cable-driven platform for a parallel link manipulator. Provides load control via teleoperative, graphic offline programming, and hybrid control modes.
Remote End-Effectors	
Safe excavation	High-pressure probe dislodges compacted and other hardened materials using air-jet/vacuum end-effecter system. Vacuums up soil.
Tentacle, highly manipulative	Teleoperated manipulator and bellows actuator. Used with a crane and manipulator. Load capabilities less than 4,000 pounds (1,814 kilograms).
Schilling Tital II	Manipulators deployed by crane for selective retrieval of barrels from soil. Basic components include hydraulic system, positioning system, electronics module, and mechanical interface.
Confined sluicing end-effector	Water jet designed for waste tank cleanout. Uses high-pressure water jets to cut material into small pieces and evacuates with a vacuum jet pump. Captures slurry water. Creates additional waste.
Innovative end-effector	Consists of a thumb, an attachable integrated transfer module, and a shovel assembly. Capable of soil retrieval and dust-free waste dumping.

MDA = material disposal area.
Source: INEEL 2002b.

In situ soil remaining after excavation must be characterized to determine whether it is sufficiently contaminated to warrant removal. Screening levels would be determined for the removal based on expectations about the future use of the site and upon established health, safety, or environmental protection criteria. Soils that do not exceed the screening levels would be left in place. Characterization techniques to be used, and their implications on operations, will depend on the contaminant under consideration; its in situ concentration; and operational or environmental factors.

Table I–32 Example Contamination Control Options

Options	Description
Confinement	Confinement structures made from plastic, metal, or other materials can enclose a piece of equipment, a work area, or a site and thereby prevent the spread of airborne contaminants. Enclosures used at a site or work area have ranged from lightweight, portable units to substantial structures.
Ventilation and vacuum systems	These systems use laminar airflow at a dig-face within enclosures to direct dust to filters. Vacuums remove loose particulates from equipment and structures and collect dust and debris.
Foams, sprays, misters, fixatives, and washes	These options can be used to control odors, volatile organic compounds, dust, and other emissions; create a barrier between work surfaces and the atmosphere; settle loose airborne contamination; and decontaminate personnel and equipment.
Electrostatics	Electrically charged plastic and electrostatic curtains form barrier walls against spread of contamination from enclosed areas. Curtains can be used upstream of emission filtering systems to neutralize charged dust particles.
In situ stabilization	Used before excavation to fix contamination into the soil and waste matrix and thereby minimize its dispersion into the air or surface water. Processes include injection of grout, resin, or polymer; vitrification; or ground-freezing.

Source: INEEL 2002a.

Excavated material must be similarly characterized in terms of its radionuclide or hazardous content to enable decisions about its further disposition. Soil or other materials that do not exceed screening levels may be recycled, disposed of as solid waste, or used as backfill. Contaminated material can be considered waste or decontaminated, if feasible and cost effective, and the decontaminated material reused, recycled, or disposed of.

Requirements for the subsequent disposition of the waste depend on the waste's classification. Wastes containing RCRA hazardous constituents must be treated according to regulatory-prescribed methods. DOE classifies wastes containing radionuclides as low-level radioactive waste if the concentrations of alpha-emitting transuranic isotopes (having half-lives exceeding 20 years) do not exceed 100 nanocuries per gram of waste.

As site preparation and excavation proceeds, site survey and monitoring programs would be conducted to ensure worker health and safety and to detect movement of radioactive or hazardous constituents from the work area to the environment.

After removal is complete, the site must be restored. An excavation at an MDA would be backfilled with soil, compacted, and revegetated. There would be an investigative effort to confirm that the corrective action objectives of the removal had been achieved. Appropriate after-action reports would be prepared for submittal and approval.

I.3.3.1.2.2 Treatment and Disposal Options

Following removal, wastes may require treatment and perhaps specialized packaging before their further disposition. Treatment options for wastes containing RCRA hazardous constituents include (LANL 2003b):

- *Neutralization*. Reactive materials can often be neutralized. Acids can be neutralized using bases and vice versa. Lithium compounds can be neutralized through reaction with water.

- *Thermal treatment*. Burning to destroy the explosive compounds can treat HE. This technology has long been used at LANL.

- *Cement stabilization*. Some materials may require stabilization before disposal as hazardous or mixed waste. This technology has long been used.

- *Debris treatment*. Treatment standards for materials meeting the RCRA definition of debris are specified in 40 CFR 268.45 and New Mexico Administrative Code 20.4.1.800. Microencapsulation is authorized for treating lead or lead-containing debris.

Some of the wastes possibly recovered from MDAs may be compressed gas cylinders.[37] Gas cylinders may present a physical hazard if they are recovered still pressurized and a chemical hazard depending on the gases contained within the cylinders. Gases in recovered cylinders may be toxic or reactive. Gases may be caustic or acidic, for example, or unstable. For example, hydrogen cyanide and ethylene oxide can undergo exothermic polymerization, while gases such as hydrogen bromide can react with moisture. Pyrophoric liquids may be stored in nonpressurized gas cylinders.

Recovered cylinders may be safely opened and the contents either recovered or treated. Basically, the recovered cylinder is placed within an explosion-resistant pressure vessel configured with various cutting tools and perhaps an inert-gas environment. (Recovered cylinders can be transported to a treatment facility external to the excavation using overpacks designed to contain the contents of the cylinder if it leaks or fails during transport.) Once the container contents are released within the pressure vessel, the gases or liquids may be transferred to appropriate external reactors or collection tanks. Gases, for example, can be transferred to wet scrubbers for neutralization. Systems are also available to treat cylinders containing biological or chemical weapon material (IES 2005).

Treatment of waste contaminated with high explosives would take place at LANL. Treatment of other RCRA hazardous wastes could take place either at LANL, if treatment capacity exists, or at an offsite location. Radioactive waste would be treated to meet the waste acceptance criteria for the facility receiving the waste.

Onsite Disposal Capacity

Onsite solid waste capacity. Solid waste currently generated by LANL's environmental restoration project is typically sent to an offsite solid waste landfill. However, a municipal solid waste landfill (to be closed) does exist within the LANL boundary (see Section I.4.9).

Onsite low-level radioactive waste capacity. The only operating low-level radioactive waste disposal facility at LANL is at Area G in TA-54. Because of the impending lack of capacity in existing disposal units, and because LANL personnel must complete remediation at MDA G by the end of 2015, LANL is expanding low-level radioactive waste disposal operations into Zone 4 and Zone 6 in TA-54 (see Section I.4.9).

---

[37] *Because LANL's mission during the period when compressed gas cylinders could have been disposed of was oriented much more to research and development than production of nuclear materials, pressurized containers possibly disposed of in LANL MDAs were probably lecture-size bottles containing no more than 1 pound as a pressurized liquid.*

Offsite Treatment and Disposal Capacity

Offsite treatment and disposal capacity exists for solid waste, hazardous waste, low-level, and mixed low-level radioactive wastes, and transuranic waste. Examples are described below.

Solid waste capacity. The Solid Waste in New Mexico, 2000 Annual Report lists 50 active solid waste landfills, including 3 landfills that accept construction and demolition wastes (NMED 2000).

Hazardous waste capacity. The 2006 U.S. Army Corps of Engineers *Report on Treatment, Storage & Disposal Facilities (TSDF) for Hazardous, Toxic, and Radioactive Waste* provides information about eighteen facilities currently engaged in commercial disposal of RCRA Subtitle C hazardous waste (ACE 2006). Five of these facilities hold a Toxic Substances Control Act permit for disposal of PCB-contaminated materials. Information about six hazardous waste sites near LANL is provided in **Table I–33**.

Table I–33 Selected Hazardous Waste Operations Near Los Alamos National Laboratory

Operator and Location	*Hazardous Waste Operations* [a]	*Waste Groups Accepted* [a]
Clean Harbors Westmorland, LLC Westmorland, CA	Treatment of heavy metals and other wastes; micro-encapsulation; solidification; waste landfill; processing of bulk or drummed wastes; storage before treatment or disposal.	RCRA hazardous waste; naturally occurring radioactive material waste from geothermal operations; Animal and Plant Health Inspection Service soils; and California-regulated wastes.
Clean Harbors Dear Trail, LLC Dear Trail, CO	TSD. Analytical capacity for TCLP, cyanide, alkaline chlorination; chemical reduction; stabilization or solidification; deactivation and neutralization; micro-encapsulation; landfill.	Contaminated process wastewaters; inorganic cleaning solutions; organic and inorganic laboratory chemicals; paint residues; debris from toxic or reactive chemical cleanups; off-spec commercial products.
U.S. Ecology Nevada, Inc. Beatty, NV	Chemical oxidation; stabilization; thermal; micro- and macro-encapsulation.	RCRA hazardous wastes, debris, and solid waste greater than 500 parts per million VOCs; PCBs; non-hazardous solid industrial, commercial, and agricultural chemical wastes; liquids for solidification; bulk or drummed solid waste; household hazardous waste; lab packs; State-regulated hazardous wastes; waste from conditionally-exempt small quantity generators; corrosive wastes and acids; asbestos or asbestos-RCRA debris.
Clean Harbors Lone Mountain, LLC Waynoka, OK	Waste treatment and storage; RCRA hazardous landfill operations; waste water treatment; rail transfer operations.	PCB soil and debris; non-hazardous soil; hazardous soil for direct landfill; hazardous soil for treatment of metals and organics on a case basis; debris for micro- or macro-encapsulation; plating waste; acidic waste; caustic waste; cyanide and sulfide bearing waste; and hazardous and nonhazardous liquids.
Waste Control Specialists Andrews, TX	TSD. Chemical oxidation or reduction; deactivation; macro-encapsulation; neutralization; stabilization; controlled reaction; amalgamation. Can dispose of treated soil. Can shred debris or treat VOC waste; aqueous waste; soil; dioxin, inorganic and organic sludges and solids; paint sludges; PCBs; pesticides; reactive material; solvents; TCLP metals; acids; caustics; oil.	Accepts >2,000 RCRA waste codes and TSCA materials. Most accepted radioactive waste is not disposed of. Can dispose of some exempt radioactive wastes, including some source material; some material containing thorium; some NORM; some materials containing rare earths; depleted uranium used for shielding; and materials exempt from licensing under Texas regulation.

Operator and Location	Hazardous Waste Operations [a]	Waste Groups Accepted [a]
Clean Harbors Grassy Mountain, LLC Salt Lake City, UT	Truck and rail logistics; drain and flush for PCB transformers; solidification & stabilization; repackaging.	PCBs; non-hazardous soils and other nonhazardous industrial wastes; asbestos wastes; hazardous waste for treatment of metals; plating wastes; acidic wastes; caustic wastes; hazardous debris; and non-PCB liquid wastes for solidification and landfill.

TSD = treatment, storage, and disposal; RCRA = Resource Conservation and Recovery Act; TCLP = toxicity characteristic leaching procedure; VOCs = volatile organic compounds; PCB = polychlorinated biphenyl; TSCA = Toxic Substances Control Act; SNM = special nuclear material; CFR = *Code of Federal Regulations*.
[a] The listed information is a summary. Consult hazardous waste operators for specific information about operations, waste groups accepted, and restrictions.
Source: ACE 2006.

Low-level and mixed low-level radioactive waste capacity. Offsite treatment and disposal capacity exists for commercial and DOE disposal of low-level radioactive waste and mixed low-level radioactive waste. Some of the treatment and disposal options that may be considered may include the Chem-Nuclear[38] low-level radioactive waste disposal facility near Barnwell, South Carolina; the U.S. Ecology low-level radioactive waste disposal facility on the Hanford Reservation; the EnergySolutions disposal facility near Clive, Utah; the Waste Control Specialists Facility near Andrews, Texas; and DOE's Nevada Test Site.

Neither the Chem-Nuclear nor the U.S. Ecology facility accepts mixed low-level radioactive waste for treatment or disposal, and both limit (or shortly will limit) the quantities of wastes that may be accepted. After FY 2008, only waste generated by members of the Atlantic Interstate Low-Level Radioactive Waste Compact may be accepted.[39] The U.S. Ecology facility accepts waste only from the eight states composing the Northwest Interstate Compact and from the three members of the Rocky Mountain Compact. Although New Mexico is a member of the Rocky Mountain Compact, waste from DOE generators is not encouraged (WSDOE 2005).

The EnergySolutions disposal facility near Clive, Utah, accepts Class A[40] low-level and mixed low-level radioactive wastes. The facility accepts bulk and containerized materials, and mixed waste for treatment by stabilization, oxidation-reduction, deactivation, chemical fixation, neutralization, and macro- and micro-encapsulation. The wastes managed at the disposal facility may not have an external contact dose rate equal to or exceeding 200 millirem per hour on a manifested container; 500 millirem per year on external, accessible surfaces of individual wastes within a container; or 80 millirem per hour for containers of resin (EnergySolutions 2006).

The Waste Control Specialists Facility near Andrews, Texas, accepts low-level and mixed low-level radioactive wastes for treatment. Low-level radioactive waste disposal is not yet authorized. Treated waste is either returned to the generator or sent to another site for disposal. RCRA hazardous wastes may be disposed of (WCS 2002).

---

[38] Chem-Nuclear, LLC, is a wholly owned subsidiary of Duratek, Inc., which merged in 2006 with other companies to form EnergySolutions, LLC.
[39] South Carolina Code of Laws, Title 48, Chapter 46, Atlantic Interstate Low-Level Radioactive Compact Implementation Act.
[40] The NRC system in 10 CFR 61.55 for classifying low-level radioactive waste is based on two tables listing waste class concentration limits for short- and long-lived radionuclides. For example, low-level radioactive waste containing alpha-emitting transuranic isotopes having half-lives exceeding 5 years is classified as Class A waste if concentrations do not exceed 10 nanocuries per gram of waste, or as Class C waste if concentrations are greater than 10 nanocuries per gram and less than or equal to 100 nanocuries per gram.

DOE's Nevada Test Site disposes of low-level and mixed low-level radioactive waste from DOE Nevada activities, as well as from approved generators, generally defined as those DOE sites and contractors that have traditionally shipped waste to the Nevada Test Site. (LANL has, in the past, shipped waste to the Nevada Test Site for disposal.)

Transuranic waste capacity. Transuranic waste disposal capacity is available at WIPP near Carlsbad, New Mexico. WIPP currently accepts defense-generated transuranic waste for disposal. Mixed contact-handled transuranic waste is acceptable; however, waste that exhibits RCRA characteristics of ignitability, corrosivity, or reactivity must be treated (DOE 2002, WIPP 2004). WIPP initially received only contact-handled transuranic waste, but the WIPP permit modification for receipt of remote-handled transuranic waste was approved in October 2006.

Transuranic waste must contain alpha-emitting transuranic isotopes, having half-lives exceeding 20 years, in concentrations exceeding 100 nanocuries per gram of waste. Pursuant to the WIPP Land Withdrawal Act, the total capacity at WIPP is 6.2 million cubic feet (0.18 million cubic meters) of transuranic waste. Several restrictions exist for acceptance of remote-handled waste.

I.3.3.1.3 Related Remedial Actions

Section I.3.3.1.3.1 summarizes case histories of removals at MDA P and the Sandia Chemical Waste Landfill. Section I.3.3.1.3.2 summarizes the removal alternative considered for remediation of MDA H. Section I.3.3.1.3.3 presents observations.

I.3.3.1.3.1 Selected Case Histories

LANL MDA P. MDA P in TA-16 operated from 1950 to 1984 and contained detonable HE, HE residues in soil, barium, and asbestos; and low levels of uranium, lead, and cadmium. The closure process began in February 1997 (LANL 2001a), when a clean closure plan was approved by NMED. The volume to be removed was estimated to be 30,000 cubic yards (22,900 cubic meters). But in the fall of 1997, work crews discovered HE ranging from the size of a fingernail to that of a softball. Plans for removal were changed. A remote excavator was acquired, as well as a team of explosive ordinance experts to screen excavated materials for high explosive (LANL 2001d). Excavation resumed in February 1999 and was completed on May 3, 2000 (LANL 2001a). Work crews used high-pressure water to remove debris potentially contaminated with HE (LANL 2001d). Nonremote excavation of contaminated soil beneath the waste pile began after the May 2000 Cerro Grande Fire and was completed in March 2001. Additional material was removed in February 2002 (LANL 2001a).

Material excavated from MDA P included 52,500 cubic yards (40,100 cubic meters) of soil and debris (including hazardous and industrial waste and recycled material); 387 pounds (176 kilograms) of detonable high explosive; 820 cubic yards (627 cubic meters) of hazardous waste with some radioactive contamination; 6,600 pounds (3,000 kilograms) of barium nitrate; 2,605 pounds (1,180 kilograms) of asbestos; 200 pounds (91 kilograms) of mixed waste;

235 cubic feet (6.7 cubic meters) of low-level radioactive waste, and 888 containers of unknown content (LANL 2001a).[41] The high explosive was burned (LANL 2001d).

Sandia Chemical Waste Landfill. This landfill was a 1.9-acre (0.77-hectare) landfill near Albuquerque, New Mexico, that was used for disposal of chemical and solid waste between 1962 and 1985 and as a storage area for hazardous waste drums between 1981 and 1989. Liquid and solid waste disposal was discontinued in 1981 and 1985, respectively. Closure of the landfill was initiated in 1988 (SNL 2003).

The site was prepared for excavation following a 2-month preparation period that included mobilization of equipment and administration trailers. Excavation began in September 1998 and was completed in February 2002, when 52,000 cubic yards (40,000 cubic meters) of soil, solid, hazardous, and mixed waste was removed. Excavation extended to 12 feet (3.7 meters) below ground surface and occasionally to 30 feet (9.1 meters). In addition to soil, excavated debris included compressed gas cylinders, intact chemical containers, partially expended munitions, thermal and chemical batteries, large metal objects (such as tanks or gloveboxes), waste containing radionuclides, asbestos-containing tiles and blocks, and biohazardous waste.

Management of the excavated waste was performed in a matter consistent with its hazard. The 357 compressed gas cylinders—apparently intact—that were recovered were processed in an onsite mobile facility. Of these, 233 were empty. Various combinations of five methods were used to process the remaining cylinders, including (SNL 2003): carbon adsorption; devalving of the containers with or without the use of liquid nitrogen; neutralization of the cylinders using sulfuric acid or sodium hydroxide; recontainerization of solids and liquids from the cylinders for appropriate disposal; and venting of the gases through a carbon scrubber.

Excavation was conducted using a large tracked backhoe (trackhoe) having Lexan windows for shielding against explosion. (Blast-resistant Lexan shielding was placed near the excavation for protection of ground personnel.) Workers were equipped with protective clothing and supplied-air breathing apparatus. The project experienced several delays and work slowdowns over the 3.25-year excavation period because of deficiencies in the rate at which excavated material could be sorted; weather conditions; safety concerns (for example, unexpected encountering of chlorobenzylidene malonitrile, an irritating powder; and an apparently erroneous detection of hydrogen cyanide); space limitations in staging and disposing of material; and other issues. Three different technologies for screening excavated soil and debris were tried. A tent was constructed over the sorting area, and a motorized conveyor belt with a site-built hopper was used to avoid manually handling excavated rock. During the first year of the project, the average excavation rate was 155 cubic yards (119 cubic meters) per 50-hour workweek; thereafter, this rate was raised to about 374 cubic yards (286 cubic meters) per 50-hour workweek.

I.3.3.1.3.2 Material Disposal Area H Removal Alternative

At MDA H (PRS 54-004), nine shafts were used for disposal of classified wastes, receiving weapons components, classified documents and paper, aluminum, plastic, stainless steel, rubber, graphite shapes, weapon mockups, depleted uranium scraps and classified shapes, and other materials (DOE 2004b, LANL 2005c). An investigation program has been completed and the

[41] *Revised waste summaries are in the MDA P Closure Certification Report (LANL 2003h).*

results submitted to NMED, along with an addendum. A Corrective Measures Study Report for MDA H was completed in May 2003 (LANL 2003b) and an environmental assessment in June 2004 (DOE 2004b). The recommended corrective remedy was capping with an evapotranspiration cover, although DOE also addressed the corrective measure alternatives of removal, and partial or complete encapsulation of the shafts. Complete encapsulation was selected by NMED, along with installation of an engineered evapotranspiration cover and a soil vapor extraction system (NMED 2007a).

For the removal alternative, the above documents present conceptual designs for the structural and site changes needed to facilitate removal (see **Figure I–19**) (DOE 2004b). Pre-excavation activities include: modification and provision of utilities; delivery of a construction trailer and portable toilets; construction of a waste sorting and declassification structure, including a storage vault; erection of excavation tenting and moisture protection around the shaft area; installation of an enclosed conveyor system; establishment of an overburden storage area; relocation and expansion of the site security fence; an access road between the sorting and declassification, characterization, and packaging operations; and maintaining an exclusion area.

Waste removal using a crane was considered a safety hazard. Backhoes would not have been able to dig sufficiently deep to recover all waste. Therefore, site excavation was to proceed by removing waste laterally in 5-foot (1.5-meter) lifts: Two trenches would be excavated parallel to the shafts and on both sides to depths of 3 to 5 feet (0.9 to 1.5 meters). The trenches would be dug to within 18 to 24 inches (45 to 60 centimeters) of the shafts but would not breach the shaft or shaft contents. The waste in the top lift would be removed. Then the two trenches would be excavated another 3 to 5 feet (0.9 to 1.5 meters) and the next layer of waste removed. This process would be repeated until all the waste was removed. The trenches would be benched at a distance of 5 feet (1.5 meters) horizontally for every 15 to 20 feet (4.6 to 6 meters) of depth. The tuff adjacent to the shafts would be dug to 62 feet (18.9 meters) below ground surface. The complete, excavated footprint would measure 260 by 120 feet (78 by 36 meters) at the bottom of the excavation and 290 by 150 feet (87 by 45 meters) at the top of the excavation. Roughly 50,000 cubic yards (38,000 cubic meters) of uncontaminated tuff would be removed from the two trenches (DOE 2004b).

Because of the possible hazard of reaction of materials such as lithium hydride, high explosive, and pyrophoric uranium hydride, different options were considered for minimizing the hazard. One option was to perform removal under a tented enclosure using a computer-controlled, remotely operated, tracked hydraulic excavator to remove potentially reactive materials. A second option was to remove the waste by operating the excavator inside an enclosure filled with an inert gas such as nitrogen. This option would maintain an atmosphere having a sufficiently low level of oxygen to manage the possibility of an unwanted reaction with oxygen. Under either option, nonsparking tools and chemical “sniffers” would be used (DOE 2004b).

Wastes removed from the shafts would be conveyed by the conveyor system to the sorting and declassification area where the waste would be checked for hazard (radiation level, fire, explosion potential). Materials requiring declassification would be shredded or crushed to declassify the materials and to reduce volume. The conveyor would be designed to convey the wastes in an inert atmosphere, if needed. The conveyor could consist of a series of units containing gloveboxes terminating in a visual inspection station (see **Figure I–20** [DOE 2004b]).

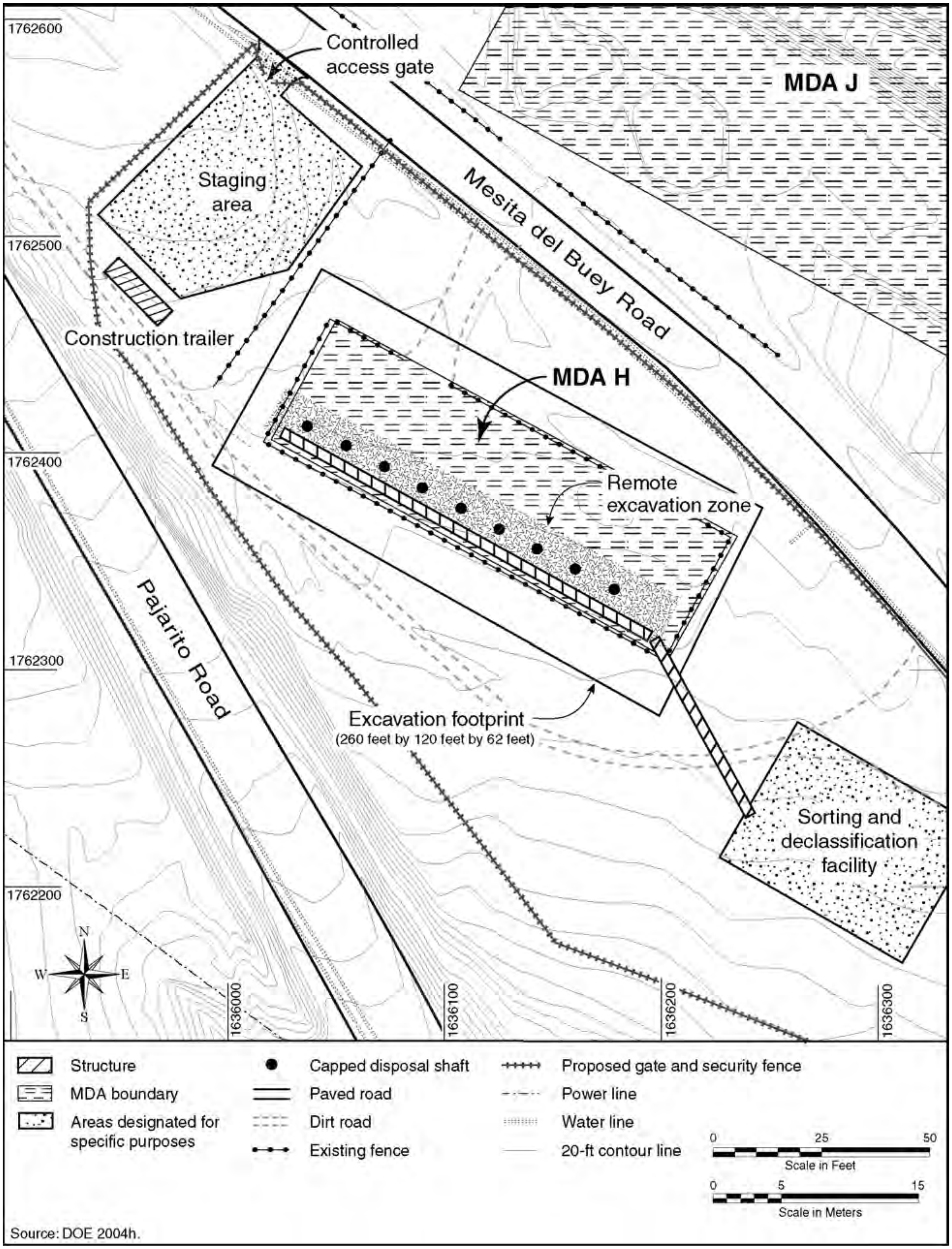


Figure I–19 Closeup View of Conceptual Site Changes to Facilitate Complete Excavation and Removal Corrective Measure Option

Figure I–20 Example of a Remotely Operated Dismantling System and Inspection Station

The inspection station would be remotely controlled, if needed, and contain manipulator arms, tools, and equipment to characterize the wastes and declassify and dismantle materials. Reactive material would be maintained in an inert environment before treatment (for example, high explosive would be safely burned). The enclosed conveyance system would move waste into a packaging and sorting area for placement of the wastes into containers (DOE 2004b).

After excavation and waste sorting is complete, the site would be restored. Stored overburden would be placed back in the hole and additional fill would be trucked in. After grading the filled area, stored topsoil would be reused and the site revegetated (DOE 2004b).

Removal would require 6 months to design and 40 months to implement. Total time for the removal operation would be 48 months. Excavation of the shafts would require 75 to 85 workers during the 48-month implementation period (DOE 2004b).[42]

I.3.3.1.3.3 Observations from Case Histories

Several observations can be made from the above case histories and analyses, including the following:

- Existing case histories are for relatively shallow disposal units. The radiation levels associated with most actual removals have been relatively low.
- Excavation can be dangerous and slow. There can be frequent problems to work around.

[42] Upgrading the existing cap, or installing an engineered cover, would require 10-12 workers for 5 months. Partial or complete encapsulation of the shafts would require 24 to 38 workers for 12 months (DOE 2004b).

- Unexpected conditions (such as the need to exhume explosives) can greatly increase the risk of removal, time required to complete removal, and expense for removal.

- Excavation of shafts can require a considerable amount of soil disturbance.

Some additional observations and comparisons can be made for the large LANL MDAs:

- The large MDAs considered in this appendix are generally deeper than those analyzed (except for MDA H).

- The large MDAs considered in this appendix frequently contain transuranic and other radionuclides and often present external radiation hazards.

- The large MDAs considered in this appendix are often nearby other, operating facilities.

I.3.3.2 Options for Remediation of Material Disposal Areas

The two major options for remediation of the MDAs are stabilization in place (Section I.3.3.2.1) and removal (Section I.3.3.2.4). Remediation of any MDA may be a combination of treatment methods.

I.3.3.2.1 Stabilization-in-Place Option

An engineered evapotranspiration cover would be placed over the MDAs using standard construction equipment. Cover placement would include best management practices. Site monitoring and maintenance would be performed thereafter.

Disposal practices at LANL have generally been performed in a manner that has reduced short-term subsidence. At most disposal trenches and pits, waste was placed in layers that were covered with thin layers of tuff and compacted. Much waste was not containerized. This reduced subsidence compared to that from adding backfill and cover to pits or trenches filled with waste. Additional measures to enhance stabilization of the MDAs could include in situ grouting or waste encapsulation, or dynamic compaction. Implementing these measures would invoke tradeoffs such as safety concerns, costs, and the time to install a final cover.

I.3.3.2.1.1 Operational Elements

Operational elements are presented in the text box.

Preliminary site work is assumed to include planning and permitting; demolishing or relocating existing operations, structures, or materials (as needed); rerouting or modifying utilities or pipelines (as needed); mobilization of equipment; and initial site preparation. It is assumed that a management area would be established near the MDA for staging heavy equipment and vehicles. A trailer or similar structure would be temporarily sited for management of operations. The size of the management area may depend on the size of the MDA and the complexity of closure operations, but would probably not, for most MDAs, exceed a few thousand square feet. An area for parking personal vehicles would be needed; in most cases probably in existing nearby parking lots or areas nearby the MDA. Utilities would be made available; for example, by accessing existing utilities in the vicinity of the MDA. Water may need to be delivered by truck at some MDAs. Portable toilets would be installed in the management area, and sanitary waste from the toilets would be trucked to a disposal location either on or offsite.

Capping Operational Elements

- *Design, Planning, and Permitting* – Includes planning for site operations, including equipment and personnel coordination. Includes health and safety plans, site security plans, erosion control plans, and others. Includes permits and authorizations.
- *Demolishing/Relocating Existing Operations, Structures, or Materials* - Includes moving, demolishing, or relocating existing structures or operations.
- *Rerouting/Modifying Utilities, Pipelines, or Similar* – Includes rerouting or modifying water, electrical, telephone, or other underground or overhead lines as needed to preclude damage. Includes removal or rerouting of liquid waste or chemical piping to preclude damage.
- *Mobilization* – Includes mobilization and initial site placement of equipment such as cranes, backhoes, dump trucks, water trucks, and graders. Includes installation of a site management trailer. Includes site storage of equipment and initial mobilization of the workforce.
- *Site Preparation* – Includes explorations needed to determine the specific locations of disposed wastes, and other site-specific studies and tests such as removal of areas of surface contamination. Includes clearing of vegetation. Includes the demolition or removal of asphalt or other hard covers over disposal units. Includes removal and disposal of existing security fencing.
- *Perform Special Activities* – Includes activities unique to a specific MDA. For MDA A, it includes stabilizing the buried General’s Tanks.
- *Install Moisture Monitoring System* – Before cover installation, includes the possible placement of moisture detection probes at selected locations, as well as ancillary equipment.
- *Regrading/Evapotranspiration Cover Installation/Revegetation* – Includes placement of the cover, including spreading and fine-grading of topsoil, compaction using heavy construction equipment, watering for dust abatement, and watering of planted areas for vegetation germination at approved levels.
- *Install New Fencing/Gate* – Includes security fencing with a gate large enough for vehicle passage, as well as appropriate signage.
- *Demobilization* - Includes demobilization of equipment such as backhoes, dump trucks, water trucks, and graders. Includes removal of the management trailer.
- *Health and Safety* – Includes development of a site health and safety plan; performing surface sampling confirming nonhazardous site conditions; monitoring site activities; and conforming to standard construction health and safety policies, laws, and procedures.
- *Project Management* – Includes an onsite project manager or foreman, who reports daily site progress, as well as site office support. Includes, as needed, specialists such as an evapotranspiration specialist for confirmation of material placement.
- *Monitoring and Surveillance* – Includes semiannual site visits to repair fencing and covers, eruption control, etc.

Areas may be needed for stockpiling cover materials before emplacement, as well as areas for packaging, characterizing, and storing wastes generated as part of preliminary operations or cover installation. The sizes of these support areas will depend on factors such as operational or impact mitigation considerations (such as minimizing delivery of bulk materials during times of high traffic density), the scope of needed preliminary demolition work, and the expected volumes of wastes to be generated. For example, capping MDAs in TA-21 would be accompanied by operations to remove nearby structures (see Section I.3.3.2.2.1), which would generate wastes requiring temporary management before transport to a disposal facility. Areas for stockpiling cover materials, or overburden removed as part of initial preparation, would be protected from erosion or runon, from airborne dispersion, and from possible cross contamination. Temporary roads may be needed between the MDA and the support areas.

Preliminary site work is also assumed to include removal of fencing to allow for site grading and placement and compaction of cover materials. This fencing may or may not be contaminated. In some cases, it may be reused; in others disposed of as waste. (The latter is conservatively assumed at large MDAs.) But depending on the size of the MDA, only portions of the fence may require removal, and removal might occur as part of the cover placement process as different sections of the MDA are sequentially addressed. For security, temporary fencing could be placed at fence openings and moved as needed.

Several of the MDAs are partially covered by asphalt or concrete. Before capping commences, this material may be removed or broken into rubble and covered. In other MDAs, such as those in TA-21, several buildings or structures may require removal. Removal of buildings and structures in TA-18 and TA-21 is addressed in, Sections H.1 and H.2, respectively, of Appendix H.

Assumptions for packaging and transporting wastes generated from capping MDAs are presented in Section I.3.5.

Capping includes placement of the cover, including spreading and fine-grading of topsoil, compaction using construction equipment, watering for dust abatement, and watering of planted areas for vegetation germination at approved levels. The Capping Option may include the installation of moisture monitoring systems, including moisture detection probes and ancillary equipment, at some of the MDAs (LANL 1999b). Each moisture monitoring system would consist of several Time Domain Reflectometry probes placed at selected locations, and a data collection center at each MDA (or group of adjacent MDAs), including a data logger, remote data access, associated solar equipment to operate the data center, and a tipping bucket rain gauge to monitor precipitation.

Because past site investigations at the MDAs have shown incidents of low levels of contamination in surface soil, capping may be preceded by efforts to remove localized pockets of radioactive or hazardous constituent contamination.

The design of each evapotranspiration cover would be tailored to each MDA based on an analysis of the potential for erosion, runon and runoff, precipitation rate, evapotranspiration, and biointrusion (see, for example, Appendix C of the *MDA Core Document* [LANL 1999b]). At all MDAs, the cover would be a mixture of tuff, gravel, cobbles, and soil amendment or compost. Each cover would be contoured to promote runoff without erosion. Cover thicknesses would be typically larger toward the centers of the footprints of the disposal units. Covers would extend beyond the footprints of the disposal units, and taper at shallow angles.

Because final cover designs for the MDAs are still being developed, a range of average thicknesses was assumed to determine cover material volumes. Consistent with a recent survey of sources for borrow materials for cover materials (Stephens 2005), it was assumed that each cover over each MDA would consist of either 3 feet (0.9 meters) or 8.2 feet (2.5 meters) of crushed tuff or similar material. For either assumed thickness, it was assumed that subgrade fill may be required. It was also assumed that the final cover over each MDA would include additional materials such as cobbles, gravel, topsoil, or soil amendment. It was assumed that the thickness of additional material would be about 10 percent of the base (crushed tuff) thickness.

I.3.3.2.1.2 Closure of Material Disposal Area G within Area G of Technical Area 54

The current schedule for the Consent Order requires submittal of a remedy completion report for MDA G within TA-54 by December 6, 2015. Closure of MDA G will be coordinated with closure of disposal units in the current 63-acre Area G footprint that are not subject to the Consent Order. Existing waste stored within Area G will require recovery, and existing waste management operations will require relocation. Closure of MDA G will be closely coordinated with closure of MDA L, which is addressed in Section I.3.3.2.1.3. The transition of waste management operations from current locations in Areas G and L so that Areas G and L can undergo closure is analyzed in Appendix H, Section H.3.

I.3.3.2.1.2.1 Overview

Area G within TA-54 is used for a variety of radioactive waste management operations. Belowground radioactive waste storage and disposal units are listed in **Table I–34** (LANL 2005k). They include:

- Numerous trenches, pits, and shafts containing radioactive waste subject to corrective action under the Consent Order (MDA G). Early disposal units may contain transuranic isotopes in concentrations exceeding current transuranic waste definitions.

- Two subsurface disposal units subject to closure under RCRA.

- Active disposal units for low-level radioactive waste that do not contain mixed low-level radioactive waste. These disposal units are neither permitted under RCRA nor subject to corrective action under the Consent Order.

Other waste management operations include radioactive waste storage; low-level radioactive waste characterization, verification, and compaction capacity; and capacity for characterizing, processing, and shipping contact-handled transuranic waste. This existing capacity is addressed in a 2005 TA-54 status report (LANL 2005k).

Waste management activities within Area G occur within structures having systems and components designed and constructed in accordance with DOE's systems of hazard and performance categorization (DOE 1993, 1997b). LANL staff conducts operations in a manner that restricts the aboveground inventory of radioactive materials within individual structures and over all of Area G. The limit for all aboveground activity in Area G, including stored waste, is 150,000 plutonium-239-equivalent curies (LANL 2006a).

Table I–34 Belowground Storage and Disposal Units at Area G

Atomic Energy Act-Regulated Storage and Disposal Units		Corrective Action Storage and Disposal Units [a]		RCRA Storage and Disposal Units
Low-level Radioactive Waste Disposal	Transuranic Waste Storage	Waste Disposal	Transuranic Waste Storage	
Pits 15, 38, 39 Shafts 21, 23, 97, 137, 141-144, 147-149, 161-177, 197, 300, 301, 307, 308, 360-367, 369, 370 Shafts C11, C14, 321, 323, 325, 327, 329, 331, 333, 335, 339, 341, 343, 345, 347, 349, 351, 355, 357 Shafts [b] 309, 311, 313, 317, 319, 337, 353, 359	Shafts 235-243, 246-253, 262-266, 302-306	Pits 1-10, 12, 13, 16-22, 24-30, 32-33, 35-37 Pit 31 Shafts C1-C10, C12, C13, 1-20, 22, 24-96, 99-112, 114, 115, 118-123, 125-136, 138-140, 150-160, 189-192, 196	Pit 9 Trenches A-D Shafts 200-232 Shaft 233 [b] Transuranic waste corrugated metal pipes (stored atop Pit 29)	Pit 29 (below storage of transuranic waste corrugated metal pipes) Shaft 124

RCRA = Resource Conservation and Recovery Act.
[a] Units regulated under RCRA and Corrective Action Requirements are also regulated by DOE under the Atomic Energy Act.
[b] Unused and empty.
Source: LANL 2005k.

Closure of MDA G within the constraints of the Consent Order would occur as waste management operations and facilities are transitioned from Area G as described in Section H.3. This would include the removal of transuranic wastes stored underground. The removal of these operations and facilities will occur in a phased approach, as described in **Table I–35**, that would allow closure activities to begin without waiting for all waste management operations and facilities to be removed (LANL 2005k).

While MDA G is being closed, new low-level radioactive waste disposal capacity would be developed, initially into Zone 4 at TA-54, and then into Zone 6 at TA-54 as needed. Six buildings across from Area L would be removed. A new guard and access station would be constructed. A waste characterization and verification facility would be constructed, as would a new low-level radioactive waste compactor facility (LANL 2005k).

I.3.3.2.1.2.2 Options for Remote-Handled Transuranic Waste

Shafts 200-232 within Area G are 33 1-foot-diameter (0.3-meter-diameter) shafts having carbon steel pipe liners that contain high-activity remote-handled transuranic waste. The environmental impacts associated with removal of this waste from 3 shafts, which would require a temporary facility to be constructed over the shafts, are analyzed in Appendix H, Section H.3.

Another option is to leave the waste in place consistent with health, safety, and environmental analyses in accordance with all applicable regulatory standards. In addition to any analyses performed as part of the Consent Order process, for example, an analysis may be required pursuant to 40 CFR Part 191, EPA’s “Environmental Standards for the Management and

Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes." The analysis must provide a reasonable expectation that the following quantitative criteria will be met:[43]

Table I–35 Closure Phases for Existing Area G Footprint

Phases 1 and 2 (Western Portion): Retrieve contact-handled transuranic waste from Pit 9, from Pit 29, and from aboveground storage structures. Characterize and ship 5,500 cubic yards (4,200 cubic meters) of formerly stored and newly generated transuranic waste. Relocate low-level radioactive waste characterization and verification operations. Clean-close or decontaminate and decommission 66 structures. Modify infrastructure such as power lines and fences, as needed. Construct a final cover.
Phases 3 and 4 (Central Portion): Retrieve contact-handled transuranic waste from Trenches A-D and from aboveground storage structures. Retrieve remote-handled transuranic waste from five shafts (shafts 302-306). Characterize and ship 2,600 cubic yards (2,000 cubic meters) of formerly stored and newly generated transuranic waste. Relocate low-level radioactive waste compactor operations. Clean-close or decontaminate and decommission 18 structures. Modify infrastructure, as needed. Construct a final cover.
Phases 5 and 6 (Eastern Portion): Retrieve contact-handled transuranic waste from aboveground storage structures. Retrieve contact-handled transuranic waste from 5 shafts (shafts 262-266). Retrieve remote-handled transuranic waste from 17 shafts (shafts 235-243 and 246-254). Retrieve remote-handled transuranic waste from 33 shafts (shafts 200-232). If necessary, construct a remote-handled facility for waste retrieval and processing for shipment. Alternatively, leave remote-handled waste in place if compliant with a 40 CFR Part 191 analysis. Characterize and ship 5,000 cubic yards (3,800 cubic meters) of formerly stored and newly generated transuranic waste. Construct a transuranic facility outside of Area G for newly generated transuranic waste. Clean-close or decontaminate and decommission 31 structures. Modify infrastructure, as needed. Construct a final cover.

CFR = *Code of Federal Regulations.*
Source: LANL 2005k.

- Containment criterion – A limit on the total quantities of particular radionuclides hypothetically released into the accessible environment over 10,000 years following waste disposal. (Allowable projected releases are scaled to the initial inventory. Because the shafts have a small inventory, allowable projected releases would be very small.)

- Individual protection criterion – An annual dose limit (15 millirem in a year) to individuals in the accessible environment for 10,000 years following waste disposal.

- Groundwater protection criterion – A requirement to project compliance with drinking water maximum contaminant levels in the accessible environment for 10,000 years following waste disposal.

The final configuration of the disposal unit containing the wastes would be designed in compliance with all required analyses and regulatory standards. Further stabilization or containment of the waste, using technologies such as in situ grouting or in situ vitrification, or modifications to the design and installation of the final cover, may be required.

[43] *40 CFR Part 191 also contains qualitative requirements pertaining to the use of active and passive institutional controls, monitoring, resource avoidance, and so forth.*

Additional analyses would be needed to make a decision on this option. It may be noted, however, that possible consequences of leaving contact- and remote-handled transuranic waste in place at LANL were addressed as part of a NEPA analysis prepared in support of disposal of transuranic waste at WIPP (DOE 1997a). This NEPA analysis addressed the consequences of leaving transuranic waste in place as part of a No Action Alternative considered in the *WIPP Disposal Phase Supplemental Environmental Impact Statement (SEIS-II)* (DOE 1997a), based on an analytical model developed by Pacific Northwest National Laboratory (PNNL 1997). *SEIS-II* considered stored and previously buried waste at seven generator-storage sites, including LANL. Stored waste configurations included soil-covered configurations and surface-stored configurations, such as storage in buildings. The analysis considered the consequences that could hypothetically occur assuming that waste at the generator-storage sites would be stored indefinitely into the future, and that loss of institutional control at the generator-storage sites would occur after 2133. Consequences included those that may be experienced by a future inadvertent human intruder into the stored and previously buried waste, and those that may result from long-term release into the environment. The analysis addressed radiological doses and risks, as well as impacts of exposure to chemical carcinogens and noncarcinogens (DOE 1997a).[44] The preferred alternative and decision (63 FR 3624) was to dispose transuranic waste in WIPP. WIPP disposal capacity is expected to be sufficient for disposal of all retrievably stored transuranic waste and all newly generated transuranic waste from the DOE complex over the next few decades, but not sufficient for this waste plus all transuranic waste buried before 1970 across the DOE complex.

Buried waste intrusion scenarios included the driller and gardener scenarios (DOE 1997a):

- *Driller.* A hypothetical intruder drills a well directly through buried or soil-covered waste to underlying groundwater, bringing contaminated soil to the surface that is mixed with topsoil.

- *Gardener.* A gardener farms a garden on the land containing the contaminated soil following the drilling incursion.

Surface-stored waste intrusion scenarios included the scavenger and farm family scenarios (DOE 1997a):

- *Scavenger.* A hypothetical scavenger intruder comes into direct contact with surface-stored transuranic waste over a 24-hour period.

- *Farm Family*. A hypothetical farm family of two adults and two children lives and farms on the land immediately over the former surface-stored transuranic waste area.

Populations and individuals living near the generator-storage sites were assumed to be impacted by long-term environmental release of contaminants. The following two scenarios were used to evaluate impacts on the maximally exposed individual (MEI) of chronic long-term environmental releases (DOE 1997a):

---

[44] *The analysis is described in detail in Appendix I of SEIS-II, which is available for viewing at the WIPP Internet site, www.wipp.energy.gov.*

- *Groundwater exposure*. The MEI from a farm family lives 980 feet (300 meters) downgradient of a waste storage area. The family grows and consumes their own crops and livestock and uses contaminated groundwater for drinking water and for watering the crops and livestock. This receptor was considered for long-term release from buried or soil-covered transuranic waste and surface-stored transuranic waste.

- *Air Pathway Exposure*. A hypothetical individual was assumed to be exposed to the maximum airborne contaminant concentration released from a stored transuranic waste site. This receptor, located at least 330 feet (100 meters) from the site but within a 50-mile (80-kilometer) radius, was considered only for long-term releases from surface-stored transuranic waste.

Offsite populations within 50 miles (80 kilometers) of the sites were assumed to be exposed via atmospheric transport of radionuclides or by contamination of surface water (used for drinking water) from releases to the groundwater pathway. (Population exposures from the groundwater-surface water pathway were not considered for LANL.) Long-term releases from both buried or soil-covered transuranic waste and surface-stored transuranic waste were included (DOE 1997a).

Analyses were performed using the modular risk analysis method used in the DOE waste management programmatic environmental impact statement and the GENII and MEPAS computer codes. Site-specific radionuclide inventories were developed for each generator-storage site, and a typical inventory of organic and inorganic constituents was considered for all generator-storage sites. The results of the analysis for a future inadvertent intruder into buried and stored transuranic waste at LANL are presented in **Table I–36**. Maximum lifetime MEI and population impacts calculated for long-term releases to the environment are summarized in **Table I–37**. Noncarcinogenic impacts were determined to have a maximum Hazard Index of 1.7×10^{-3}, principally from mercury through the resuspended soil ingestion pathway (DOE 1997a).

Table I–36 Inadvertent Future Intruder Impact Summary

	Intrusion into Buried Waste				***Intrusion into Surface-Stored Waste***			
	Contact-Handled Waste		***Remote-Handled Waste***		***Contact-Handled Waste***		***Remote-Handled Waste***	
Impact measure	Driller	Gardener [a]	Driller	Gardener [a]	Scavenger	Farmer [b]	Scavenger	Farmer [b]
Dose (rem)	4.5×10^{-3}	41	2.2×10^{-3}	6.1	6.58	2,400	1.39	550
Radiological LCF	2.3×10^{-6}	0.021	1.1×10^{-6}	3.6×10^{-3}	3.3×10^{-3}	1.2	6.9×10^{-4}	0.27
Hazardous Chemical Impacts								
PEL [c]								
Cadmium	9.8×10^{-2}		9.8×10^{-2}		5.2		5.2	
Beryllium	17		17		91		91	
Lead	27		3,000		1,400		160,000	
Mercury	12		12		6.2		6.2	
Hazard Quotient/Index								
Cadmium		0.01		0.01		15		15
Beryllium		0.08		0.08		10		10
Lead		36		3,900		50,000		5.2×10^{6}
Mercury		77		77		100,000		100,000

	Intrusion into Buried Waste				*Intrusion into Surface-Stored Waste*			
	Contact-Handled Waste		*Remote-Handled Waste*		*Contact-Handled Waste*		*Remote-Handled Waste*	
Cancer Incidence								
Cadmium	1.4×10^{-9}	2.0×10^{-5}	1.4×10^{-9}	2.0×10^{-5}	2.0×10^{-6}	0.02	2.0×10^{-6}	0.02
Beryllium	1.3×10^{-7}	1.0×10^{-4}	1.3×10^{-7}	1.0×10^{-4}	2.0×10^{-4}	1.9	2.0×10^{-4}	1.9

LCF = latent cancer fatality, PEL = permissible exposure limit.
[a] Impact measures for the gardener are totals over 30 years.
[b] Impact measures for the farmer are for the first year of intrusion.
[c] Air concentrations exceeding PEL – that is, "17" means 17 times the PEL.
Note: From the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a) No Action Alternative 2 Analysis.
Source: DOE 1997a.

Table I–37 Maximum Lifetime Maximally Exposed Individual and Population Impacts after Assumed Loss of Institutional Control

	Radiological Impacts			*Chemical Carcinogenic Impacts*	
Receptor	***Lifetime Dose (rem per 70 years)***	***Lifetime LCF*** [a]	***Dominant Pathway***	***Lifetime Cancer Incidence***	***Dominant Pathway***
MEI	0.09	4.5×10^{-5}	Inhalation	2.4×10^{-4}	Resuspended soil ingestion
Population	162	8.1×10^{-2}	Inhalation	2.4×10^{-4}	Resuspended soil ingestion

LCF = latent cancer facility, MEI = maximally exposed individual.
[a] Lifetime LCF is the probability of an LCF for an MEI and the number of LCFs in a population.
Note: From the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a) No Action Alternative 2 Analysis.
Source: DOE 1997a.

I.3.3.2.1.2.3 Final Stabilization of Area G

Stabilization of the existing 63-acre Area G footprint will proceed in three separate periods. In each of these periods, after removal of structures in the specific area to be covered, the area would be graded and capped. In addition, a soil vapor extraction system would be placed in Area G to remove and treat the volatile organic compound plume at the eastern portion of the MDA (LANL 2005k).

Waste Generation. It was postulated that small quantities of waste would be generated as part of capping MDA G and other disposal units in the existing 63-acre footprint of Area G. These volumes were estimated by assuming that the fencing currently surrounding the MDA is removed and disposed of as waste, and that the concrete and asphalt covering a portion of the site is removed and disposed of as waste. However, the fencing may actually be recycled or reused, and the asphalt and concrete may actually be broken up and buried beneath the final cover. See Section I.3.3.2.2.1 for estimated volumes.

Bulk Materials for Area G Final Cover. The cover for the existing 63-acre Area G footprint is being developed with the support of the updated Area G performance assessment and composite analysis. The final cover would cover all disposal units in the existing footprint, including the active and inactive disposal units that are subject to RCRA closure and the Consent Order (LANL 2005k), and is assumed to cover 65 acres (Stephens 2005). The cover design and thickness will be consistent with a final stabilization analysis that will evaluate alternatives such as stabilization of specific pits before installation of a final cover. The current cover ranges considerably in thickness. A 2002 report proposed increasing the thickness of the interim cover by 4.6 to 7.9 feet (1.4 to 2.4 meters), resulting in a fairly uniform final thickness of about 11.2 feet (3.4 meters) (LANL 2002b).

The current conceptual design for the cover includes the following materials (DOE 2005a):

- Crushed tuff – 514,000 cubic yards (393,00 cubic meters)
- Imported cap material (crushed tuff from another location) – 818,000 cubic yards (625,000 cubic meters)
- Imported clay – 80,000 cubic yards (61,000 cubic meters)
- Imported rock – 167,000 cubic yards (128,000 cubic meters)
- Imported rock armor – 70,000 cubic yards (54,000 cubic meters)
- Imported top soil or soil amendment – 65,000 cubic yards (50,000 cubic meters)
- Pea gravel – 25,000 cubic yards (19,000 cubic meters)
- Surface area for vegetation, mulch, and fertilizer – 80 acres (32 hectares)

This design is assumed to represent the higher end of a reasonable range of possible thicknesses—that is, the thickness of the crushed tuff (514,000 + 818,000 = 1,332,000 cubic yards [1,018,000 cubic meters]) represents a maximum thickness of 8.2 feet (2.5 meters). Again, cover thickness would vary to promote drainage. A thinner cap (about 3 feet [1 meter]) would imply about 487,000 cubic yards (372,000 cubic meters). For this appendix, it was assumed that the additional clay, rock, topsoil, and other material would be roughly similar for either a thin or a thick cover. The minimum and maximum material and shipment requirements assumed in this appendix are listed in **Table I–38**.

Table I–38 Estimated Cover Materials for Material Disposal Area G and Other Area G Disposal Units

Materials	*Thin Cover*			*Thick Cover*		
	In-Place Volume (cubic yards)	*Delivered Quantities* [a]		*In-Place Volume (cubic yards)*	*Delivered Quantities* [a]	
		Cubic Yards	*One-Way Shipments*		*Cubic Yards*	*One-Way Shipments*
Tuff	487,000	643,000	38,000	1,330,000	1,760,000	104,000
Additional Materials	407,000	537,000	32,000	407,000	537,000	32,000
Total	894,000	1,180,000	70,000	1,740,000	2,300,000	136,000

[a] Delivered quantities are based on an assumed 20 percent swell after excavation from a borrow, a density of 1.3 tons per cubic yard, a 10 percent contingency, and an average load per truck of 22 tons.

Note: To convert cubic yards to cubic meters, multiply by 0.76456. Numbers have been rounded.

I.3.3.2.1.2.4 Schedules

The following start and completion dates (and elapsed months) for the three assumed groups of Area G closure phases are used in this appendix (LANL 2005k):

- Phases 1 and 2: 10/1/2010 - 9/30/2011 (12 months);
- Phases 3 and 4: 12/1/2012 – 9/30/2013 (12 months); and
- Phases 5 and 6: 9/29/2014 – 12/28/2015 (16 months).

I.3.3.2.1.3 Closure of Material Disposal Area L within Area L of Technical Area 54

Background. All disposal units in Area L are inactive. Some subsurface disposal units (MDA L) are subject to corrective action under the Consent Order; other subsurface disposal units are RCRA-regulated units subject to RCRA closure and postclosure care. Active waste management operations include storage of mixed low-level radioactive waste and storage and processing of wastes regulated under RCRA or TSCA as described in Section H.3. This waste is managed in container storage units (CSUs) subject to RCRA permitting or interim status requirements.[45] The waste is sent offsite for further processing (as needed) and disposal. Waste management units at Area L are summarized in **Table I–39** (LANL 2005k).

Table I–39 Summary of Waste Management Units at Area L

RCRA Disposal Units	*Corrective Action Disposal Units (MDA L)*	*Aboveground CSUs*	*Lead Stringer Shaft CSUs*
Shafts 1, 13-17, and 19-34 Impoundments B and D	Shafts 2-12 and 18 Pit A Impoundment C	54-215, 54-216, 54-31, 54-32, 54-35, 54-36, 54-58, 54-68, 54-69, 54-70, 54-39, and Area L CSU	Shafts 36 and 37

RCRA = Resource Conservation and Recovery Act, MDA = material disposal area, CSU = container storage unit.
Source: LANL 2005k.

The RCRA disposal units are inactive subsurface units used for hazardous waste disposal after the effective date of the RCRA hazardous waste management regulations. They are subject to RCRA closure and postclosure requirements under 40 CFR Part 264. Some of these disposal units have been previously identified as being subject to corrective action. But under the terms of the Consent Order (NMED 2005), these disposal units are not subject to corrective action but to RCRA closure and postclosure care (LANL 2005k).

In addition to remedial investigations, a pilot study has been conducted to determine the effectiveness of an extraction system for the vapor phase volatile organic compound plume under the site (LANL 2005k, 2006m). A January 2008 Corrective Measures Report to NMED recommended a corrective remedy incorporating an engineered evapotranspiration cover, a soil vapor extraction system, monitoring, and maintenance (LANL 2008a).

Scope of Closure. The intent is to close in a single integrated action those subsurface disposal units regulated under RCRA and those subject to corrective action. Closure would be performed in a manner allowing for continued use of Area L for hazardous and toxic waste treatment and

[45] *Container storage units at MDA L are described in Attachment G of the LANL TA-54 Part B Permit Renewal Application (LANL 2003h).*

storage. To accomplish this, waste management operations would need to be either altered so a smaller area is impacted, or completely removed. These changes to waste management operations are described and analyzed in Appendix H, Section H.3.

Closure activities analyzed in this appendix include capping of the subsurface disposal units and treating the subsurface volatile organic compound vapor plume under the site. One option would be to emplace two separate covers. One cover would envelop the pit and three impoundments and the lines of shafts to the south of Pit A. A second cover would cover the six shafts at the northwest portion of the site. As a second option, a single cover may be installed covering the pits, impoundments, and all shafts except for the lead stringer shafts.

The corrective measure determined by NMED may include removal of some or all of the subsurface units subject to corrective action. In this case, closure and future use plans would require modification.

Waste Generation While Capping. It was postulated that small quantities of waste would be generated as part of capping MDA L. These volumes were estimated by assuming that a portion of the fencing currently surrounding Area L would be removed and disposed of as waste, and that the concrete and asphalt covering a portion of the site would be removed and disposed of as waste. However, the fencing may be recycled or reused, and the asphalt and concrete may be broken up and buried beneath the final cover. See Section I.3.3.2.2.1 for estimated volumes.

Materials for Site Stabilization. The final cover for MDA L is being developed. The 2005 Status Report for TA-54 envisions two 3-foot-thick alternative RCRA covers (LANL 2005k). However, for conservatism, a single large cover was assumed consistent with the 2005 Borrow Source Survey (Stephens 2005).

The Stephens report prepared preliminary designs for MDAs C and L (Stephens 2005). The materials required under this proposal for MDA L are listed in **Table I–40**, assuming two thicknesses of cover. Although the ultimate design for MDA L may differ from that described by Stephens, the range in thicknesses should bound the volumes of bulk cover material that may be required (Stephens 2005). The two thicknesses—i.e., either 3 feet (1 meter) or 8.2 feet (2.5 meters)—refer to the thickness of the fill before addition of topsoil, rock armor, or similar material. Adding this material would add about 10 percent to the final thickness.

Placement of this cover may require removal of a gabion retaining wall that exists along the northern and eastern site boundaries to meet the requirement for cover longevity (Stephens 2005).

Schedules. In its January 2008 Corrective Measures Evaluation Report for MDA L, DOE proposed a DD&D schedule starting in fall 2008 and continuing through 2010; the proposed capping schedule was to start in Spring 2011 and extend through Spring 2012 (LANL 2008a). The actual remediation scope and schedule will depend on decisions made by NMED.

Table I–40 Bulk Materials for Material Disposal Area L Final Cover

Material	Three-Foot Cover				Eight-Foot Cover			
	In-Place Volume (cubic yards)	Delivered Quantities [a]			In-Place Volume (cubic yards)	Delivered Quantities [a]		
		Cubic Yards	Tons	One-Way Shipments		Cubic Yards	Tons	One-Way Shipments
Soil rooting medium	5,052	6,669	8,670	394	26,153	34,522	44,879	2,040
Topsoil	1,344	1,774	2,306	105	1,918	2,532	3,291	150
Select fill	2,942	3,883	5,048	229	2,784	3,675	4,777	217
Gravel	134	177	230	10	192	253	329	15
Cobbles	134	177	230	10	192	253	329	15
Angular boulders (1- to 2-foot diameter) [b]	543	717	932	42	555	733	952	43
Soil amendment/ compost [c]	67	88	88	4	96	127	127	6
Total	10,216	13,485	17,504	796	31,890	42,095	54,685	2,487

[a] Delivered quantities are based on assumed 20 percent swell after excavation from a borrow, a soil density of 1.3 tons per cubic yards, and a contingency of 10 percent. Shipments are based on assumed use of trucks containing average individual loads of 22 tons (Stephens 2005).
[b] Angular boulders may be optional on slopes of 25 to 33 percent.
[c] Soil amendment density: 1 cubic yard = 1 ton.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; tons to kilograms, multiply by 907.18.
Source: Stephens 2005.

I.3.3.2.2 Materials Requirements for Stabilizing Additional Large Material Disposal Areas

I.3.3.2.2.1 Site Preparation

Capping would be initiated by suitable site preparation, including removal of existing structures, demolition of fences surrounding the MDAs, clearing of vegetation as needed, and regrading.

Additional work would be needed at MDA T to remove many of the existing structures. Building 21-257 and associated structures (tanks) would be removed under a TA-21 DD&D program (see Appendix H, Section H.2). This would include portions of Buildings 21-005, 21-150, and all of Building 21-286, the aboveground Diesel Tank 21-57, about half of the remaining slab of Building 21-228, and Water Tower 21-342. Removal would include foundations and buried gas and water pipes because they lie within the outer 50 feet (15 meters) of the intended cap (see below). The abovegrade portion of the structures would be removed, and concrete slabs, sumps, and tank pads would be reduced to rubble and left in place along with the below-grade concrete foundations and remaining pipes. Pipes may be filled with a solidifying foam prior to terminating within 50 feet (15 meters) of the cap edge.[46] A 6-inch (0.2-meter) cross-mesa buried gas pipeline located between MDAs T and A would require relocation to the east of MDA A. Approximately 350 feet (107 meters) of pipe would be left in place after filling with solidifying foam. Another 100 feet (30 meters) of the pipe would be removed (LANL 2006a).

---

[46] *Pipes beyond 50 feet (15 meters) would be removed under remedy programs for other solid waste management units.*

At MDA A, before capping would take place, Water Tower 21-342 and abovegrade Diesel Tank 21-57 would be removed under a TA-21 DD&D program (see Appendix H, Section H.2). Removal would include foundations and buried gas and water pipes because they lie within the outer 50 feet (15 meters) of the intended cap (LANL 2006a).

For both MDA T and MDA A, removal and relocation of the perimeter road would be required, as well as electrical poles.

At MDA C, rather than removing or relocating existing buildings and pipes, retaining walls may be constructed (Stephens 2005).

For the remaining large MDAs, it was assumed that small quantities of wastes would be generated as part of final stabilization. To estimate the volumes of these wastes, it was assumed that as part of site preparation, some or all of the fencing around the MDAs would be removed and disposed of, and that some or all of the concrete and asphalt covering portions of some of the MDAs would be removed and disposed of.

Table I–41 presents the assumed volumes of solid waste produced from site preparation, where the linear footage of fencing removed was estimated based on scale drawings of the MDA sites. Also presented are the estimated volumes of waste, assuming that each 100 linear feet (30 meters) of fence generates about 2,300 pounds (1,040 kilograms) of waste (including mesh, posts, top bars, and concrete footers).[47] Assuming that the bulk density is about the same as common rubbish, then 100 linear feet (30 meters) of fencing would generate about 2.8 cubic yards (2 cubic meters) of solid waste.[48]

Portions of MDAs A, B, L, and G are covered with asphalt or concrete that would be broken up or removed before installation of the site covers. Waste volumes were estimated by multiplying an assumed area removed by an assumed average thickness of 6 inches (15 centimeters). (Much of the concrete and asphalt at the MDAs is probably thinner than 6 inches [15 centimeters]).

- MDA A: Estimated upon assumption of 10 to 20 percent of surface covered with asphalt. Fifteen percent of 1.3 acres (0.53 hectare) is 8,200 square feet (762 square meters).

- MDA B: Estimated from Section I.2.5.2.2 (1,500 by 120 feet = 180,000 square feet [457 by 37 meters = 16,909 square meters]).

[47] Considered poles, top bar, mesh, concrete, and neglected fittings and gates. Assumed an 8-foot fence, with 10-foot-6-inch (3.2-meter) poles every 10 feet (3 meters). Assumed each pole was embedded in concrete footings 8 inches in diameter and 30 inches deep. From www.hooverfence.com, assumed mesh weighs 561 pounds (254 kilograms) per 100 feet (30 meters), and the weight of a 10-foot 6-inch (3.2 meter) post is 24.3 pounds (11 kilograms). Assumed the density of concrete to be 150 pounds per cubic foot (2.4 grams per cubic centimeter). Rounded addition of posts, top pole, mesh and concrete to 2,300 pounds (1,040 kilograms) per 100 feet (30 meters) of fencing.

[48] From (Reade 2005), the bulk density of common rubbish (garbage) is 480 kilograms per cubic meter (30 pounds per cubic feet).

Table I–41 Solid Waste Generation during Capping of Large Material Disposal Areas

MDA	Fencing Removed (linear feet)	Solid Waste (cubic yards)
A	1,300	37
B [a]	4,800	140
T	1,500	43
U [b]	700	20
AB	450	13
C	6,900	200
G [c]	9,500	270
L	500	14

MDA = material disposal area.
[a] These volumes are conservatively included for completeness. The current plan is to completely remove the waste in MDA B (see Section I.3.3.2.7 of this appendix).
[b] These volumes are conservative because NMED has issued a Corrective Action Complete with Controls certificate for the SWMUs comprising MDA U (NMED 2006b) (see Section I.2.5.2.4 of this appendix).
[c] Capping MDA G includes capping other disposal units in the existing 63-acre Area G footprint that are not subject to the Consent Order.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; feet to meters, multiply by 0.3048. Numbers have been rounded.

- MDA L: Estimated by scaling from Figure B–1 of the MDA L Historical Investigation Report (LANL 2003m).[49]
- MDA G: Estimated by scaling from Figure B–5 of the Investigation Work Plan for MDA G (LANL 2004c).

Except for MDA L, it was assumed that half could be disposed of as solid waste and half as low-activity low-level radioactive waste. For MDA L, it was assumed that about half would be solid waste and half chemical waste. Waste quantities are listed in **Table I–42**. (See Section I.3.5 for assumptions about shipment of waste to disposal facilities.)

Table I–42 Asphalt or Concrete Removal from Material Disposal Areas

Parameter	MDA A	MDA B	MDA L	MDA G
Surface area (square feet)	8,200	180,000	4,300	130,000
Waste volume (cubic yards) [a]	150	3,300	80	2,400
Waste volume (cubic meters): [b]	120	2,500	61	1,800
Solid waste	58	1,300	30	920
Chemical waste [c]			30	
Low-level radioactive waste	58	1,300		920

MDA = material disposal area.
[a] Assuming an average asphalt thickness of 6 inches (15 centimeters) and an average concrete thickness of 6 inches (15 centimeters).
[b] As-shipped volumes would be larger because packaging efficiencies are less than 100 percent.
[c] Includes waste regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or is otherwise unacceptable for sanitary landfill disposal.
Note: To convert square feet to square meters, multiply by 0.0929. Numbers have been rounded.

[49] *Area L is currently entirely covered with asphalt. The only asphalt expected to be removed would be that needed for remediation of MDA L pursuant to the Consent Order. If all asphalt from Area L were to be removed from the 2.6-acre site, then up to an additional 1,050 cubic yards (800 cubic meters) of solid waste would be generated, as would up to an additional 1,050 cubic yards (800 cubic meters) of chemical waste. This would require up to 80 shipments of solid waste and 87 shipments of chemical waste.*

I.3.3.2.2.2 Cover Materials

Cover material assumptions for MDA G and MDA L are provided in Sections I.3.3.2.1.2.3 and I.3.3.2.1.3, respectively. Cover assumptions for other MDAs and landfills are presented below.

Large MDAs. The Stephens report includes preliminary designs for MDA C (Stephens 2005). Materials are listed in **Table I–43**, assuming two thicknesses for fill tuff. Although the ultimate design for MDA C may differ from that described by Stephens, the range in thicknesses should bound the required volumes of bulk cover material. The two thicknesses—that is, either 3 feet (0.9 meters) or 8.2 feet (2.5 meters)—refer to the thickness of the fill before addition of topsoil, rock armor, or other material. Adding this material adds about 10 percent to the final thickness.

Table I–43 Bulk Materials for Material Disposal Area C Final Cover

Material	*Three-Foot Cover*				*Eight-Foot Cover*			
	In-Place Volume (cubic yards)	*Delivered Quantities* [a]			*In-Place Volume (cubic yards)*	*Delivered Quantities* [a]		
		Cubic Yards	*Tons*	*One-Way Shipments*		*Cubic Yards*	*Tons*	*One-Way Shipments*
Soil rooting medium	37,237	49,153	63,899	2,905	117,942	155,683	202,388	9,199
Topsoil	7,943	10,485	13,630	620	8,730	11,524	14,981	681
Select fill	51,544	68,038	88,449	4,020	51,964	68,592	89,170	4,053
Gravel	794	1,048	1,363	62	873	1,152	1,498	68
Cobbles	794	1,048	1,363	62	873	1,152	1,498	68
Angular boulders (1- to 2-foot diameter) [b]	1,094	1,444	1,877	85	2,911	3,843	4,995	227
Soil amendment/ compost [c]	397	524	524	24	436	576	576	26
Total [d]	99,803	131,740	171,105	7,778	183,729	242,522	315,106	14,323

[a] Delivered quantities are based on assumed 20 percent swell after excavation from a borrow, a soil density of 1.3 tons per cubic yard, and a contingency of 10 percent. Shipments are based on assumed use of trucks containing average individual loads of 22 tons (20 metric tons) (Stephens 2005).
[b] Angular boulders may be optional on slopes of 25 to 33 percent.
[c] Soil amendment density: 1 cubic yard = 1 ton.
[d] Does not include retaining walls for Material Disposal Area C.
Note: To convert cubic yards to cubic meters, multiply by 0.7646; tons to metric tons, multiply by 0.907; square feet to square meters, multiply by 0.0929.
Source: Stephens 2005.

Because of the proximity of buildings and buried pipes, retaining walls may be installed at MDA C to terminate the cover edge. Retaining walls would range in length from 1,000 to 1,400 feet (305 to 427 meters) for the 3-foot (0.9-meter) and 8.2-foot (2.5-meter) covers, respectively. The Stephens report estimates material quantities in terms of linear feet for a reinforced concrete option or square feet for a dry-stack rock option. Material quantities are listed in **Table I–44**, along with the average and maximum heights of the retaining walls corresponding to the optional 3- and 8.2-foot (0.9- and 2.5-meter) cover thicknesses (Stephens 2005).

Table I–44 Summary of Material Disposal Area C Retaining Wall Quantities

Material Disposal Area C Cover	*Retaining Wall Dimensions*			
	Length (feet)	*Height (feet)*		*Surface Area (square feet)*
		Average	*Maximum*	
3-foot	1,001	4.6	11	4,571
8.2-foot	1,412	8.7	16	12,333

Note: To convert feet to meters, multiply by 0.3048; square feet to square meters, multiply by 0.0929.
Source: Stephens 2005.

A dry-rock retraining wall was assumed for this appendix. It is a mortarless wall using stacked rocks (or prefabricated reinforced concrete elements, usually L-shaped to enable interlocking successive layers) sloped against the horizontal force of backfill and provided with drain holes to avoid hydrostatic pressure. The depth of a concrete reinforced block often ranges from 1 to 1.5 feet (0.3 to 0.5 meters), depending on variables such as the height of the wall. Assuming 1.5-foot (0.5-meter) blocks, the total wall mass would be 184 pounds per square foot (900 kilograms per square meter) (DCA 2005). This information yields an estimate of about 420 tons (381 metric tons) of concrete reinforced block for the 4-foot (1.2-meter) cover and 1,135 tons (1,030 metric tons) of concrete reinforced block for the 8.2-foot (2.5-meter) cover. Assuming use of 22-ton (20-metric-ton) trucks, this implies (including a 10 percent contingency) 21 to 57 rock retaining wall shipments (one way).

For the remaining MDAs, cover materials were estimated on a nominal cover acreage, an assumed minimum thickness of added tuff of 3.0 feet (0.9 meters), and an assumed maximum thickness of added tuff of 8.2 feet (2.5 meters). Additional cover materials (topsoil, rock, soil amendment, gravel, etc.) were assumed, representing a 10 percent increase in in-place material volume. In addition, subgrade fill would be provided for the MDAs in quantities amounting to about 20 percent of the in-place tuff volume. For cover acreage, LANL expects that MDAs A and T would be capped as a single unit because only 120 feet (37 meters) separate them. LANL indicates that the cap for MDA A would extend 100 feet (30 meters) beyond the limits of the fence surrounding MDA A, thus covering 2.7 acres (1.1 hectares). The cap for MDA T would extend 100 feet (30 meters) beyond the limits of the fence surrounding the MDA, thus covering 6.2 acres (2.5 hectares) (LANL 2006a). The northern edge of the MDA T cap may require riprap (covering about 0.75 acre [0.3 hectare]) to control surface water runoff without erosion (LANL 2006a). For the remaining MDAs, cover acreages assumed for the *Borrow Source Survey* (Stephens 2005) are also assumed here. Material requirements are listed in **Table I–45**.

Current NNSA plans call for complete removal of the waste in MDA B (Section I.3.3.2.7); consequently, the volumes provided in Table I–45 for MDA B are conservative estimates based on assumed capping of all waste and contamination in MDA B. Also, because NMED has determined that the Consent Order requirements have been satisfied for the SWMUs comprising MDA U (NMED 2006b), capping may be unnecessary.

Table I–46 presents the assumed numbers of one-way shipments that would be required for delivery of these materials, assuming that each truck contains 22 tons (20 metric tons) of material and a 20 percent swell factor (Stephens 2005). A 10 percent contingency factor was assumed.

Table I–45 Cover Materials for Selected Material Disposal Areas (cubic yards)

Material Disposal Area	Cover Area		Minimum Cover Thickness (3 feet of tuff)			Maximum Cover Thickness (8.2 feet of tuff)		
	Acres	Square Feet	Tuff	Additional Material	Total	Tuff	Additional Material	Total
A	2.7	120,000	16,000	1,300	17,000	43,000	3,600	46,000
B [a]	6.0	260,000	35,000	2,900	38,000	95,000	7,900	100,000
T [b]	6.2	270,000	36,000	3,000	39,000	98,000	8,200	110,000
U [c]	0.2	8,700	1,200	97	1,300	3,200	260	3,400
AB	1.4	61,000	8,100	680	8,800	22,000	1,900	24,000

[a] Estimates for MDA B are based on the assumption that all waste and contamination at MDA B would be capped. Current plans call for complete removal of waste from MDA B. The Capping Option is retained for MDA B for completeness.
[b] Does not include 0.75 acres of riprap comprising 1,210 cubic yards, assuming a thickness of 1 foot.
[c] Estimates for capping MDA U are conservative because NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).
Note: To convert acres to hectares, multiply by 0.4047; square feet to square meters, multiply by 0.092903; cubic yards to cubic meters, multiply by 0.7646. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–46 One-Way Shipments for Delivery of Cover Materials for Selected Material Disposal Areas

Technical Area	Material Disposal Area	Minimum Cover Thickness (3 feet of tuff)			Maximum Cover Thickness (8.2 feet of tuff)		
		Tuff	Additional Material	Total	Tuff	Additional Material	Total
21	A	1,200	100	1,300	3,300	280	3,600
21	B [a]	2,700	230	2,900	7,400	620	8,000
21	T [b]	2,800	230	3,000	7,700	640	8,300
21	U [c]	91	8	98	250	21	270
49	AB (Areas 1-4)	630	53	690	1,700	140	1,900

[a] Estimates for MDA B are based on the assumption that all waste and contamination at MDA B would be capped. Current plans call for complete removal of waste from MDA B. The Capping Option is retained for MDA B for completeness.
[b] Delivery of riprap for MDA T would entail an additional 72 shipments.
[c] Estimates for capping requirements for MDA U are conservative because NMED has issued a Corrective Action Complete with Controls certification for SWMUs comprising MDA U (NMED 2006b).
Note: Because numbers have been rounded, the sums may not equal the indicated totals.

Small MDAs and landfills. Remediation may be required at several small MDAs and landfills.[50] Assuming that these MDAs are capped in place, the assumed coverage areas of the MDA caps, and capping thicknesses, are listed in **Table I–47**. Cover materials were estimated based on a nominal cover acreage, an assumed minimum thickness of added tuff of 3 feet (0.9 meters), and an assumed maximum thickness of added tuff of 8.2 feet (2.5 meters). Additional cover materials (topsoil, rock, soil amendment, gravel) were assumed, representing an increase in in-place material volume of 10 percent. In addition, subgrade fill was assumed to be provided for the MDAs in quantities amounting to about 20 percent of the in-place tuff volume. For material shipments, each truck was assumed to contain 22 tons (20 metric tons) of material with a 20 percent swell factor. A 10 percent contingency was assumed (**Table I–48**).

[50] *Some MDAs are not addressed in this section. MDA M has been remediated and has been recommended for no further action. MDA S is an active 100-square-foot (9.3-square-meter) test plot. MDA W is administratively complete. MDA X has been remediated and recommended for no further action. MDA K has been largely remediated, although two small aboveground disposal areas remain. Capping is not a reasonable option for these disposal areas.*

Table I–47 Cover Assumptions for Remaining Material Disposal Areas (cubic yards)

Technical Area – Material Disposal Area	Assumed Cover Area		Minimum Cover Thickness (3 feet of tuff)			Maximum Cover Thickness (8.2 feet of tuff)		
	Acres	Square Feet	Tuff	Additional Material	Total	Tuff	Additional Material	Total
06 - F	1.4	61,000	8,100	680	8,800	22,000	1,900	24,000
08 - Q	0.2 [a]	8,700	1,200	97	1,300	3,200	260	3,400
15 - N	0.92 [b]	40,000	5,400	450	5,800	15,000	1,200	16,000
15 - Z	0.23 [c]	10,000	1,300	110	1,400	3,600	300	3,900
16 - R	2.3 [d]	99,000	13,000	1,100	14,000	36,000	3,000	39,000
33 - D	0.11 [e]	4,800	640	53	690	1,700	150	1,900
33 - E	0.7 [f]	30,000	4,100	340	4,400	11,000	930	12,000
36 - AA	0.4 [g]	17,000	2,300	190	2,500	6,300	530	6,800
39 - Y	0.66 [h]	29,000	3,900	320	4,200	11,000	880	11,000

[a] Dimensions uncertain, estimated (LANL 1999b). The Capping Option for this MDA may be unlikely.
[b] Assumed a pit, 40,176 square feet.
[c] Dimensions uncertain. Assumed 10,000 square feet, with some existing material removed.
[d] Dimensions uncertain. Assumed 2.27 acres (LANL 2005c). The Capping Option for this MDA may be unlikely.
[e] Assumed cap is 2,400 square feet to account for depth of chambers.
[f] Assumed one large cap over four pits, a test chamber, and a shaft. Site comprises 0.7 acres.
[g] Assumed two separate trenches, with cap extending to 12 feet around sides of both trenches (i.e., footprint for one trench is 6,656 square feet; footprint for second trench is 10,056 square feet).
[h] Assumed one cap covers northern two trenches, and a second cap covers southern trench. Assumed cap extends 12 feet around all sides of both trench groups (i.e., northern footprint is 17,888 square feet; southern footprint is 11,008 square feet). Does not include any rock armor or other measures to preclude erosion from nearby ephemeral stream.
Note: To convert cubic yards to cubic meters, multiply by 0.7646; acres to hectares, multiply by 0.405; square feet to square meters, multiply by 0.0929. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–48 One-Way Shipments of Cover Materials for Remaining Material Disposal Areas

Technical Area – Material Disposal Area	Minimum Cover Thickness (3 feet of tuff)			Maximum Cover Thickness (8.2 feet of tuff)		
	Tuff	Additional Material	Total	Tuff	Additional Material	Total
06 - F	630	53	690	1,700	140	1,900
08 - Q [a]	91	8	98	250	21	270
15 - N	420	35	450	1,100	95	1,200
15 - Z	100	9	110	280	24	310
16 - R [a]	1,000	86	1,100	2,800	230	3,000
33 - D	50	4	54	140	11	150
33 - E	320	26	340	870	72	940
36 - AA	180	15	200	490	41	530
39 - Y	300	25	330	820	68	890

[a] The Capping Option for these material disposal areas may be unlikely.
Note: Because numbers have been rounded, the sums may not equal the indicated totals.

Capping these MDAs may result in generation of waste. Projected waste generation rates for these MDAs are listed in **Table I–49**. Most wastes were from MDAs R and Z. Both MDAs contain debris that is piled above grade, as well as buried debris. It was assumed that the aboveground debris from both MDAs would be removed before capping. This removal waste volume was assumed to be half of the total volume of debris estimated for these MDAs (see Section I.3.3.2.4.3).

In addition to MDAs, other landfills or contaminated areas may require capping. These include the landfill at Area 6 at TA-49 and contaminated soils in Area 12 at TA-49. Capping of the Airport Landfill was completed in 2007 and the landfill remedy completion report was submitted to and approved by NMED (LANL 2006a). Remediation decisions about Areas 6 and 12 of TA-49 have not yet been made.

Table I–49 Waste Generation through Fiscal Year 2016 from Capping Additional Material Disposal Areas

	Solid Waste	*Chemical Waste*	*Low-Level Radioactive Waste*	*Mixed Low-Level Radioactive Waste*	*Total*
Volumes [a] (cubic yards)	14,000	4,400	1,500	190	20,000

[a] In situ volumes. Because much material will be soil and debris, which will "swell" upon removal, and because of packaging inefficiencies, as-shipped volumes will be somewhat larger than in situ volumes.
Note: To convert cubic yards to cubic meters, multiply by 0.76456. Because numbers have been rounded, the sums may not equal the indicated totals.

Cover materials estimated for the two TA-49 contaminated areas are summarized in **Tables I–50** and **I–51**.

Table I–50 Cover Assumptions for Technical Area 49 Contaminated Areas (cubic yards)

Landfills and Areas	*Assumed Cover Area*		*Minimum Cover Thickness (3 feet of Tuff)*			*Maximum Cover Thickness (8.2 feet of Tuff)*		
	Acres	*Square Feet [a]*	*Tuff*	*Additional Material*	*Total*	*Tuff*	*Additional Material*	*Total*
Area 6, TA-49 [a]	5	218,000	29,000	2,400	31,000	79,000	6,600	86,000
Area 12, TA-49 [a]	0.3	13,000	1,700	150	1,900	4,800	400	5,200

TA = technical area.
[a] Cover area estimated (Stephens 2005).
Note: To convert cubic yards to cubic meters, multiply by 0.7646; acres to hectares, multiply by 0.405; square feet to square meters, multiply by 0.0929. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–51 One-Way Shipments for Technical Area 49 Contaminated Areas

Landfills and Areas	*Minimum Cover Thickness (3 feet of Tuff)*			*Maximum Cover Thickness (8.2 feet of Tuff)*		
	Tuff	*Additional Material*	*Total*	*Additional Material*	*Tuff*	*Total*
Area 6, TA-49 [a]	2,300	190	2,500	6,200	520	6,700
Area 12, TA-49 [a]	140	11	150	370	31	400

TA = technical area.
[a] Cover area estimated (Stephens 2005).
Note: Because numbers have been rounded, the sums may not equal the indicated totals.

MDA H. Remediation of MDA H has been addressed in corrective measure investigations and evaluations, as well as NEPA analyses (DOE 2004b). The remedy selected by NMED is encapsulation of shafts, installation of an engineered evapotranspiration cover, and installation of a soil vapor extraction system (see Section I.3.3.2.2.4) (NMED 2007a). The final evapotranspiration cover for MDA H (DOE 2004b) would require 2,185 cubic meters (2,860 cubic yards) of bulk materials obtained from onsite or local sources. Assuming a gross material density of 1.3 tons per cubic yard, 22-ton trucks, and 20 percent material swell, transporting 2,860 cubic yards of bulk materials over an estimated period of 5 months would require roughly 200 one-way shipments. Shipments of encapsulation material (grout or micro-concrete) and equipment would also be required. Assuming that remediation occurs during the time period covered in this SWEIS, bulk material volumes and shipments projected in this section could be augmented by those summarized above.

I.3.3.2.2.3 Hydraulic Barriers

An option for some MDAs may be to install hydraulic barriers to restrict lateral movement of moisture and contamination. The design and installation of hydraulic barriers at any MDA would be integrated with the design for its final configuration and would be based on a site-specific analysis that considered the environmental processes affecting the MDA, including surface and subsurface water dynamics. Two example installations are described below.

Using MDA A as an example, a hydraulic barrier could nominally be a high-density polyethylene (HDPE) sheet installed in a slit trench and backfilled with bentonite slurry. The barrier would extend along the north and east sides of the final cap, or about 800 feet (244 meters). The depth of the barrier would range from 20 to 30 feet (6.1 to 9.1 meters), assuming that the barrier is seated 5 feet (1.5 meters) into the bedrock. The average depth may be closer to 20 feet (6.1 meters), because a paleochannel at the west side of the cap forms the deeper limit and has limited lateral extent (LANL 2006a).

Sheet pile cutoff walls are installed by driving interlocking steel or HDPE sheets into the ground. The joints between individual sheets are typically plugged using clay slurry (steel sheets) or an expanding gasket (HDPE sheets). The steel sheets can be driven directly into the ground; the HDPE sheets are driven using a steel backing that is removed once the sheet is in place. Slurry walls can be constructed using a trench backfilled with a slurry mixture of bentonite and native materials, or a vibrating beam, where a steel plate is forced into the ground, and, as the plate is removed, bentonite is injected to fill the space of the beam. A typical slurry wall installed by trenching is 1.5 to 6.5 feet (0.5 to 2 meters) wide. It can be installed to 50-foot (15-meter) depths. Slurry walls using the vibrating beam method are narrower and typically installed at shallower depths (NFESC 2005).

An HDPE barrier installed by trenching may be conservative in terms of materials. An 800-foot (240-meter) wall would require 20,000 square feet (1,900 square meters) of HDPE, assuming an average depth of 25 feet (7.6 meters). Assuming a trench width of 3.3 feet (1 meter), 2,430 cubic yards (1,860 cubic meters) of bentonite and native materials would be needed.

Using MDA T as an example, a hydraulic barrier could again nominally be sheet HDPE installed in a slit trench and backfilled with bentonite slurry. The barrier would extend along the north and west sides of the cap, or 1,150 feet (350 meters). The depth of the barrier would range from 20 to 30 feet (6.1 to 9.1 meters), assuming the barrier is seated 5 feet (1.5 meters) into the bedrock. The average depth may be closer to the 20-foot (6.1-meter) depth, because a paleochannel at the west side of the cap forms the deeper limit and has limited lateral extent (LANL 2006a).

Assuming a length of 1,150 feet (350 meters) and an average depth or 25 feet (7.6 meters), about 28,750 square feet (2,670 square meters) of HDPE sheeting would be required, plus 3,500 cubic yards (2,700 cubic meters) of bentonite and native materials, assuming a trench width of 3.3 feet (1 meter).

I.3.3.2.2.4 Soil Vapor Extraction Systems

Soil vapor extraction systems are contemplated for several MDAs. The investigation work plans to be implemented for these MDAs are intended, in part, to determine the extent of volatile organic compound plumes detected beneath the MDAs (see LANL 2003k, 2003m, 2004c). Alternatives for addressing the plumes will be developed based on these investigations.

An often-used technology for removing soil vapors is an active soil vapor extraction system. A mechanical blower applies a vacuum to a well screened in the vadose zone, causing vapor surrounding the open interval of the well to be drawn to the surface. An active system was constructed and tested near the outer boundary of the volatile organic compound plume under MDA L. Two boreholes were constructed to depths of 215 feet (66 meters) in the immediate vicinity of two source zones. Volatile organic compounds removed from the plume were treated using granular activated carbon to absorb the chemical contaminants. The results from the pilot study will be used to evaluate the potential of soil vapor extraction systems for remediating the MDA L plume and to assess system design criteria. The results of the study will be considered as part of the corrective measure evaluation for the MDA (LANL 2005f, 2006d).

Active soil vapor extraction systems reach a point of limited contaminant flow where the cost per mass of contaminant removed, including operator attention, system maintenance, and a power source, is increased (LANL 1999e). Passive vapor extraction systems become useful as a polishing effort after active systems (or other methods) have reduced existing concentrations, or for situations where the existing concentrations in soil are too low for effective removal using active systems.

Passive soil vapor extraction, also known as barometric pumping, uses differences between atmospheric pressure and subsurface pressures to move contaminants from the vadose zone to the soil surface. Passive soil vapor extraction wells function like active air injection or extraction wells but do not use mechanical pumps. At any time, the atmospheric pressure at the surface and the soil gas pressure in the subsurface are different. If these two zones are connected by a vadose zone well, the pressure differential results in flow either into or out of the well. When atmospheric pressure is higher than subsurface pressure, air flows through wells into the subsurface. But when atmospheric pressure is lower than subsurface pressure, air flows out of the wells into the atmosphere, taking the volatile organic compounds in the gas phase (Initiatives 2001).

The system functions through a series of extraction wells set into the polluted area. Removal efficiency is improved through placement of one-way valves at the tops of the wells, allowing flow only out of the wells. Valves are small and inexpensive. A Baroball® valve is a small housing containing a ping-pong ball in a conical seat, permitting gas flow in one direction and needing minimal pressure (1 millibar) to lift the ball from the seat. Volatile organic compounds flowing out of the well can be captured and treated, commonly by passing the gases through a passive carbon absorption system. Incineration, catalytic oxidation, or condensation may be used depending on the contaminant (Initiatives 2001). Passive soil vapor extraction systems have been used at Hanford (Initiatives 2001) and Savannah River (WSRC 1997, 2000).

Whether active or passive, soil vapor extraction systems are unobtrusive. Although active systems require a source of power, the equipment is portable. Passive systems project only a small distance above the ground. Either system could probably be installed and used without interrupting procedures for final site cover.

I.3.3.2.2.5 Grouting the General's Tanks in Material Disposal Area A

Once used to store solutions containing plutonium, the two 50,000-gallon (189,000-liter) tanks in MDA A contain sludge containing transuranic isotopes (LANL 1991). One option is to solidify some or all of the sludge in place, using a system that achieves a final waste form that is reasonably homogenous. A jet grout system is assumed as a typical decontamination and solidification process. It can wash the interiors of tanks, mix tank contents before removing samples or introducing grout or other stabilization agents, or remove sludge from the tanks. It has been applied to a tank in LANL's TA-50 and to tanks at Oak Ridge National Laboratory. It can be used in tanks having interior obstructions (DOE 1999d).

Pipes are extended from a charge vessel into the sludge and supernatant covering the bottom of a tank. Existing pipes may be used or ones that are inserted. Water is added to the tanks, as needed, as well as chemicals (such as acids) to dissolve the sludge and remove material adhering to surfaces. A jet pump draws a vacuum into a charge vessel, sucking material into the charge vessel. When the mixture reaches a predetermined level in the charge vessel, the jet pump is switched from vacuum to pressure mode. The fluid is forced from the charge vessel into the tank, mixing the contents. The system may be vented to depressurize the charge vessel. The process is repeated until the sludge and supernatant are mixed. Then samples of the mixture can be obtained or grout introduced and mixed with the sludge and supernatant to provide a final solidified waste form. Otherwise, the mixture can be withdrawn, treated, and solidified. Secondary waste streams from jet mixer operations would include small volumes of personal protective equipment, contaminated equipment and hardware, plastic sheeting and containers, and structured steel support and platforms. Decontamination and reuse of some equipment may be possible (DOE 1999d).

Operational Elements. Operational elements for tank grouting include:

- Design, planning, permitting, and developing authorization documents and work orders and providing notifications to regulators or others as needed.
- Training of personnel, as needed.

- Demolishing or relocating existing fences or structures, as needed.
- Identifying utilities such as gas lines, as needed to maintain safety, and, as needed, providing additional utilities (for example, water or electricity).
- Mobilizing equipment.
- Performing preliminary characterization and analyses, including an initial criticality review.
- Preparing the site, including any needed excavations to provide access to the tanks, and installing safety and environmental detection equipment.
- Performing initial entry into the tanks and sampling and stabilizing the atmosphere within the tanks.
- Fabricating and installing equipment into the tanks for mixing, sampling, waste removal, and grouting.
- Sampling and analyzing tank contents and developing grout mix formulations from bench scale testing.
- Stabilizing the tank contents (mixing, grouting, removing, and solidifying material, as needed).
- Managing the small quantities of liquid or solid wastes generated from operations.
- Decontamination of equipment, as needed, and demobilization.
- Final stabilization of the site (for example, backfilling excavations and installing a final cover).

Equipment to be mobilized largely already exists at LANL. The major modules of the system are (AEAT 2004):

- Charge vessel skid (contains the charge vessel, de-mister, jet pumps, piping, and main process valves).
- Control hut (contains a valve rack and the system control panel).
- In-tank charge vessel with wash nozzle module and hydraulic power pack.
- Offgas skid (used to achieve a slight negative pressure on the system, it contains air treatment capacity such as high-efficiency particulate air [HEPA] filters).

After any initial excavation needed to access the tanks, and installation of platforms or scaffolding needed to support equipment, initial operations will focus on accessing the tanks at up to three locations in each tank. All activities will be in accordance with approved documented safety analyses. Because the tanks have been sealed for many years, hydrogen or other gases may have built up within the tanks. The atmosphere within the tanks must be stabilized; depending on the results of sampling and as authorized, the gas may be vented or treated. Following tank atmosphere stabilization, sludge samples will be obtained and analyzed for radioactive and chemical materials. If the sample results indicate RCRA constituents of concern, NMED would be notified and an appropriate path forward negotiated. Next, mixing, sampling, and benchscale testing of grout mixtures will be performed. The grout mixture may contain additives such as fly ash or bentonite. A hot-cell facility may be needed for sampling analysis. Once a final grout mixture is developed, and after any needed additional fabrication or modification of equipment, final stabilization of the tanks will take place consistent with established plans, authorizations, and all safety and environmental reviews and analyses.

Final stabilization of the tank may involve solidification of all material in place or may involve removal of some material and solidifying the remaining material in place.

Assuming that the radioactive material would be all solidified in place, a small concrete batch plant could be installed convenient to the MDA and grout produced as needed. Following these and other preliminary activities, the system would be initially operated to mix the sludge and the supernatant, and then grout would be introduced in a manner achieving a mixture of sludge and grout within the tanks. One approach would be to first mix and solidify the sludge (heel), and then use clean grout to fill the remaining void. The process for each tank could require about 250 cubic yards (190 cubic meters) of grout per tank.

Assuming that the jet grout system is first used to remove most of the sludge from the tank before stabilization, the removed sludge would be treated and solidified. Experience at three 50,000-gallon (189,000-liter) tanks at Oak Ridge National Laboratory demonstrated a removal efficiency ranging from 96 to 98 percent. The ratio of liquid to sludge volume in the material removed from each tank ranged from 2.4 to 9 (DOE 1999d).

The volume of sludge remaining in the General's Tanks is uncertain. Because most of the liquid was removed from the tank, there may be little remaining supernatant. The General's Tanks Characterization Activities Documented Safety Analysis estimates a sludge volume of 3.22 cubic yards (2.46 cubic meters) (LANL 2003j). Assuming that roughly 6 times as much liquid would be added as the original sludge volume, about 22.5 cubic yards (17.2 cubic meters) of mixture would be generated from each tank.[51] Assuming 95 percent removal efficiency, the mixture from the west tank would contain about 45.65 curies of alpha-emitting transuranic isotopes, while the east tank would contain about 11.6 curies. Assuming these mixtures at an increase in volume of about 50 percent results in a final waste volume of about 34 cubic yards (26 cubic meters) from each tank.

It is expected that waste solidification could take place using a mobile waste treatment system temporarily located at the site. Alternatively, existing LANL waste treatment and solidification capacity may be used, depending on the characteristics of the removed sludge. Removed mixture would be pumped from the system charge vessel into containers for safe transfer to the treatment facility.

[51] A document prepared by AEA Technology indicates that optimum mixing is achieved with a supernatant-to-sludge ratio of about 2 to 1 (AEAT 2004). A 6 to 1 ratio was assumed based on experience at Oak Ridge (DOE 1999d) and because the sludge has been left in place for several years.

Waste from either tank was assumed to be transuranic waste. Assuming use of 55-gallon (208-liter) drums at a 90 percent packing efficiency and 20 percent contingency, the solidified mixture would require about 8 one-way shipments to WIPP, assuming the waste can be contact handled.[52]

The heel left in the tanks after removal would be solidified as discussed above. About the same volume of grout would be required as before.

I.3.3.2.2.6 Schedules

Schedules for capping MDA G and MDA L are provided in Sections I.3.3.2.1.2.4 and I.3.3.2.1.3, respectively. For MDAs A, B, C, T, U, and AB, it was assumed that work periods for stabilization and capping schedules are completed by the schedules for submittals of their respective remedy completion reports. The assumed start and completion dates, and work periods, are listed in **Table I–52**.

Work periods for MDAs A, B, C, T, U, and AB were assumed by extrapolating from published estimates for MDAs G, L, and H (LANL 2005k, DOE 2004b). Work periods would depend on the volumes of capping materials emplaced, operational difficulties and constraints (such as existing nearby structures), economies of scale, funding, and other considerations. For simplicity, a thicker cap was assumed to require the same installation time as a thinner cap.

Stabilization and capping the remaining small MDAs (F, Q, N, Z, R, D, E, AA, and Y) and additional landfills may be carried out, if needed. Consistent with Consent Order schedules, remediation is assumed to start in FY 2007 and continue through FY 2016.

Table I–52 Temporal Assumptions for Capping Large Material Disposal Areas

Material Disposal Area	*Assumed Start of Stabilization and Capping*	*Assumed Completion of Stabilization and Capping*	*Assumed Work Time (months)*
A	1/11/2010	3/11/2011	14
B [a]	2/23/2010	6/23/2011	16
T	6/19/2009	12/19/2010	18
U [b]	5/6/2011	11/6/2011	6
AB	6/1/2014	1/31/2015	8
C	11/5/2008	9/5/2010	22
G	10/1/2010	12/28/2015	40
L	4/30/2010	6/30/2011 [c]	14

[a] Current plans call for complete removal of waste from MDA B. In January 2007, NMED approved the revised Investigation and Remediation Work Plan for MDA B that addresses removal (NMED 2007b). The Capping Option is retained in this Appendix for completeness.
[b] The Capping Option for MDA U is conservatively retained for completeness. NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).
[c] The current schedule for MDA L remediation calls for submittal of a remedy completion report by July 9, 2011.

[52] *This waste was conservatively included for the Capping Option.*

I.3.3.2.3 Sources of Bulk Materials for Stabilizing Material Disposal Areas

Materials required for placing a final cover of the MDAs could include fill material such as crushed tuff, gravel, cobbles and angular boulders, concrete reinforced block or similar dry-stack rock, sand, clay, top soil or rooting media, soil amendment, or compost. Additional bulk materials for stabilizing the MDAs may include barrier wall material such as HDPE sheets and bentonite or similar material. Grout would be needed to stabilize the General's Tanks.

To minimize costs and environmental impacts, bulk materials should be acquired close to the point of use. The *MDA Core Document* (LANL 1999b) and Stephens report (Stephens 2005) documented several sources within and local to LANL for bulk materials such as rocks, clay, or soil amendment. Information from the U.S. Geological Survey and the State of New Mexico confirms the extensive production of nonfuel minerals in New Mexico. The state was a significant producer of construction sand and gravel and dimension stone (USGS 2003). A 2001 reference lists roughly 300 mines, mills, and quarries in New Mexico (Pfeil et al. 2001). Production of masonry cement in 1996 was roughly 100,000 tons (WERC 2002).

The capping material needed in largest quantity is crushed tuff or other fill. The Borrow Source Survey (Stephens 2005) pointed out the potential for stockpiling fill and other material from construction projects, and that two sediment retention and flood control structures built at LANL following the 2000 Cerro Grande Fire could be removed by 2010 as watersheds become revegetated. These structures may provide a source of material for cover construction, perhaps up to 50,000 cubic yards (38,250 cubic meters) (Stephens 2005). But the most significant onsite source would be the existing LANL borrow pit in TA-61.

TA-61 Borrow Pit. Also known as the East Jemez Site, TA-61 is a long, narrow, and relatively small site created from a portion of TA-3 when LANL redefined its TAs in 1989 (LANL 1999d). It contains physical support and infrastructure facilities. In addition to the borrow pit next to East Jemez Road and east of the Royal Crest Manufactured Home Community, TA-61 contains the county landfill, which, when closed, would be the site of a solid waste transfer station.

TA-61 is bordered by TA-43, TA-41, and TA-02 to the north, TA-53 to the east, TA-60 to the south, and TA-3 to the east. Access to TA-61 is via East Jemez Road, a high-traffic publicly used two-lane thoroughfare traversing TA-61 lengthwise in an east-west orientation.[53]

The setting of TA-61 within LANL, and its topography, can be visualized in **Figure I–21**, which shows major physiographic features, the surrounding TAs, and the conceptual geologic model of Operable Unit 1114 (LANL 1993e). The ground slopes upward from east to west. TA-61 is bounded on the north by Los Alamos Canyon and on the south by Sandia Canyon, which is about 400 feet (120 meters) wide and 40 to 140 feet (12 to 43 meters) deep at TA-61 (LANL 1999d). The distance to the regional aquifer is 1,300 feet (396 meters) (LANL 2005a).

[53] *The entrance to the borrow pit is near a steep hill, and there is little room for an acceleration lane (LANL 2003j).*

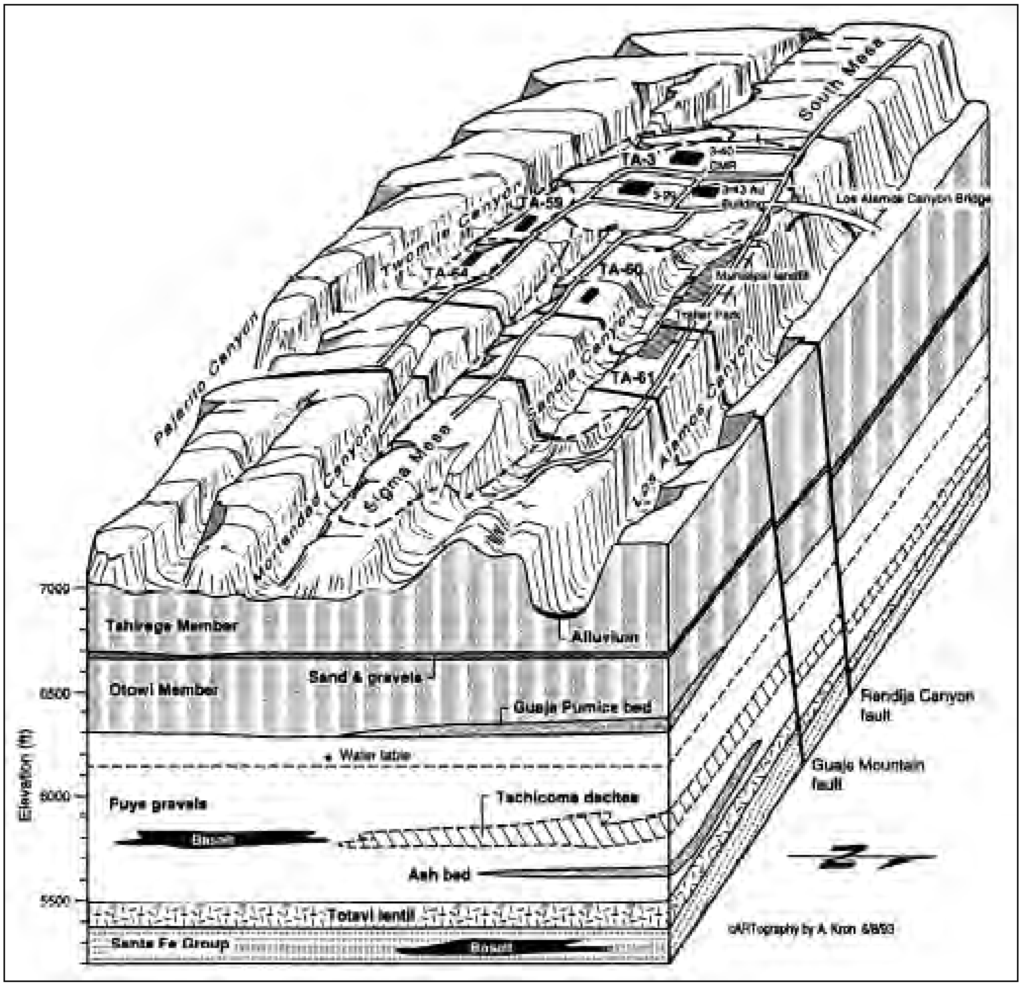


Figure I–21 Conceptual Geologic Model of Operable Unit 1114

Used for soil and rubble storage and pickup, the borrow pit is within a 43-acre (17-hectare) site (LANL 2003a). It is on the south side of East Jemez Road across from its intersection with La Mesita Road, which provides access to the Los Alamos Neutron Science Center (LANSCE). The borrow pit is 2 miles (3.2 kilometers) from the county landfill, a few thousand feet to the east of the trailer park, and across Sandia Canyon from TA-60, Sigma Mesa. A natural gas line is to the west (LANL 2004b, 2005a).

Figure I–22 is an aerial photograph of the triangular-shaped clearing in the forest that comprises the borrow pit (LANL 2003a). Figure I–22 shows the jog in the stream in Sandia Canyon that occurs at the borrow site.[54] **Figure I–23** is a view from within the pit looking to the east (LANL 2003a). The knoll to the left (north) in the figure shields the pit from visibility from East Jemez Road.

[54] *This suggests that if the borrow pit is expanded to the southwest, measures would have to be taken to ensure that drainage does not cause surface water quality problems*

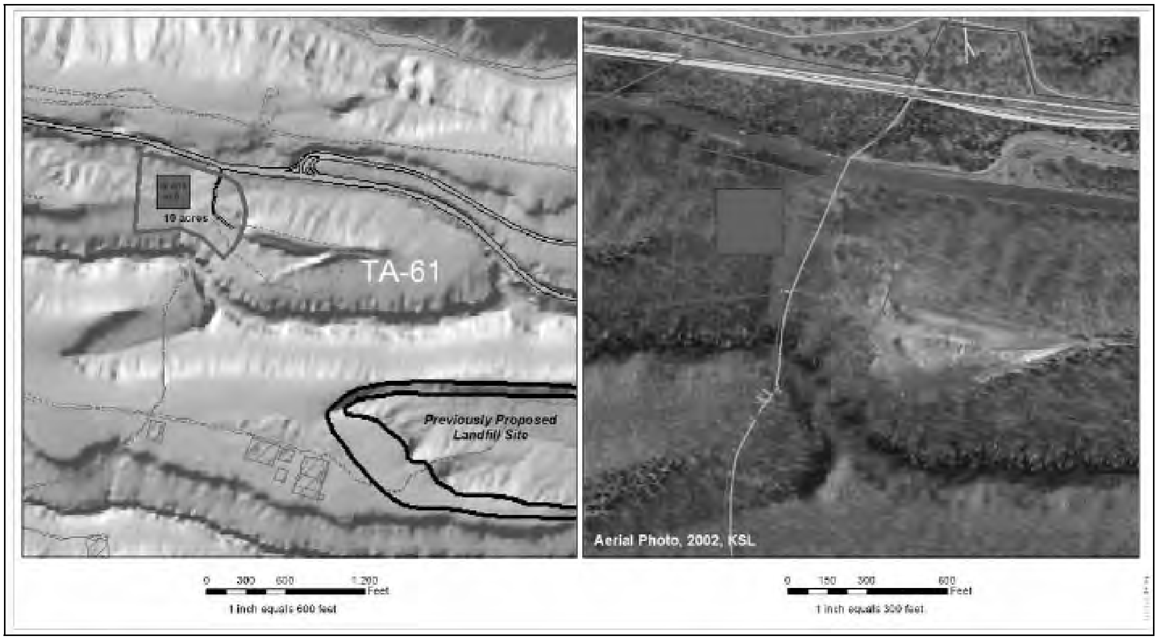


Figure I–22 Aerial Illustrations of Borrow Pit

Figure I–23 View to the East from within the Technical Area 61 Borrow Pit

I.3.3.2.4 Removal Option

Removals are difficult to characterize. Information is still being acquired through corrective measure investigation programs. Simplifying assumptions are made based on studies and experience at LANL and other DOE sites.

I.3.3.2.4.1 Operational Elements

Operational elements associated with removing any of the MDAs are summarized in the text box.

MDA Removal Operational Elements

- *Design, Planning, and Permitting* – Includes planning for site operations, including equipment and personnel coordination. Includes health and safety plans, site security plans, erosion control plans, etc. Includes permits and authorizations.
- *Demolishing/Relocating Existing Operations, Structures, or Materials* – Includes moving, demolishing, or relocating existing structures or operations.
- *Rerouting/Modifying Utilities, Pipelines, or Similar* – Includes rerouting or modifying water, electrical, telephone, or other underground or overhead lines as needed to preclude damage. Includes removal or rerouting of liquid waste or chemical piping to preclude damage.
- *Mobilization* – Includes mobilization and initial site placement of equipment such as cranes, backhoes, dump trucks, water trucks, and graders. Includes installation of a site management trailer. Includes site storage of equipment and initial mobilization of the workforce.
- *Site Preparation* – Includes explorations needed to determine the specific locations of disposed wastes, as well as other site-specific studies and tests. Includes clearing of existing vegetation. Includes the removal of asphalt or other existing covers over disposal units, such as topsoil and the top layer of crushed tuff over the MDAs. Includes removal and disposal of existing security fencing.
- *Perform Special Activities* – Includes activities unique to a specific MDA.
- *Exhumation* – Includes waste exhumation, sorting, characterizing, classifying, packaging as necessary, and shipping for treatment, storage, or disposal.
- *Regrading/Revegetation* – Includes spreading and fine-grading of topsoil, compaction using construction equipment, watering for dust abatement, and watering of planted areas for vegetation germination at approved levels.
- *Demobilization* – Includes demobilization of equipment, including removal of a site management trailer.
- *Health and Safety* – Includes developing a site health and safety plan; performing surface sampling and confirmation of nonhazardous site conditions; monitoring site activities; and conforming to standard construction health and safety policies, laws, and procedures.
- *Project Management* – Includes an onsite project manager or foreman, who reports daily site progress, as well as site office support. Includes specialists such as explosives experts.

Excavation would be preceded by extensive planning and site investigations to confirm the dimensions of the disposal units and the presence of other contamination and buried objects. Other preliminary site work could include permitting; demolishing or relocating existing operations, structures, or materials (as needed); rerouting or modifying utilities or pipelines (as needed); mobilization of equipment; and initial site preparation. Preliminary work may generate wastes requiring treatment and disposal.[55] It is assumed that a management area would be established near the MDA for heavy equipment and vehicles. A trailer or similar structure would be sited for management of operations. The size of the management area may depend on the size of the MDA and the complexity of removal operations, but, for most MDAs, would probably not exceed a few thousand square feet. An area for parking personal vehicles would be needed; in most cases; existing nearby parking lots or areas nearby the MDA could be used. Utilities would be made available, for example, by hooking up to existing utilities in the vicinity of the MDA. Water may need to be delivered by truck at some MDAs. Portable toilets would be installed in the staging area, and sanitary waste from the toilets would be trucked to a disposal location either on or offsite.

Preliminary work would include development of areas supporting waste removal. The scope and size of support operations would depend on the amount of waste to be removed from the MDAs and the hazards that the waste presents. Support operations could include:

- Capacity for storing and managing exhumed wastes and for decontaminating equipment, as needed
- Capacity for storing bulk materials such as excavation spoils, final cover materials, or demolition debris
- Capacity for preliminary classification of exhumed materials by hazard and staging for further management
- Capacity to process waste as needed for shipment for treatment or disposal
- Capacity to characterize the waste for its organic, inorganic, and radioactive material content

It is expected that this support capacity would be sized to support multiple activities, such as those proposed to support MDA remediation and DD&D at TA-21 (see Section I.3.3.2.7). For large operations, such as that proposed for TA-21, or for removal of large MDAs, support areas could cover several acres. Areas for managing exhumed wastes or stockpiling overburden or other bulk material removed as part of initial preparation would be protected from erosion or runon, airborne dispersion, and possible cross-contamination. There may be a need to construct temporary roads between the MDAs and the support areas.

Excavation and removal of uncontaminated topsoil or tuff can be performed using conventional equipment such as backhoes and bulldozers. On average, the top 3 feet (0.9 meters) of topsoil and existing cover soil was assumed to be removed from the existing MDA covers and

[55] *It was assumed that generation of solid waste, chemical waste, and low-level radioactive waste during site preparation would be the same as that for the Capping Option.*

stockpiled at a location as close as reasonably possible considering topography, best management practices, or the proximity of other facilities. The actual volume of the existing cover soil that would be removed will depend on the thickness of cover over each MDA. Maximum, minimum, and average thicknesses can vary considerably within each MDA and over all MDAs. A 3-foot (0.9-meter) thickness for nearly all MDAs was assumed as an average approximation. It represents all the preliminary work at the MDAs that requires movement of soil.

Some removed material may be contaminated. Soil exceeding screening levels would be disposed of as waste. Otherwise, soil meeting screening levels may still be contaminated. Soil not disposed of as waste was assumed to be stockpiled and returned to the excavation along with additional backfill obtained from a local borrow. After backfilling and compaction, topsoil, and related materials would be imported, and the thickness of this final cover would be about 6 inches (15 centimeters).

Only small portions of an MDA would be excavated and backfilled at one time.

Exhumation may take place within an enclosure such as a tension support dome when the waste contains materials that may present a significant inhalation hazard or when removal would be performed within close proximity to operating facilities at LANL or to members of the public. The enclosure would be moved as needed to each successive work area (see Section I.3.3.2.6).

Material would be excavated using heavy equipment. Depending on the hazard presented by the waste, excavation may be possible using conventional equipment such as tracked backhoes, or may require use of specialized equipment such as remotely operated or heavily shielded excavators. Procedures to screen, sort, and classify the removed material would also depend on the hazard presented by the waste. The rates of excavation, sorting, and classification of contaminated materials can vary greatly, depending on the hazard presented by the materials. Materials presenting an external or inhalation hazard would require more time to excavate, sort, and classify. If the material presents an external hazard, then remote operations may be required. If the material presents an inhalation hazard, then use of high-level personal protection equipment may significantly improve work efficiency.

Excavating many of the MDAs considered in this section would generate large quantities of contaminated materials containing hazardous constituents and radionuclides. The materials may present significant handling hazards (for example, external radiation or inhalation concerns) or may otherwise require special consideration because of security concerns. Procedures and equipment may be needed, for example, to contain exhumed compressed gas cylinders or other problematic wastes awaiting sampling and disposal, treatment of gases that cannot be transferred to another container or be transported on highways, hot-tapping of compressed gas cylinders, or excavation or removal of explosives. Remote-operated, shielded facilities may be needed to characterize, treat, and package wastes having high surface radiation levels.

Excavating shafts may be difficult. Removal of the material in shafts could be conducted in many cases using the trenching approach described in Section I.3.3.1.3.2 for MDA H. Many of the shafts in the MDAs have been drilled to roughly similar depths (about 60 feet [18 meters]). In other cases, cranes or specialized equipment may be required.

Volumes of uncontaminated soil removed and temporarily stockpiled during exhumation depend on the method assumed for exhumation, whether all waste is removed or only portions, the depth of excavation, and the configuration of the site.

Once exhumed, waste must be characterized and classified by type. Different types of waste have significantly different requirements for treatment, packaging, and disposal. It was assumed that recovered high explosives would be safely burned at a suitable location within LANL. For other types of radioactive and nonradioactive solid wastes, the total volume of contaminated material excavated from each MDA was estimated, and then the volume was distributed among the different waste types based on available information. It was assumed that the volumes implied by the nominal dimensions of the pits, trenches, and shafts give the total volume of contaminated material.[56] Backfill placed with the waste when disposed of was conservatively assumed to be contaminated. To assist in waste groupings, radionuclide inventories of the larger MDAs were assessed to provide a sense of radionuclide concentrations and external radiation levels that may be associated with exhumed wastes.

A June 2000 DOE study was used to estimate the volumes of transuranic and alpha-contaminated low-level radioactive wastes that might result from exhuming the MDAs.[57] This DOE study developed its estimates through surveys of DOE national laboratories. Estimates for LANL MDAs are summarized in **Table I–53** (DOE 1999g, 2000a). Note that “alpha-contaminated low-level radioactive waste” does not represent an official DOE classification of waste. Distinctions among low-level radioactive waste subtypes (such as low-activity radioactive waste, alpha-contaminated low-level radioactive waste, and others) were considered in this appendix to enable enhanced analyses of possible impacts of radioactive waste transportation.[58]

After classification and sorting, waste must be treated and disposed of or stored. Solid and chemical wastes would be sent to authorized treatment facilities or landfills. Low-level radioactive waste that is not mixed could be either disposed of onsite or sent to another site. No onsite disposal capacity now exists for mixed low-level radioactive waste.

---

[56] *The as-built dimensions of the pits, shafts, and trenches, often not documented, may be different from the nominal (design) dimensions. The waste volume and potentially contaminated backfill placed in the disposal units would be actually somewhat smaller than that implied by the nominal disposal unit dimensions, because of ramps and sloping walls within pits and trenches. Also, the waste was not placed all the way to the tops of the disposal units. Assuming the disposal unit dimensions, however, accounts for the likelihood of movement of small amounts of contamination laterally and (particularly) vertically downward outside the nominal boundaries of the disposal units after initial waste displacement.*

[57] *The great bulk of this transuranic-contaminated material was disposed of before operational distinctions between low-level radioactive and transuranic wastes were made at DOE sites.*

[58] *The estimated total volume of material that may meet the current definition of transuranic waste (22,100 cubic yards [16,900 cubic meters]) is somewhat larger than that assumed for the 1997 WIPP Disposal Phase Final Supplemental Environmental Impact Statement (about 18,300 cubic yards (14,000 cubic meters) of buried contact-handled transuranic waste and 157 cubic yards (120 cubic meters) of buried remote-handled transuranic waste) (DOE 1997a).*

Table I–53 Volumes of Transuranic-Contaminated Materials Estimated to be Within Los Alamos National Laboratory Material Disposal Areas

Technical Area	Material Disposal Area	*Transuranic-Contaminated Material Buried in Pits or Absorption Beds (cubic meters)*		*Transuranic-Contaminated Material Buried in Shafts (cubic meters)*		*Total Transuranic-Contaminated Material in Pits, Absorption Beds, and Shafts (cubic meters)*	
		Transuranic Waste [a]	*Alpha-Contaminated Low-Level Radioactive Waste* [b]	*Transuranic Waste* [a]	*Alpha-Contaminated Low-Level Radioactive Waste* [b]	*Transuranic Waste* [a]	*Alpha-Contaminated Low-Level Radioactive Waste* [b]
21	A	700	13,300	–	–	700	13,300
21	B	525 [c]	20,475 [c,d]	–	–	525 [c]	20,475 [c]
50	C	2,600	100,400 [e]	70	70	2,670	100,470
54	G	4,785	179,215	6	1,044	4,791	180,259
21	T	162	2,538	3,610	190	3,772	2,728
49	AB	–	–	4,400	–	4,400	–
21	V [f]	–	4,300 [f]	–	–	–	4,300 [f]
Total		8,772	320,228	8,086	1,304	16,858	321,532

[a] For the DOE study, this material was assumed to meet the current DOE definition of transuranic waste.
[b] For the DOE study, this material was assumed to meet the current DOE definition of low-level radioactive waste, but would contain alpha-emitting transuranic isotopes having half-lives exceeding 20 years and in concentrations between 10 and 100 nanocuries per gram. "Alpha-contaminated low-level radioactive waste" is not an official DOE waste category, but was considered for this appendix to enable enhanced analysis of possible impacts from radioactive waste transportation.
[c] More recent analyses of waste in MDA B (LANL 2006i) suggest that these estimates of transuranic and alpha-contaminated low-level radioactive waste volumes in MDA B may be over-conservative.
[d] The DOE database (DOE 1999g) estimates that 5,000 cubic meters of the alpha-contaminated low-level radioactive waste in MDA B may be mixed waste.
[e] The DOE database (DOE 1999g) estimates that 25,100 cubic meters of the alpha-contaminated low-level radioactive waste in MDA C may be mixed waste.
[f] The transuranic content of this waste was over-estimated. None of the material from MDA V removal (completed in May 2006) exceeded 10 nanocuries of transuranic radionuclides per gram of waste (LANL 2006a).
Note: To convert cubic meters to cubic yards, multiply by 1.308.
Sources: DOE 1999g, 2000a.

I.3.3.2.4.2 Waste and Bulk Material Requirements for Removal of Large Material Disposal Areas

This section summarizes estimates of wastes and bulk material requirements for removal of MDAs A, B, T, U, AB, C, G, and L. Summaries of waste generation and shipment of solid wastes from these MDAs are in **Table I–54**. Summaries of volumes and shipments of bulk materials such as soil and backfill are in **Table I–55**. Summaries for liquid wastes are in **Table I–56**, based on information from LANL (LANL 2006a).

The listed volumes include wastes from preliminary site work such as destruction of fencing and removal of concrete and asphalt slabs over portions of the MDAs. Listed volumes for both wastes and materials are in situ volumes. Shipment estimates for wastes and bulk materials reflect the assumption of 20 percent swell of soil once removed from the ground. This swell assumption is applied to removed waste because much of it will be soil and debris.

Table I–54 Waste Volumes and Shipments for Removal of Material Disposal Areas A, B, C, G, L, T, U, and AB

Material Disposal Area	*Solid*	*Chemical* [a]	*Low-Level Radioactive Waste*						*Transuranic Waste*		*Total*
			Low Activity	*Mixed Low Activity*	*Alpha*	*Mixed Alpha*	*Remote Handled*	*Mixed Remote Handled*	*Contact Handled*	*Remote Handled*	
Volumes (cubic yards)											
A	1,200	440	1,800	130	16,000	1,700	–	–	1,100	–	22,000
B [b]	10,000	3,100	9,800	1,000	20,000	6,500	–	–	690	–	51,000
C	22,000	10,000	22,000	2,700	99,000	33,000	6.6	0.7	3,400	46	190,000
G	1,500	–	620,000	69,000	210,000	24,000	1,200	140	6,300	3.9	940,000
L	54	3,300	–	–	–	–	–	–	–	–	3,400
T	43	–	230	32,000	–	3,600	–	–	4,900	–	41,000
U	20	–	570	12	–	–	–	–	–	–	600
AB	13	1,600	2,900	3,700	–	–	–	–	5,800	–	14,000
One-Way Shipments											
A	95	37	130	10	1,200	140	–	–	120	–	1,800
B [b]	760	260	690	82	1,600	520	–	–	80	–	4,000
C	1,700	850	1,500	220	7,900	2,600	3	1	400	70	15,000
G	110	–	44,000	5,500	17,000	1,900	590	66	730	6	70,000
L	4	280	–	–	–	–	–	–	–	–	280
T	3	–	16	2,600	–	280	–	–	570	–	3,400
U [c]	2	–	40	1	–	–	–	–	–	–	42
AB	1	130	200	300	–	–	–	–	670	–	1,300

[a] Includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for disposal in a sanitary landfill.

[b] These volumes and shipments are based on conservative assumptions about the quantities and radiological characteristics of waste from complete removal of waste from MDA B. Most recent projections of waste from MDA B removal are in Section I.3.3.2.7. Total volumes of waste from these more recent estimates are smaller than those presented in this table.

[c] These volumes and shipments are based on conservative assumptions about the waste's resulting from complete removal of MDA U. NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).

Note: Volumes are in situ volumes. As-shipped volumes would be larger because of swell of excavated material and packing efficiencies being smaller than 100 percent. Volumes include waste from preliminary site work such as fencing removal but not DD&D of structures. To convert cubic yards to cubic meters, multiply by 0.76456. Because numbers have been rounded, the sums may not equal indicated totals.

Table I–55 Volumes and Shipments of Bulk Materials for Removal of Material Disposal Areas A, B, C, G, L, T, U, and AB

Material Disposal Area	*Cover Removed*	*Additional Soil Removed*	*Total Stockpiled Soil Returned*	*Additional Fill*	*Topsoil*	*Total*
Volumes (cubic yards)						
A	6,100	12,000	18,000	21,000	1,100	58,000
B [a]	19,000	12,000	32,000	48,000	3,200	110,000
C	57,000	340,000	390,000	190,000	9,500	990,000
G [b]	220,000	2,900,000	3,200,000	930,000	36,000	7,300,000
L	4,800	9,500	14,000	3,300	810	33,000
T	–	270,000	230,000	41,000	3,200	540,000
U [c]	480	610	1,100	580	81	2,800
AB	6,800	12,000	18,000	14,000	1,100	52,000
One-Way Shipments						
A	430	840	1,300	1,500	78	4,100
B [a]	1,400	870	2,200	3,400	230	8,100
C	4,000	24,000	28,000	14,000	670	70,000
G [b]	15,000	210,000	220,000	66,000	2,600	520,000
L	340	670	1,000	230	57	2,300
T	–	19,000	16,000	2,900	230	38,000
U [c]	34	43	78	41	6	200
AB	480	830	1,300	990	80	3,700

[a] These volumes and shipments are associated with conservative assumptions about the quantities of waste resulting from complete removal of waste from MDA B. Removal of smaller volumes of waste from MDA B, as projected in Section I.3.3.2.7, should result in smaller volumes of bulk materials moved.

[b] Capping the remain disposal units in the existing Area G footprint following MDA removal is projected, depending on whether a thick or thin cap would be installed, to require from 190,000 to 510,000 cubic yards (140,000 to 390,000 cubic meters) of crushed tuff, and 160,000 cubic yards (120,000 cubic meters) of additional material. One-way shipments of crushed tuff would range from 15,000 to 40,000, with 12,000 shipments of additional material.

[c] The volume and shipments are based on conservative assumptions about removal of waste from MDA U. NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).

Note: To convert cubic yards to cubic meters, multiply by 0.76456. Because numbers have been rounded, the sums may not equal the indicated totals.

MDA A

This MDA consists of the two relatively long and narrow Eastern Pits, a large Central Pit, and the two General’s Tanks containing contaminated sludge. Challenges include: (1) the uncertain waste inventory; (2) its location between DP East and DP West; (3) the proximity of TA-21 to populated areas; and (4) the General’s Tanks.

The same buildings, piping, and other structures assumed to be removed as part of capping MDA A (Section I.3.3.2.2.1) would be removed before site exhumation.

Table I–56 Liquid Waste Volumes and Shipments from Large-Material-Disposal-Area Exhumation

Material Disposal Area	*Industrial*	*Hazardous*	*Low-Level Radioactive*	*Mixed Low Level*	*Total*
Volumes (gallons)					
A	–	–	75	–	75
B [a]	2,000	–	450	–	2,450
C	55	–	–	–	55
G	–	–	–	–	–
L	–	10,000	–	–	10,000
T	–	–	–	–	–
U	–	–	–	–	–
AB	–	–	–	–	–
One-Way Shipments [a]					
A	–	–	1 [b]	–	1 [b]
B [a]	3	–	1 [b]	–	3
C	1 [b]	–	–	–	1 [b]
G	–	–	–	–	–
L	–	13	–	–	13
T	–	–	–	–	–
U	–	–	–	–	–
AB	–	–	–	–	–

[a] More recent estimates of liquid waste from removal of MDA B (Section I.3.3.2.7) are smaller than those presented in this table.
[b] Indicates less than a full shipment.
Note: To convert gallons to liters, multiply by 3.78533.

Pits. The two Eastern Pits are each 125 by 18 by 13 feet deep (38 by 5.5 by 4.0 meters deep). The site was assumed to be initially graded, resulting in the removal of 0.2 acre (0.08 hectare) to an average depth of 3 feet (0.9 meters). About 970 cubic yards (742 cubic meters) of soil would be stockpiled for reuse. Excavation was assumed to resemble a general prismatoid, having walls sloping at angles of 45 degrees. This assumption results in an excavation having dimensions of 82 by 151 feet (25 by 46 meters) on the surface and 56 by 125 feet (17 by 38 meters) at the base of the excavation. The total amount of waste removed (before sorting) was estimated to be 2,200 cubic yards (1,700 cubic meters). In addition, 50 cubic yards (38 cubic meters) of contaminated soil was assumed to be removed from the former drummed storage area[59] (LANL 2006a).

Assuming the distance between the pits is 20 feet (6.1 meters), the total amount of clean soil removed (before bulking) is 2,400 cubic yards (1,900 cubic meters). This material was assumed to be stored and returned to the excavation, along with the material originally removed, and 2,200 cubic yards (1,700 cubic meters) (as compacted) of additional backfill. Topsoil and materials to promote vegetation would total 161 cubic yards (123 cubic meters).

The Central Pit has a depth of 22 feet (6.7 meters) and a total capacity of 18,700 cubic yards (14,300 cubic meters). The waste mass was assumed to have a surface area of 23,000 square feet (2,140 square meters); the length of this surface area (assumed to be a square) was 152 feet (46 meters). About 0.9 acre (0.36 hectare) of soil having an average thickness of

[59] *The soil was contaminated from leaking drums of stable iodine in a NaOH solution.*

3 feet (0.9 meters) would be initially removed (4,360 cubic yards [3,330 cubic meters]). The total volume of waste and soil then excavated would be 24,800 cubic yards (19,000 cubic meters), of which 6,060 cubic yards (4,600 cubic meters) would be soil meeting screening levels. This soil, as well as the top cover initially removed, would be stored and then returned to the excavation after waste removal, along with 18,700 cubic yards (14,300 cubic meters) of additional soil (as compacted in place). Topsoil and other growth media would be added and compacted, sufficient to cover an area of about 0.9 acre (0.36 hectare).

It was assumed that removal of contaminated material from the MDA pits would result in 916 cubic yards (700 cubic maters) of contact-handled transuranic waste and 17,400 cubic yards (13,300 cubic meters) of alpha-contaminated low-level radioactive waste (DOE 1999g, 2000a). These volumes represent in situ volumes and may be overestimates. It was assumed that the transuranic and alpha-low-level waste referenced in the DOE database was entirely contained in the Central Pit. The Eastern Pits were used during the 1940s, while the Central Pit was used during the 1970s, when programs generating transuranic-contaminated wastes were more extensive. Also, the projected total volume of waste from the Eastern Pits is much smaller than the total quantity of transuranic and alpha-contaminated low-level wastes, (18,300 cubic yards [14,000 cubic meters]) projected in the DOE database (DOE 1999g). It was assumed that 10 percent of the alpha-contaminated low-level radioactive waste would be mixed.

The remaining 425 cubic yards (325 cubic meters) of waste from removal of the Central Pit was assumed to be 40 percent solid waste, 15 percent chemical waste, 40 percent low-activity low-level radioactive waste, and 5 percent mixed low-activity low-level radioactive waste. (As reported in 1989 by Gerety, Nyhan, and Olive, the Central Pit in MDA A received waste from operations in TA-21, as well as plutonium-contaminated debris from the demolition of Building TA-21-12, a two-story frame and masonry building, after which it continued to receive waste through 1977 [LANL 1989]). A similar distribution was assumed for the 2,170 cubic yards (1,660 cubic meters) removed from the Eastern Pits. The 50 cubic yards (38 cubic meters) of contaminated soil removed from the former drummed storage area was assumed to be chemical waste. It was added to the chemical waste projected from the Eastern Pits.

General's Tanks. The General's Tanks have each been placed on four concrete piers and buried in two pits. The tanks are parallel to one another and about 20 feet (6.1 meters) apart. An 8-inch (70-centimeter) concrete slab was poured above both tanks (see Figure I–6), and soil was mounded above the concrete slab to about 5 feet (1.5 meters) above grade. A vent extends above one end of each tank. At the other end of each tank, a fill pipe leads to a concrete box on the surface.

Because the tanks are large and may be of questionable structural integrity, it was assumed that the tanks could not be removed intact. Rather, it was assumed that the tanks would be exposed and cut into sections for disposal. Removing the tanks in this manner is expected to be difficult, requiring extensive controls to protect health, safety, and the environment.

To expose the tanks, the soil mounded above the concrete slab above the tanks would be removed, as would the concrete slab. From Section I.2.5.2.1, it was estimated that the slab covers 3,860 square feet (360 square meters), and with the earth cover 10 percent more, for a total of 4.250 square feet (400 square meters). About 790 cubic yards (600 cubic meters) of soil cover would thus be removed and stored, and 95 cubic yards (73 cubic meters) of solid waste would be generated from removal of the concrete slab.

The excavation would likely extend to the bottom of the concrete piers and somewhat to the sides of the tanks. The depth of excavation was assumed to be 14 feet (4.3 meters); the surface area at the base of the excavation was assumed to be 6,000 square feet (560 square meters); and the excavation footprint at the top of the excavation was assumed to be 11,300 square feet (1,050 square meters). After the tanks were removed, the total excavated void would be 4,400 cubic yards (3,370 cubic meters).

Waste from removal of the tanks would include the eight concrete piers (33 cubic yards [26 cubic meters]), the two fill boxes (2.6 cubic yards [2.0 cubic meters]), some piping, contaminated soil, and contaminated metal scrap from cutting apart the tanks. The piping should be very small in volume. Contaminated soil volume was estimated by assuming a 3-foot-thick (0.9-meter-thick) contaminated band around the outsides of both tanks. This volume would be 700 cubic yards (530 cubic meters). It was assumed that all of this waste except for the sectioned tanks would be low-activity low-level radioactive waste.

It was assumed that before the tanks were dismantled, as much contamination would be removed as reasonably practical. In so doing, the inside walls and support structures would be washed using remotely operated equipment and available technologies such as the jet grout system discussed in Section I.3.3.2.2.5. The inventory within the tank would be then fixed in place to minimize dispersion during cutting.

As the tank is cut into sections, the sections would be placed into containers for disposal. Assuming that the tanks have an average thickness of 0.5 inches (1.3 centimeters), and assuming an average steel density of 0.286 pounds per cubic inch, about 54 tons (49 metric tons) of contaminated steel would be generated. This mass was increased by 10 percent to account for internal and ancillary structures, totaling 59 tons (53 metric tons). The tanks were in use for about 30 years before the stored material was removed, and about 30 years have passed since this removal occurred. The distribution of contamination within interior tank surfaces is unknown. Therefore, all of the waste from sectioning the tanks was assumed to be contact-handled transuranic waste. Each standard waste box for WIPP can contain 63 cubic feet (1.8 cubic meters) of waste, having a maximum weight of 4,000 pounds (1.8 metric tons). Assuming 4,000 pounds per box, this implies a transuranic waste volume of about 68 cubic yards (52 cubic meters). However, operational restrictions would probably reduce the amount of waste that could be shipped per container. Consistent with the approach taken for other wastes in this analysis (see Section I.3.5), the as-shipped volume was assumed to be somewhat larger.

The soil initially removed over the top of the tanks would be used as backfill. Some of the soil removed as part of exposing the tanks for dismantlement would be returned as well. About 210 cubic yards (160 cubic meters) of topsoil and other growth media would be spread on top of the backfill.

MDA B

The configuration and inventory of radioactive and hazardous constituents within MDA B is not well known. Additional challenges include: (1) the site is large and relatively close to the Los Alamos community; (2) the only paved road access to TA-21 lies immediately north of and parallels the site; (3) businesses exist on the other side of this road opposite to MDA B; and (4) the topography to the south of MDA B falls off quickly to BV Canyon.

LANL personnel plan an investigation and remediation program at MDA B that will remove all waste. For this appendix, a conservative analysis was performed on the quantities of waste that could result from complete removal of MDA B. This analysis resulted in larger quantities of wastes than those estimated by LANL for the investigation and remediation program (see Section I.3.3.2.7).

From the 2004 Investigation Work Plan for MDA B (LANL 2004d) the total volume of waste from MDA B removal was assumed to be 47,900 cubic yards (35,600 cubic meters). It was assumed that all waste in and about MDA B could be represented as a single trench having dimensions of 2,000 by 52 feet (610 by 16 meters). Assuming an average soil cover of 3 feet (0.9 meters), this corresponds to an average depth of the representative trench of 15.5 feet (4.7 meters) (including 12.5 feet [3.8 meters] of waste and backfill).

Soil was assumed to be removed to a depth of 3 feet (0.9 meters) over an area of 4 acres (1.6 hectares), which covers the footprint of the assumed representative trench (about 2.4 acres [0.97 hectare]) plus a small space (a little over 15 feet [4.6 meters]) around it. This results in an initial top cover removal of 19,400 cubic yards (14,800 cubic meters). A pit was assumed having an average depth of 12.5 feet (3.8 meters), sides sloping back at 45 degrees, a base of about 2,000 by 52 feet (610 by 16 meters), and a top footprint of 2,025 by 77 feet (617 by 23 meters). About 60,100 cubic yards (46,000 cubic meters) of waste and soil would be exhumed, of which 12,200 cubic yards (9,330 cubic meters) would be soil meeting screening levels. This soil would be temporarily stored. The remaining 47,900 cubic yards (36,600 cubic meters) of excavated material was assumed to be waste.

Using the DOE database for buried transuranic-contaminated waste (DOE 1999g, 2000a), it was assumed that complete removal of MDA B would generate 686 cubic yards (525 cubic meters) of contact-handled transuranic waste, 20,240 cubic yards (15,475 cubic meters) of alpha low-level radioactive waste and 6,540 cubic yards (5,000 cubic meters) of mixed alpha low-level radioactive waste. This assumption may be a significant overestimate.[60] A precise determination of the quantities of transuranic-contaminated materials buried in MDA B will result from the MDA B investigation and remediation program described in Section I.3.3.2.7.

The remaining 20,400 cubic yards (15,600 cubic meters) of waste was distributed as follows: 40 percent industrial solid waste, 15 percent chemical waste, 40 percent low-activity low-level radioactive waste, and 5 percent mixed low activity low-level radioactive waste. A relatively large fraction of the waste was assumed to contain hazardous constituents because it was an early

[60] *Average transuranic concentrations within MDA B were estimated based on projected radionuclide inventories, total waste volumes as assumed above, and a density of 1.6 grams per cubic centimeter. The average transuranic concentration was 0.4 nanocuries per gram.*

disposal site (1945 to 1948) used for disposal of all types of waste. The MDA received chemicals from laboratories and may include chemical waste disposal pits.

After waste is removed, the stored clean soil would be returned and backfilled, along with 47,900 cubic yards (36,600 cubic meters) (as compacted) of clean soil from a local borrow and 3,230 cubic yards (2,470 cubic meters) of materials intended to support revegetation.

MDA T

This MDA consists of four absorption beds plus 62 shafts used for disposal of higher-activity waste. The depths of contamination beneath the absorption beds are not well known. Contamination under Absorption Bed 1 has been found at 100 feet (30 meters) below ground surface. The shaft depths range to 60 feet (18 meters) below the ground surface. In addition to these challenges: (1) MDA T is located nearby existing structures in TA-West; (2) several buried pipes and utilities are in the vicinity of MDA T; (3) the North Perimeter Road runs along the northern side of MDA T; and (4) the land slopes steeply down to DP Canyon to the north of MDA T.

Removal would follow actions needed to relocate or remove nearby buildings, structures, and underground piping and utilities at risk (see Section I.3.3.2.2.1). DD&D of buildings and structures in the vicinity of MDA T is addressed in Appendix H, Section H.2.

Although the total volume comprising the four absorption beds is 2,100 cubic yards (1,630 cubic meters), the volume of contaminated material will be larger because water and liquid waste was discharged to the beds. For at least one absorption bed (Bed 1), contamination may extend to a depth of 100 feet (30 meters).

For this appendix, it was assumed that contamination moved vertically from all beds to a depth of 100 feet (30 meters). This assumption was considered conservative because it extends contamination to greater depths than may be realistic for all beds. This assumption results in a total contaminated volume beneath the beds of 35,600 cubic yards (27,200 cubic meters). Using the DOE transuranic waste database, it was assumed that removal of the beds would generate 212 cubic yards (162 cubic meters) of transuranic waste and 3,320 cubic yards (2,538 cubic meters) of alpha-contaminated low-level radioactive waste (DOE 1999g, 2000a). Because the beds received metals and organic and inorganic chemicals, much of this alpha-contaminated low-level radioactive waste may be mixed waste. For conservatism it was assumed that all would be mixed. It was also assumed the remaining 32,000 cubic yards (24,500 cubic meters) of waste would be mixed low-activity low-level radioactive waste.

The total volume of waste to be removed from the shafts was assumed to be equivalent to the envelope volume of the shafts, which is 5,200 cubic yards (3,990 cubic meters).[61] From the DOE database, it was assumed that complete removal of the shafts would generate 4,720 cubic yards (3,610 cubic meters) of transuranic waste and 250 cubic yards (190 cubic meters) of alpha-contaminated low-level radioactive waste (DOE 1999g, 2000a). Because the cement paste

[61] The shafts were not filled to the top with waste. Nonetheless, use of the envelope volume of the shaft to estimate waste volumes should offset the unknown extent to which contamination may have moved beneath and laterally from the shafts. Because the larger shafts, at least, were lined with asphalt, lateral movement may be small.

placed in the shafts probably contained most of the same chemicals discharged to the beds, most of both types of waste may be mixed. For conservatism, it was assumed that all would be mixed. It was also assumed that all transuranic waste resulting from shaft removal would be contact-handled transuranic waste.

The remaining waste volume implied by the shaft dimensions, 252 cubic yards (193 cubic meters) was assumed to be 90 percent low-activity low-level radioactive waste and 10 percent mixed low-activity low-level radioactive waste. It was assumed that this waste would consist mainly of contaminated backfill and asphalt.

Excavation of the bed contamination and the shafts was assumed to have base dimensions of 150 by 300 feet (46 by 92 meters) and a depth of 100 feet (30 meters). This size should be sufficient for all absorption beds plus the shafts. The sides for the top 20 feet (6.1 meters) of the excavation, which is soil, were assumed sloped at an angle of 3 horizontal to 1 vertical. The sides for the bottom feet of the excavation, which is rock, were assumed sloped at an angle of 0.5 horizontal to 1 vertical. These assumptions result in a surface footprint of 175,000 square feet (16,300 square meters) and a total removed volume of 266,000 cubic yards (203,000 cubic meters) of soil, rock, and waste (LANL 2006a).[62] Subtracting waste, 225,000 cubic yards (172,000 cubic meters) of uncontaminated soil would be stockpiled. This material would be returned to the excavation along with 40,800 cubic yards (31,200 cubic meters) of additional fill (as compacted) from a local borrow. The top of the excavation would be replanted, requiring 3,240 cubic yards (2,480 cubic meters) of additional material.

MDA U

MDA U consists of two absorption beds, each having lengths of 80 feet (24 meters), widths of 20 feet (6.1 meters), and depths of 6 feet (1.8 meters) below the original ground surface. A portion of the contamination in the absorption beds was removed in 1985 by excavating a 20- by 100- by 4-to 13-foot (6.1 by 30 by 1.2 to 4.0 meter) trench. For this appendix, the remaining contamination was assumed to be a volume of material 60 by 20 by 13 feet deep (18 by 6.1 by 4 meters deep), or 578 cubic yards (442 cubic meters).[63]

It was assumed that the top 3 feet (0.9 meters) of soil would be removed over an area of 2,630 square feet (244 square meters), which covers the 60- by 20- foot (18- by 6.1-meter) area addressed above plus 15 feet (4.6 meters) on all sides. This would result in the initial removal of 480 cubic yards (370 cubic meters) of soil cover. Excavating the waste was then modeled as a pit having a base dimension of 60 by 20 feet (18 by 6.1 meters), a surface footprint of 86 by 46 feet (26 by 14 meters), and a volume of 1,190 cubic yards (910 cubic meters). This volume was assumed to comprise 580 cubic yards (440 cubic meters) of waste and 610 cubic yards (470 cubic meters) of soil meeting screening action levels. This soil would be stockpiled for later return to the excavation.

---

[62] *Uncontaminated topsoil (such as that over the shafts) is included in this volume.*

[63] *The 2006 Investigation Report for MDA U concluded that neither additional corrective action nor further characterization was required and that the land use be maintained as industrial (LANL 2006e). NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006a). The Removal Option is herein considered for completeness.*

The waste removed from MDA U was assumed to consist of low-activity and mixed low-activity low-level radioactive waste. This assumption is consistent with that for excavation of MDA V (LANL 2004j), which comprises a set of absorption beds used to receive liquid wastes from a laundry. Similar to MDA V, it was assumed that 98 percent would be low-activity low-level radioactive waste and 2 percent would be mixed low-activity low-level radioactive waste.[64]

After waste removal, the 1,090 cubic yards (840 cubic meters) of removed topsoil and clean soil from the excavation would be returned and compacted. An additional 580 cubic yards (444 cubic meters) (as compacted) of clean soil would be delivered, as would 81 cubic yards (62 cubic meters) of materials to support vegetation.

MDA AB

The hydronuclear and support shafts at Areas 1, 2, 2A, 2B, and 4 in MDA AB contain large inventories of plutonium, uranium, beryllium, and lead and are at depths to 142 feet (43 meters) below ground surface. Shafts at Area 3 in MDA AB have much smaller levels of contamination to depths of 57 to 142 feet (43 meters). Wastes resulting from exhumation of MDA AB were assumed to consist of two groups: concentrated waste from the bottoms of the shafts, and lower-activity material, including surface contaminated metals and other wastes that were placed in dump and test shafts.

Regarding the first group of wastes, because large quantities of lead and beryllium were used in the tests, all of the wastes possibly generated from exhuming the wastes at the bottom of the shafts were assumed to be either mixed waste or chemically hazardous waste. The DOE database on buried transuranic-contaminated material (DOE 1999g, 2000a) estimates that the bottoms of the shafts contain 5,755 cubic yards (4,400 cubic meters) of material that would meet current definitions of transuranic waste. This estimate is consistent with an assumption that the bulk of the contamination is within a radius of about 10 feet (3 meters) from the detonation points in the 37 shafts (LANL 1992b) where plutonium was used in the tests. Regarding the other test shafts, 6 shots used uranium-235, 7 shots used uranium-238, 11 shots used tracers, and 11 shots were containment shots (LANL 1992b). Possible waste volumes from exhuming the contamination from these shots were estimated by determining the volumes represented by 10-foot-radius (3-meter-radius) spheres of contamination at the bottoms of the shafts. The uranium and tracer shot contamination was assumed to be mixed low-activity low-level radioactive waste. The containment shot contamination was assumed to be chemical waste.

Regarding the second group of wastes, it is difficult to project those shafts that may contain contaminated material and the depths to which the material was placed before backfilling.[65] The summed depth of all test shafts is 5,070 feet (1,550 meters). Assuming 6-foot-diameter (1.8-meter-diameter) shafts, on average, a total volume in the shafts of 5,310 cubic yards (4,060 cubic meters) is implied. Assuming that, on average, the bottom half of all shafts would

---

[64] The MDA U beds probably received organic and inorganic chemicals, plus acids and oils, implying that much of the waste originally in the beds may have been mixed. However, most of the original contamination has been removed, and the extent to which removal of residual contamination may generate mixed waste is unknown.
[65] Burial depth may be highly variable. Waste was dumped in the test holes and in an unknown number of shallow holes of small diameter.

be contaminated, 2,660 cubic yards (2,030 cubic meters) of low-activity low-level radioactive waste would be generated. It was assumed that 10 percent of this waste would be mixed.

Excavating the waste presents a challenge because of the depth of the contamination and because of the contaminated metal and other materials disposed of in the shafts. Excavation might be accomplished partly using conventional excavators such as backhoes and partly using remote techniques such as suspending excavating tools from cranes.

It was assumed that the top 3 feet (0.9 meters) of soil would be removed over the six main areas composing MDA AB. Assuming a total surface area over these six areas of 1.4 acres (6.6 hectares), the total volume of earth removed would be 6,780 cubic yards (5,180 cubic meters). Assuming that about 3 feet (0.9 meters) around each existing 6-foot-diameter (1.8-meter-diameter) shaft would be removed (that is, 12-foot-diameter (3.7-meter-diameter) shafts would be excavated), then 25,600 cubic yards (19,600 cubic meters) of waste and soil would be removed before sorting between waste and clean soil. This would result in 11,700 cubic yards (8,950 cubic meters) of material meeting screening levels and 13,900 cubic yards (10,600 cubic meters) of waste. The material meeting the screening levels would be placed back into the holes, as well as other stored material. About 13,900 cubic yards (10,600 cubic meters) of clean crushed tuff would be imported from a local borrow, as well as 1,130 cubic yards (864 cubic meters) of materials intended to promote vegetation growth.

MDA C

MDA C is a large disposal area consisting of six large radioactive waste pits, a smaller chemical pit, and 108 shafts. Both the shafts and the pits contain a variety of chemicals, some of which may be reactive. The shafts were usually used for disposal of wastes presenting an external radiation hazard. MDA C is immediately south of structures associated with TA-50 waste management operations.

Removal would follow actions needed to relocate or remove nearby buildings, structures, and underground piping and utilities at risk.

The physical relationship of the various rows of shafts with respect to the pits presents safety concerns. Assuming excavation of Pit 3, which has an as-built depth of 25 feet (7.6 meters), there may be concern about the potential for sidewall collapse leading to exposure of the contamination in Shaft Group 2. Assuming excavation of Pits 1 through 4, there may be concerns about end-wall collapse leading to exposure of contamination in Shaft Group 3. A retaining wall may be needed between Shaft Group 1 and Pit 5, or a wall between Shaft Group 3 and the ends of Pits 1 through 4.

From the nominal dimensions of the shafts and pits, the projected volumes of wastes are:

- Pits: 190,830 cubic yards (145,900 cubic meters)
- Shafts: 198 cubic yards (151 cubic meters)

This results in a total waste generation of about 191,000 cubic yards (146,000 cubic meters).

Assuming a surface area of 11.8 acres (4.8 hectares) (Stephens 2005), a volume of 57,100 cubic yards (43,660 cubic meters) of surface soil would be removed and stockpiled.

Excavation was assumed to occur in two groups: one group is Pit No. 6 and the chemical pit, and the second is the remaining pits plus the shafts. Regarding the first group, assuming the excavation walls slope at angles of 45 degrees from the pits, and assuming an average excavation depth of 25 feet (7.6 meters), removing Pit 6 and the chemical pit would excavate 48,800 cubic yards (37,300 cubic meters) of waste and 17,200 cubic yards (13,140 cubic meters) of clean soil.[66] Regarding the second group, assuming that removal of the pits would include excavating the spaces between the pits, the area covered by the footprint of these pits and shafts would cover 10.5 acres (4.2 hectares). Assuming the soil on all sides of this footprint would be sloped at 45-degree angles, and assuming an average excavation depth of 25 feet (7.6 meters), 318,000 cubic yards (243,000 cubic meters) of clean soil would be excavated along with 142,000 cubic yards (109,000 cubic meters) of waste.

From the DOE database on buried transuranic contamination (DOE 1999g, 2000a), it was assumed that exhuming the MDA C pits would generate about 3,400 cubic yards (2,600 cubic meters) of transuranic waste (including 880 cubic yards [675 cubic meters] of mixed transuranic waste) and 131,240 cubic yards (100,400 cubic meters) of alpha-contaminated low-level radioactive waste, of which 32,810 cubic yards (25,100 cubic meters) would be mixed waste. It was assumed that transuranic waste generated from exhuming pits would be contact-handled waste. Assuming a total waste volume of 191,000 cubic yards (146,000 cubic meters), then the remaining radioactive waste would amount to 54,300 cubic yards (41,500 cubic meters). Exhuming the chemical pit was assumed to generate 2,000 cubic yards (1,530 cubic meters) of hazardous waste. The remaining waste from pit exhumation was assumed to consist of 40 percent solid waste, 15 percent chemical waste, 40 percent low-activity low-level radioactive waste, and 5 percent mixed low-activity low-level radioactive waste. These distributions were assumed because the pits were used mostly in the 1950s, and disposal logbooks as well as other information suggest that the pits were used for disposal of hazardous constituents as well as general trash and demolition waste (see Section I.2.5.4).

From the DOE database on buried transuranic-contaminated material (DOE 1999g, 2000a), it was assumed that exhumation of the MDA C shafts would generate 92 cubic yards (70 cubic meters) of transuranic waste and 92 cubic yards (70 cubic meters) of alpha-contaminated low-level radioactive waste. Similar to the assumptions for waste resulting from exhuming MDA G shafts (see below), it was assumed that half of the transuranic waste would be remote-handled waste. It was assumed that 10 percent of the alpha-contaminated waste would be mixed waste.

The total volume of waste implied by the shaft dimensions is 197 cubic yards (151 cubic meters). Subtracting the transuranic and alpha-contaminated low-level radioactive waste leaves 14 cubic yards (11 cubic meters) of waste. This waste was assumed to be low-level radioactive

---

[66]*Assuming a pit having walls sloping at a 1:1 ratio and an average depth of 25 feet (7.6 meters), the surface area on the bottom of the excavation would be 109 by 505 feet = 55,000 square feet (5,110 square meters). The surface area at the top of the excavation would be 159 by 555 feet = 88,245 square feet (8,200 square meters). This provides a conservative estimate of soil and waste that may be removed from the excavation. However, shoring may be required along the northern edge of the excavation to avoid damage to structures, utilities, and piping. Shoring could reduce excavated volumes by roughly 0.5 (25 by 25 by 505 feet) = 160,000 cubic feet (4,530 cubic meters).*

waste. A conservative analysis of the MDA G shafts, which were used during a time that overlapped the use of shafts at MDA C, suggests that up to 50 percent of the originally emplaced waste in MDA G may be remote-handled waste. This estimate was applied to the waste in the MDA C shafts. Therefore, it was assumed that half of the remaining 14 cubic yards (11 cubic meters) of waste from shaft removal would be remote-handled low-level radioactive waste and half would be low-activity low-level radioactive waste. Similar to assumptions for other MDAs, it was assumed that 10 percent of both the remote-handled and low-activity low-level radioactive wastes would be mixed wastes.

After waste removal, the stockpiled soil meeting screening levels would be returned to the excavation, along with 191,000 cubic yards (146,000 cubic meters) of additional backfill and about 9,520 cubic yards (7,280 cubic meters) of material promoting vegetation growth.

MDA G

This MDA is located within Area G, which contains active waste disposal units. Current waste management facilities and operations at Area G will be removed or relocated as addressed in Appendix H, Section H.3. It was conservatively assumed there would be extensive removal of the disposal units in MDA G to bound impacts that may result from MDA G remediation. As an upper-bound case, it was assumed that removal would involve all pits through 37, all four trenches used for transuranic waste storage,[67] and 194 shafts. The total volume of waste to be generated from pit removal was assumed to correspond to the field-measured volumes for the pits as given in the Historical Investigation Report for MDA G (LANL 2004c). (For other MDAs, because field-measured volumes were generally unavailable, envelope volumes implied by nominal pit dimensions were assumed.) The total volume of waste thus assumed to be generated from MDA G removal was 931,000 cubic yards (712,000 cubic meters) from the pits and trenches and 3,880 cubic yards (2,970 cubic meters) from the shafts.

It was assumed that the excavation footprint for MDA G removal could be approximated by a 40-acre (16-hectare) rectangle having sides of 4:1. It was assumed that exhumation would be nominally preceded by removal of the top 3 feet (1 meter) of soil over about 45 acres (18 hectares). Assuming an average excavation depth of 60 feet, and assuming an excavation having walls sloping at 45-degree angles, then exhumation would remove about 3,875,000 cubic yards (2,962,000 cubic meters) of waste and soil. After separating waste, about 2,940,000 cubic yards (2,248,000 cubic meters) of soil meeting screening levels would be removed and stockpiled near MDA G for backfilling into the excavation.

Although disposal operations began at MDA G in 1957, it was used later than most of the other MDAs considered in this section. Therefore, it was assumed that MDA G was not used as a general depository for all types of waste, but was used exclusively for radioactive wastes, some of which contained RCRA-constituents.

From the DOE database on buried transuranic contamination (DOE 1999g, 2000a), it was assumed that removal of the MDA G pits would generate 6,260 cubic yards (4,785 cubic meters) of transuranic waste and 234,400 cubic yards (179,215 cubic meters) of alpha-contaminated low-

[67] The transuranic waste in Trenches A–D will be removed and shipped to WIPP, as addressed in Appendix H, Section H.3. The backfill in these trenches was conservatively assumed to be contaminated and was thus included in the removal volumes.

level radioactive waste. The radioactive inventory within the pits composing MDA G was estimated using information from the Area G Performance Assessment and Composite Analysis (LANL 1997). Analysis of this inventory suggested that little, if any, of the transuranic waste that would be generated from MDA G removal would be remote handled. Hence, all was assumed to be contact-handled. About 10 percent of the alpha-contaminated low-level radioactive waste was assumed to be mixed waste. The remainder of the waste that would be generated from MDA G pit removal was assumed to be low-activity and remote-handled low-level radioactive waste.

This remaining low-level radioactive waste consists of originally emplaced waste and backfill that was assumed to be contaminated. An analysis of the originally emplaced waste suggests that up to 107 cubic yards (81.5 cubic meters) of this waste could be remote-handled low-level radioactive waste. The remaining originally emplaced waste and backfill was assumed to be low-activity low-level radioactive waste. Ten percent of the remote-handled and low-activity low-level radioactive waste was assumed to be mixed waste.

From the DOE database on buried transuranic contamination (DOE 1999g, 2000a), it was assumed that removal of the MDA G shafts would generate 7.8 cubic yards (6 cubic meters) of transuranic waste and 1,370 cubic yards (1,044 cubic meters) of alpha-contaminated low-level radioactive waste. A conservative analysis of the radionuclide inventories in the shafts indicated that up to about 50 percent could be remote-handled. Therefore, half of the transuranic waste from postulated removal of the shafts was assumed to be remote handled. About 10 percent of the alpha-contaminated low-level radioactive waste was assumed to be mixed waste.

The remaining 2,510 cubic yards (1,920 cubic meters) of the waste generated from shaft removal was assumed to be low-level radioactive waste. Similar to the assumption above for transuranic waste, it was assumed that half would be remote handled low-level radioactive waste and half would be low-activity low-level radioactive waste. It was assumed that about 10 percent of both types of waste would be mixed waste.

It was assumed that the remaining disposal units within the existing Area G footprint would be capped using either a thin or thick cap as addressed in Section I.3.3.2.1.2.3. But the cap was assumed to cover 25 acres (10.2 hectares) rather than 65 acres (26.3 hectares). Projected volumes and shipments of bulk capping materials are in a footnote to Table I–55.

MDA L

MDA L is a relatively small site once used for disposal of chemical waste. It is contained within Area L, which is currently used for authorized storage of RCRA, PCB, and mixed waste. It was assumed that all waste to be generated from MDA L removal would be hazardous waste. Disposal units subject to corrective action are listed in Table I–39. Decisions about remediation of MDA L disposal units (pursuant to the Consent Order or for other reasons) will be made in the future. For conservatism, it was assumed that all disposal units would be removed. The total waste volume from its pit, impoundments, and shafts was estimated to be 3,280 cubic yards (2,505 cubic meters).

In addition to structures removed as addressed in Appendix H, Section H.3, it was assumed that the fence near the working area would be removed and disposed of as solid waste, and a temporary security fence would be emplaced at a distance from the work area and tied into the remaining fence around MDA L. About 80 cubic yards (61 cubic meters) of asphalt would also be removed, of which half was assumed to be solid waste and half chemical waste. It was assumed that about 1 acre (0.4 hectare) of land would then be removed at a depth of about 3 feet (0.9 meters), resulting in 4,840 cubic yards (3,700 cubic meters) of soil for temporary storage.

Excavation may be difficult, particularly for shafts, because of their proximity to nearby structures and LANL operations. The pits were dug to depths of 10 to 12 feet (3.0 to 3.7 meters), and could possibly be exhumed using standard construction equipment. But the shafts have been drilled to 60-foot (18-meter) depths, and their excavation may require use of cranes. Shoring and specialized removal techniques may be needed. An excavation having sloping walls was assumed for the pit and impoundments. The base was assumed to be 80 by 300 feet (24 by 91 meters), the top footprint 324 by 104 feet (99 by 32 meters), and the depth 12 feet (3.7 meters). This results in a total excavated volume of 12,800 cubic yards (9,770 cubic meters), of which 3,280 cubic yards (2,505 cubic meters) would be waste and 9,500 cubic yards (7,260 cubic meters) would be soil meeting screening levels. This excavated soil would be stockpiled at a nearby location for replacement into the excavation. Additional crushed tuff would be backfilled. A final cover would be emplaced, requiring about 810 cubic yards (620 cubic meters) of material. An alternate proposal involving a larger amount of excavated material was submitted to NMED in January 2008 (LANL 2008a).

I.3.3.2.4.3 Wastes and Materials for Removal of Remaining Material Disposal Areas

Waste volumes from removal of several additional small MDAs are summarized in **Tables I–57**, while shipments are presented in **Table I–58**. Additional materials excavated and returned, as well as additional backfill and cover material, are presented in **Tables I–59** and **I–60**.

Less information exists about these remaining MDAs compared with previous MDAs. Waste volumes from removal of each MDA were assumed to be given by the nominal volumes of all disposal units composing the MDA (length by width by average depth). Unless the MDA includes aboveground debris (MDAs Z and R), it was assumed that 3 feet (0.9 meters) of topsoil would be removed and stored. The waste and soil then removed was represented as a general sigmatoid having walls sloping at 45-degree angles. The waste would be sorted into waste type, and clean soil would be returned along with additional fill from a LANL or local borrow pit. An additional 0.5 feet (15 centimeters) of topsoil, soil amendment, and other material would be delivered and emplaced.

The waste removed from the excavation was assumed to be distributed among different types of waste based on information from LANL (LANL 2006a). Estimates of liquids that may be generated during removal were based on LANL information (LANL 2006a).

Table I–57 Waste Projections for Removing Remaining Material Disposal Areas

Nonliquid Wastes (cubic yards) [a]					
Material Disposal Area	***Solid Waste***	***Chemical Waste*** [b]	***Low-Level Radioactive Waste*** [b]	***Mixed Low-Level Radioactive Waste*** [b]	***Total Waste Volume***
F [c]	–	–	11,000	–	11,000
Q [d]	3,600	18	–	–	3,600
N [e]	10,000	330	2,700	330	13,000
Z [f]	3,000	1,100	3,000	370	7,400
R [g]	26,000	7,700	–	–	33,000
D [h]	12,000	–	12,000	–	24,000
E and K [i]	1,800	2.2	440	1.1	2,200
AA [j]	1,300	380	2,100	–	3,800
Y [k]	5,300	–	–	–	5,300
Liquid Wastes (gallons)					
Material Disposal Area	***Industrial Waste***	***Hazardous Waste***	***Low-Level Radioactive Waste***	***Mixed Low-Level Radioactive Waste***	***Total Waste Volume***
F	–	–	–	–	–
Q	–	25	–	–	25
N	–	–	–	100	100
Z	–	55	500	–	555
R	–	5	–	–	5
D	–	–	100	–	100
E and K	–	5	55	–	60
AA	–	–	–	100	100
Y	–	110	100	–	210

[a] In situ volumes reduced to two significant figures. As-shipped volumes would be larger because of swell of excavated material and packaging inefficiencies.

[b] Low-level and mixed low-level radioactive wastes were assumed to be low-activity wastes. Chemical waste was assumed to include material regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.

[c] Assumed two pits 50 by 150 by 20 feet (15 meters by 46 meters by 6.1 meters) deep pits and four shafts 6 by 6 by 6 feet (1.8 by 1.8 by 1.8 meters).

[d] Assumed one pit covering 90 by 90 by 12 feet (27 by 27 by 3.7 meters).

[e] Assumed one pit covering 100 by 300 by 12 feet (30 by 91 by 3.7 meters).

[f] Partly above-ground debris pile, about 20 by 200 feet (6.1 by 61 meters), with one side approximately 15 feet (14.6 meters) high and the other side at grade. Unknown depth. Assumed a virtual subsurface disposal facility 20 feet (6.1 meters) deep.

[g] Shallow trash pile, comprising three 75-square-feet bermed pits. Waste was bulldozed into pits and likely spread in the vicinity. Some waste has been removed. Assumed to be 300 by 300 by 10 feet (91 by 91 by 3 meters).

[h] Assumed one large excavation to remove buried chamber and elevator shaft. Assumed a 0.3-acre (0.12-hectare) footprint, 50 feet deep.

[i] For MDA E, assumed Pit 3 has same dimensions as largest of four pits. For the buried chamber, assumed a contaminated footprint (244 square feet [23 square meters]) describing the area of the elevator shaft (48 square feet [4.5 square meters]) and the buried chamber (approximately 196 square feet [18 square meters]). For MDA K, assumed two surface disposal piles 15 by 15 by 12 feet (4.6 by 4.6 by 3.7 meters); and 10 by 20 by 12 feet (3.0 by 6.1 by 3.7 meters).

[j] Assumed two trenches, one 80 by 40 by 15 feet (24 by 12 by 4.6 meters) and a second 120 by 30 by 15 feet (37 by 9.1 by 4.6 meters).

[k] Assumed three pits having dimensions estimated from the RFI Work Plan for Operable Unit 1132 (LANL 1993b).

Note: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.785, feet to meters, multiply by 0.3048; square feet to square meters, multiply by 0.0929. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–58 One-Way Shipments from Exhuming Remaining Material Disposal Areas

Nonliquid Wastes					
Material Disposal Area	***Solid Waste*** [a]	***Chemical Waste*** [a]	***Low-Level Radioactive Waste*** [a]	***Mixed Low-Level Radioactive Waste*** [a]	***Total*** [a]
F	–	–	790	–	790
Q	270	2	–	–	280
N	760	28	190	27	1,000
Z	230	93	210	30	560
R	2,000	640	–	–	2,600
D	940	–	830	–	1,800
E and K	140	–	31	–	170
AA	100	32	150	–	280
Y	400	–	–	–	400
Liquid Wastes					
Material Disposal Area	***Industrial Waste***	***Hazardous Waste***	***Low-Level Radioactive Waste***	***Mixed Low-Level Radioactive Waste***	***Total*** [a]
F	–	–	–	–	–
Q	–	1 [b]	–	–	1 [b]
N	–	–	–	1 [b]	1 [b]
Z	–	1 [b]	1 [b]	–	1 [b]
R	–	1 [b]	–	–	1 [b]
D	–	–	1 [b]	–	1 [b]
E and K	–	1 [b]	1 [b]	–	1 [b]
AA	–	–	–	1 [b]	1 [b]
Y	–	1 [b]	1 [b]	–	1 [b]

[a] Low-level and mixed low-level radioactive wastes were assumed to be low-activity wastes. Chemical waste was assumed to include materials regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.

[b] The shipment contains less than a full load.

Note: Because the numbers have been rounded, the sums may not equal the indicated totals.

Table I–59 Soil and Similar Materials for Removal of Remaining Material Disposal Areas (cubic yards)

Material Disposal Area	***Soil Cover and Initial Preparation***	***Clean Soil Exhumed***	***Stockpiled Material Returned***	***Additional Backfill***	***Topsoil and Soil Amendment***	***Total***
F	1,700	6,800	8,500	11,000	660	29,000
Q	900	1,000	1,900	3,600	240	7,700
N	3,300	2,200	5,600	13,000	740	25,000
Z	–	4,100	4,100	7,400	400	16,000
R	–	2,300	2,300	33,000	1,900	40,000
D	1,400	27,000	29,000	24,000	850	82,000
E and K	720	9,900	11,000	2,100	520	24,000
AA	760	2,600	3,300	3,800	310	11,000
Y	1,300	3,100	4,400	5,300	480	14,000

Note: To convert cubic yards to cubic meters, multiply by 0.7646. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–60 One-Way Shipments of Soil and Similar Materials for Removal of Remaining Material Disposal Areas

Material Disposal Area	*Soil Cover and Initial Preparation*	*Clean Soil Exhumed*	*Stockpiled Material Returned*	*Additional Backfill*	*Topsoil and Soil Amendment*	*Total*
F	120	480	600	790	47	2,000
Q	64	70	140	260	17	550
N	240	160	390	950	53	1,800
Z	–	290	290	530	28	1,100
R	–	160	160	2,400	130	2,800
D	100	1,900	2,000	1,700	60	5,800
E&K	51	700	750	150	37	1,700
AA	54	180	240	270	22	760
Y	93	220	310	370	34	1,000

Note: Because numbers have been rounded, the sums may not equal the indicated totals.

MDA H. In November 2007, NMED selected a corrective remedy for MDA H involving complete encapsulation of the nine MDA H waste shafts, installation of an engineered evapotranspiration cover, and installation of a soil vapor extraction system (NMED 2007a). Implementation of this corrective remedy could produce small quantities of waste. Although uncontaminated cuttings from boreholes installed as part of the encapsulation process would be stockpiled for use in the evapotranspiration cover, contaminated drill cuttings (if any) would be properly disposed. Routine monitoring and maintenance activities may produce a very small amount of operational wastes (DOE 2004b).

I.3.3.2.5 Schedules for Material Disposal Area Removal

Schedules for removal of eight large MDAs are provided in **Table I–61**. It was generally assumed that, depending on the MDA, roughly 12 to 18 months would be needed to complete a corrective measure evaluation for an MDA. Planning for removal of an MDA would require from 4 to 8 months. Then removal would take place, with the goal of completing operations by the (adjusted) remedy completion dates in the Consent Order.

Table I–61 Temporal Assumptions for Removing Large Material Disposal Areas

Material Disposal Area	*Assumed Start of Removal Operations*	*Assumed Completion of Removal Operations*	*Assumed Work Time (months)*
A	6/11/2009	3/11/2011	21
B	10/1/2008 [a]	10/1/2010 [a]	24 [a]
T	12/19/2008	12/19/2010	24
U [b]	1/6/2011	11/6/2011	10
AB	1/1/2013	1/31/2015	24
C	11/5/2008	9/5/2010	22
G	2/6/2009	12/6/2015	82
L	5/30/2011	6/30/2011	37

[a] This schedule is based on Revision 1 to the 2006 Investigation/Remediation Work Plan for MDA B (LANL 2006i). NMED approved the plan with modifications January 2007 (NMED 2007b).

[b] The Removal Option is conservatively assumed for this appendix, although NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).

The schedules presented in Table I–61 result in conservative estimates of waste generation and environmental impacts and are consistent with Consent Order requirements. However, if removal of a significant quantity of waste is actually contemplated for several MDAs, then schedules for completion of corrective measures at these MDAs may be difficult to meet.

If any or all of the remaining MDAs were removed, schedules would need to be developed consistent with the Consent Order. Removal of some or all of these MDAs was assumed to occur at any time starting in FY 2007 and extending through FY 2016.

I.3.3.2.6 Use of Enclosures for Material Disposal Area Removal

Enclosures may be used for removal of waste from some MDAs. The enclosures would be modular, possibly constructed of fabric over metal frames. Similar enclosures have long been used at LANL for temporary storage of transuranic waste, have been used at Rocky Flats, and are now used at Idaho National Laboratory for retrieval of waste from Pit 4 at Idaho National Laboratory's Radioactive Waste Management Complex. Contamination at the dig face would be controlled using soil fixing agents or other techniques. The enclosures would be held at a slight negative air pressure, and air from the enclosures would be exhausted through an air treatment system incorporating a minimum of a prefilter and one or more HEPA filters.

Enclosures can be conceptually configured to meet the specific situation at any MDA. Enclosure sizes and accessory equipment would be designed on an MDA-specific basis, considering the area to be covered, depth of contamination, types of hazards unearthed at the excavation, topography, other nearby structures, and costs. For some MDAs, a single large enclosure (to be moved as needed) may be cost-effective. For other MDAs, two or more enclosures may be cost-effective.

Fabric-covered domes have been used at LANL to support waste recovery efforts. As part of the LANL Transuranic Waste Inspectable Storage Project, drums of stacked transuranic waste that had been stored under a layer of crushed tuff at Area G were recovered under a fabric-covered dome constructed to meet Performance Category 2 wind-loading and seismic events. The dome was supplied with a ventilation system exhausting to a prefilter and a HEPA filter bank. A dome was not used, however, for subsequent retrievals of stored transuranic waste (LANL 2002d).

A decision about the use of an enclosure for removal of waste from an MDA would depend on the hazards represented by the waste. Like the other aspects of the contemplated removal, the design and use of the enclosure would be subject to review and approval by DOE and NMED. Optimum numbers, sizes, configurations, and relocation schedules would be determined as part of these reviews.

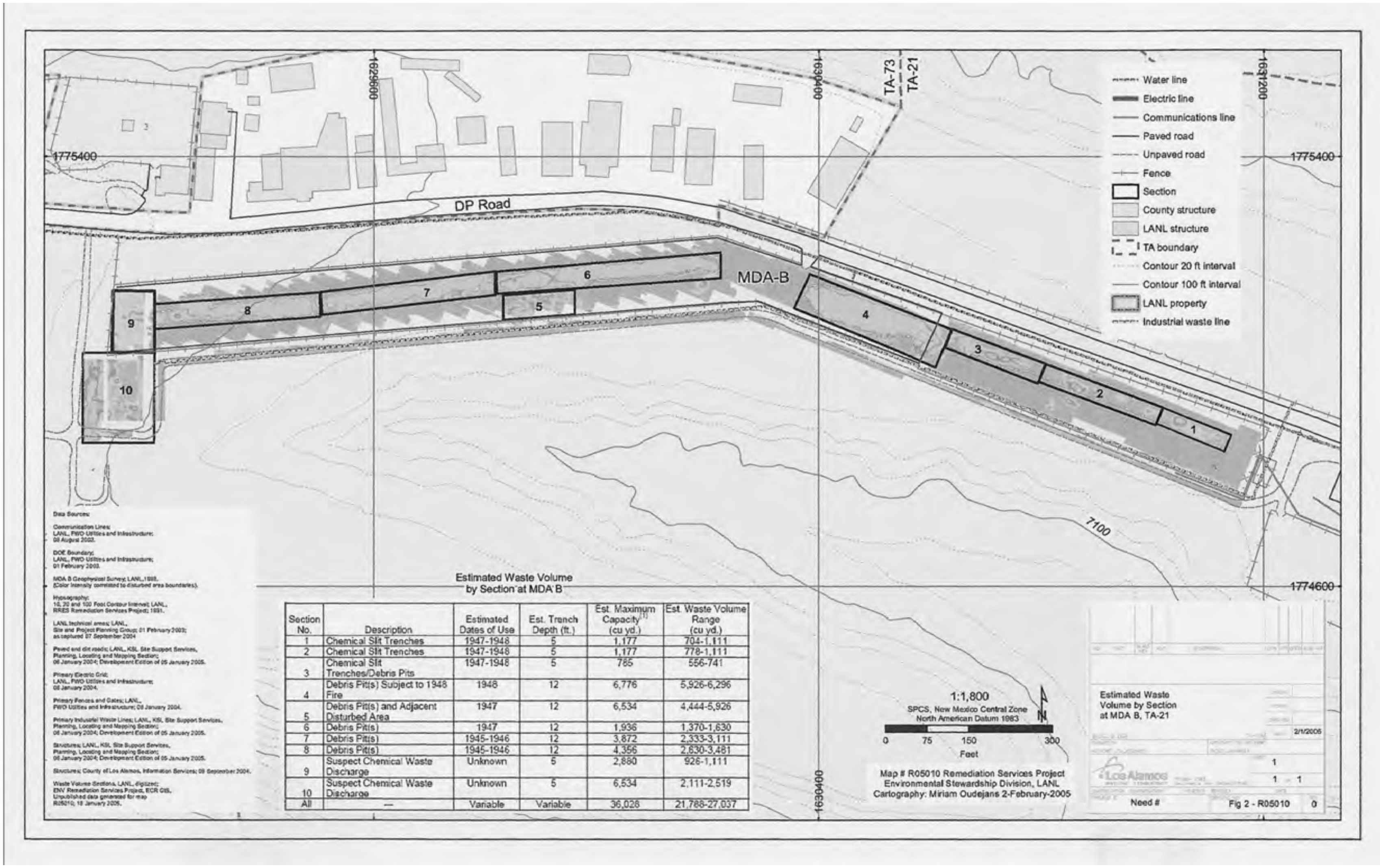
I.3.3.2.7 Material Disposal Area B Investigation and Remediation Program

LANL staff initially planned an investigation, remediation, and restoration program for MDA B that would excavate trenches perpendicular to the length of the MDA as well as numerous test pits. For this purpose, MDA B was divided into 10 study sections as summarized in **Figure I–24** (LANL 2005p). Current plans call for removal of all waste buried in MDA B as addressed in the October 2006 *Investigation/Remediation Work Plan for MDA B, Revision 1* (LANL 2006i). The volumes of waste estimated in this work plan are summarized in **Table I–62** (LANL 2006i). Total waste volumes from the work plan are bounded by those estimated for this SWEIS in Section I.3.3.2.4.2.

Achieving the principal objectives of the MDA B investigation and remediation program (see Section I.2.5.2.2) will require LANL to directly excavate into the MDA B disposal trenches, remove the historical content of MDA B, and remediate the site to residential cleanup levels for chemicals and screening action levels for radionuclides. Following excavation, LANL will prepare a sampling and analysis plan (if necessary) for NMED approval to define and nature and extent of any residual contamination at MDA B. This would be accomplished by sampling directly beneath former waste disposal trenches after the waste was removed, and possibly also by drilling subsurface boreholes (LANL 2006i).

Excavation will be performed inside an enclosure to provide site access control, help control offsite environmental impacts, reduce exposure to the public, and protect the excavation operations from environmental factors. The enclosure will provide access for equipment and waste containers that need to be moved in or out during the excavation. A fresh air circulation system will continuously replace air in the enclosure and eliminate combustion gases at a determined rate. Waste inspection and segregation will be performed inside a separate area of the excavation enclosure or within an additional enclosure (LANL 2006i).

Excavations will be completed using a hydraulic excavator to carefully expose and remove trench contents for inspection, identification, and removal. Excavator attachments such as a grappler or shears may be used. Only a small quantity of waste will be exposed and removed at any time (see Section I.5.12.1). If the proximity of waste trenches to DP Road on the north side precludes side sloping of the excavation, shoring or other methods may be used as needed to ensure excavation stability. Equipment, procedures, and administrative controls will be used to ensure safety and environmental protection during the investigation and remediation program. Several monitoring or remote sensing tools will be used for continuous monitoring for radiation, volatile organic compounds, gases, heat of trench contents, pyrophoric materials, or other hazardous conditions. If warranted, excavated wastes may be transferred to a new container or over-packed (LANL 2006i). For example, compressed gas cylinders, if found in the excavation, may be placed within overpacks designed to safely contain the contents of the cylinder if it leaks or fails during transport (IES 2005).



Section No.	Description	Estimated Dates of Use	Est. Trench Depth (ft.)	Est. Maximum Capacity[1] (cu yd.)	Est. Waste Volume Range (cu yd.)
1	Chemical Slit Trenches	1947-1948	5	1,177	704-1,111
2	Chemical Slit Trenches	1947-1948	5	1,177	778-1,111
3	Chemical Slit Trenches/Debris Pits	1947-1948	5	785	556-741
4	Debris Pit(s) Subject to 1948 Fire	1948	12	6,776	5,926-6,296
5	Debris Pit(s) and Adjacent Disturbed Area	1947	12	6,534	4,444-5,926
6	Debris Pit(s)	1947	12	1,936	1,370-1,630
7	Debris Pit(s)	1945-1946	12	3,872	2,333-3,111
8	Debris Pit(s)	1945-1946	12	4,356	2,630-3,481
9	Suspect Chemical Waste Discharge	Unknown	5	2,880	926-1,111
10	Suspect Chemical Waste Discharge	Unknown	5	6,534	2,111-2,519
All	—	Variable	Variable	36,028	21,788-27,037

Figure I–24 Material Disposal Area B Investigative Sections

Table I–62 Summary of Investigation-Derived Waste from MDA B Removal

Waste Stream	*Expected Waste Type*	*Estimated Volume (cubic yards)*
Drill cuttings	LLW, MLLW, hazardous, or solid/industrial waste	60
Spent personal protective equipment	LLW, MLLW, hazardous, or solid/industrial waste	20
Disposable sampling supplies	LLW, MLLW, hazardous, or solid/industrial waste	20
Decontamination fluids	LLW, MLLW, hazardous waste, or nonhazardous wastewater	500 gallons
Material from trenches	Solid/industrial	2,590
	RCRA hazardous waste	7,189
	LLW	10,800
	MLLW	4,028
Trench spoils	Return to excavation site if nonhazardous and meets screening criteria; or LLW, MLLW, hazardous, or solid/industrial waste	14,000

LLW = low-level radioactive waste, MLLW = mixed low-level radioactive waste, RCRA = Resource Conservation and Recovery Act.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; from gallons to liters, multiply by 764.54.
Source: LANL 2006i.

Removal operations would include verification sampling; implementation of stabilization and surface water diversion measures; implementation of final restoration measures, including the placement and compaction of backfill; placement of a topsoil and native seed mix; and placement of additional barriers, roads, and paths as needed. Volumes of backfill and other bulk materials (and associated shipments) needed for removal operations are bounded by the analysis in Section I.3.3.2.4.2.

The investigation and remediation program would be integrated with other DD&D and PRS remediation activities at TA-21. Preliminary work would include similar operational elements as those described in Section I.3.3.2.4.1, including (LANL 2006f):

- Clearing and grubbing of vegetative material, debris, and obstructions;
- Installation of new fencing and removal of old fencing;
- Preparation of equipment and material staging areas;
- Modification of existing haul and access roads;
- Construction of a decontamination area;
- Installation of administrative facilities;
- Installation of run-on diversion structures to minimize stormwater impacts to the site and prevent migration of site contaminants;
- Completion of pre-fieldwork surveys, including land surveys, radiological surveys, and biological surveys;
- Collection of supplemental background samples for comparison of underlying tuff contaminant concentrations;

- Installation of area and perimeter monitoring systems, alarms, and communication equipment; and
- Execution of mockup drills and emergency response drills with MDA B site personnel.

A haul road has been created on the southern side of MDA B to divert operations traffic from the DP Road business area. Power will be needed to provide utility power for the enclosure, emergency backup generators, and health-and-safety trailers along that area (LANL 2006i).

It is expected that several temporary support capabilities will be needed for the investigation and remediation program. Support capabilities may include those for definitive identification of waste contents, sorting, temporary storage of waste and excavation spoil, project management, vehicle decontamination, waste processing or analysis, or other needs. It is expected that none of these temporary capabilities would intrude on habitat or buffer areas of protected wildlife. The capabilities may be located partly within the excavation closure and partly or wholly at separate temporary facilities such as those conceptually described below (LANL 2006a). Other permutations of these capabilities may be implemented as needed.

The *Definitive Identification Facility (DIF)* and storage area would encompass an area of a few acres. This storage area would be enclosed within chain-link fencing with a central temporary "Sprung" type dome enclosure as the major feature. The dome would enclose several other temporary buildings, such as a Permacon®-type building[68] that will house the DIF itself. Pre-DIF staging areas within the DIF storage area would store preliminarily hazard-categorized materials awaiting sampling or repackaging by DIF personnel. Post-DIF staging areas would temporarily store materials until verified analytical results determine waste disposition. In all staging areas, hazardous materials would be segregated according to known incompatibilities (for example, oxidizers, flammables, explosives). The DIF would be used to inspect and evaluate containers to determine their contents. Activities could range from removing a "bung" from a drum to sample its contents to "hot-tapping" compressed gas cylinders, which requires drilling into the sides of the containers. Depending upon regulatory controls, gases within some cylinders may be released to the environment (for example, hydrogen), whereas other gases may need treatment or transfer to another container. Exhaust air from the DIF, along with its enclosing dome would be HEPA-filtered and passed through an activated carbon absorption system. Fire protection systems would be used as required to reduce or mitigate accidental releases of hazardous materials to the environment.

The *Waste Processing Facility*, if constructed, would support all MDA and DD&D activities on DP Mesa. This facility would be a chain-link enclosed "yard" or laydown area for the accumulation of waste materials prior to shipment offsite. Some temporary buildings would house administrative activities. Various other structures may be necessary to store RCRA and radioactive materials before shipment. The Waste Processing Facility would be located at the end of DP East and comprise an area of less than 10 acres (4 hectares) of previously disturbed land. The facility would be used to package or repackage waste materials. The Waste Processing Facility would require areas for truck parking, turnaround, and loading by use of cranes, boomtrucks, forklifts, or other suitable heavy equipment. Incompatible materials would be segregated as required and stipulated by regulation. This facility would comply with all

[68] *A Permacon® unit is a type of modular containment system (NFS RPS 2005).*

RCRA regulations as it will function as a treatment, storage, or disposal facility. The Waste Processing Facility would likely include a truck decontamination pad along with a hazardous materials screening area for screening prior to offsite transport. Radioactive materials would be removed as required and shipped to on- or offsite locations for disposal. Roads would be improved or constructed to allow for the additional truck traffic. If the Waste Processing Facility is not constructed, waste processing and packaging would take place within the MDA B area of concern. After waste processing and manifesting, filled waste containers may be staged at other locations within the TA-21 boundary prior to transport and disposal (LANL 2006a).

DP Mesa Field Office and Laboratory Facilities. The facilities would comprise several transportable buildings housing analytical capabilities and offices to support MDA investigation and remediation and TA-21 DD&D activities. It is likely that at least three and maybe four transportable buildings would be required to provide the analytical chemistry capability for organic, inorganic, and radioactive material analysis. A fifth building may be required for administrative activities. The buildings and associated parking areas would fit on less than 2 acres (0.8 hectare) of previously disturbed lands. This facility would provide analytical data of sufficient quality to meet waste disposition manifesting and disposal requirements. It would include a treatment, storage, or disposal facility for RCRA waste accumulation.

Office trailers would be needed to support subcontractor and LANL administration. The area selected would require access using roads that would allow staff to reach work areas without crossing potentially controlled work areas. Extension of utilities from the existing utility grid would be required. To the extent practicable, a centralized area would be developed to minimize support utility requirements. The area of disturbance for administrative support would be limited to less than 2 acres (0.8 hectare).

Spoil Staging Areas. It is expected that clean and suspected-clean soils and construction debris staging areas would be placed as necessary at several locations around the DP Mesa. This would generally take place in locations near the point of their generation or intended use. These spoil piles would be protected from erosion or airborne dispersion by keeping them wet or covered as necessary. Appropriate runon controls would be implemented. These could total many acres in size and would be located in previously disturbed areas when possible, but may require additional land at the east end of DP Mesa.

The total affected area from TA-21 DD&D and MDA remediation is expected to involve about 80 acres (32 hectares) of previously disturbed area and up to 30 acres (12 hectares) of undisturbed mesa top. Another 20 acres (8.1 hectares) of previously undisturbed canyon wall or bottom may also be partially disturbed (LANL 2006a).

I.3.3.2.8 Characterization and Treatment Capacity for Waste from Material Disposal Area Removal

If large-scale removal of waste from the MDAs is required, LANL capacity to characterize and repackage waste may be insufficient. One option to address this problem would be to construct a dedicated facility for waste separation, characterization, treatment, packaging, and staging for shipment. The size, cost, and environmental impacts associated with such a facility would depend on the quantities and characteristics (e.g., radioactive material content) of the exhumed waste, which would depend on remediation decisions to be made in the future. A second option would be to site a number of smaller facilities at strategic LANL locations providing specific services similar to those contemplated for the MDA B investigation and remediation program (see Section I.3.3.2.7). This option could be combined as needed with an upgrade and expansion of existing waste management capacity in TA-54 or other technical areas.

A facility for processing exhumed transuranic waste was considered as part of an early LANL study addressing options for future disposition of buried waste in LANL MDAs A, B, C, G, T, and V (LANL 1981). The facility envisioned in this study would cover 40,550 square feet (3,765 square meters), with an additional 17,570 square feet (1,630 square meters) dedicated to support areas. The envisioned facility would be capable of accommodating remote-handled waste. Its design throughput would be 1 million cubic feet (28,320 cubic meters) of waste over 15 years (1,900 cubic meters per year) (LANL 1981). A facility for treatment of contact handled waste exhumed from Idaho National Laboratory disposal facilities has also been envisioned (INEEL 2002a). Waste would be transferred to the facility from a lag storage area covering 70,000 square feet (6,500 square meters) and capable of storing 6,400 cubic yards (4,900 cubic meters) of waste. Waste introduced into the treatment facility would be handled remotely using manipulators, conveyors, and gloveboxes. The two-story facility was projected to address 18,800 cubic yards (14,400 cubic meters) of waste per year and would have a surface area of 130,000 square feet (12,100 square meters) (INEEL 2002a).

Assuming extensive exhumation, annual waste generation rates from exhuming the LANL MDAs could be on the order of a hundred thousand cubic meters of low-activity low level radioactive waste, several thousand cubic meters of alpha-contaminated low-level radioactive waste, a few hundred cubic meters of high-activity low-level radioactive waste, and up to a few thousand cubic meters of transuranic waste. A facility receiving such a volume of waste could cover a few hundred thousand square feet. Assuming that funding was approved, several years may be required to design the facility and additional years to construct and test.

The second option would be to develop several facilities for waste handling at appropriate LANL locations as needed consistent with future decisions about MDA remediation. The facilities would be temporary, using modular equipment as available and appropriate, and could be moved to new locations consistent with remediation schedules. Similar to those described in Section I.3.3.2.7, facilities could include capacity for safety inspections of removed containers, waste processing and storage, radioactive and chemical analyses, and other support services. Facilities would be transportable or consist of modular glovebox or similar systems covered by domed enclosures. Shielded, remotely operated systems may be needed for processing some wastes. The designs of the facilities and their capabilities would depend on the characteristics of the wastes to be addressed, which would be different for different MDAs, and on the acceptance criteria for the treatment or disposal facilities receiving the wastes.

This option could be combined with the expanded use of existing LANL waste management capacity. Existing LANL capabilities for management of waste in TA-54 are described in Section H.3 of Appendix H, along with the environmental impacts of alternatives for relocation, replacement, or augmentation of this capacity. As needed, additional, augmented, or mobile waste management equipment or facilities could be developed at LANL similar to those described in Section H.3.2.2. Use of existing LANL capabilities for remotely handling radioactive material could be also considered.

Although several such facilities may be required, depending on future remediation decisions, the impacts of siting and operating the facilities would be temporary.

I.3.4 Remediation of PRSs other than Material Disposal Areas

In addition to the MDAs addressed in Section I.3.3, numerous PRSs such as firing sites, outfalls, or areas of contaminated soil or sediment must be addressed. The volumes of wastes that may be generation from remediating these PRSs are uncertain, as is the timing for waste generation. Section I.3.4.1 reviews possible treatment technologies. Section I.3.4.2 characterizes waste generated from remediation of representative PRSs. For the Capping and Removal Options, estimates from Section I.3.4.2 were added to projections of wastes from the No Action Option to address the PRSs that may be remediated through FY 2016 (see Section I.3.4.3).

I.3.4.1 Possible Treatment Technologies

Numerous treatment technologies could be used, depending on the contaminant and the contaminated media. As observed in the Federal Remediation Technologies Roundtable's Screening Matrix and Reference Guide, the three primary strategies that may be used separately or in conjunction to remediate most sites are destruction or alteration of contaminants, extraction or separation of contaminants from environmental media, and immobilization of contaminants. Treatment technologies capable of contaminant destruction by altering their chemical structure include thermal, biological, and chemical treatment methods applied either in or ex situ to contaminated media. Treatment technologies commonly used for extraction and separation of contaminants from environmental media include soil treatment by thermal desorption, soil washing, solvent extraction, and groundwater treatment using phase separation, carbon absorption, air stripping, ion exchange, or some combination of technologies. Immobilization technologies include stabilization, solidification, and containment technologies such as disposal in a landfill or construction of slurry walls. Because generally no single technology can remediate an entire site, several treatment technologies may be combined at a single site to form a treatment train. As noted, many treatment technologies require removal of the contaminated media, which, after treatment, may be returned or disposed of as waste. Descriptions of treatment technologies are provided in **Table I–63** (FRTR 2005). Other sources of information about treatment technologies include the Interstate Technology and Regulatory Council and, for groundwater contamination, the Ground-Water Remediation Technologies Analysis Center (GWRTAC 2005).

Treatment technologies used either individually or in combination at any PRS would be applied as needed and as approved by NMED. More complex and involved remedies might include requirements for staging areas and moderate augmentation of infrastructure (such as plumbing for extracted water or other wastes) to support the operational aspects of the remedy. If large volumes of wastewater are generated, there could be an increase in truck traffic to transport the wastewater to (generally onsite) treatment facilities.

Table I–63 Treatment Group Examples

Treatment Groups	*Comments*
Soil, Sediment, and Sludge	
In situ biological treatment	Technologies include bioventing, enhanced biodegradation, and phytoremediation. Bioremediation technologies have been used to remediate soils, sludges, and groundwater contaminated by petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals.
In situ physical/chemical treatment	Uses the physical properties of the contaminants or contaminated medium to chemically convert, separate, or contain the contamination. Treatment technologies include electrokinetic separation, fracturing, soil flushing, soil vapor extraction, and solidification/stabilization.
In situ thermal treatment	Thermally enhanced soil vapor extraction uses temperature to increase the volatility of soil contaminants. In situ vitrification uses heat to melt soil, destroying some organic compounds and encapsulating inorganics.
Ex situ biological treatment (assuming excavation)	Technologies include biopiles, composting, landfarming, and slurry-phase biological treatment.
Ex situ physical/chemical treatment (assuming excavation)	Technologies include chemical extraction, chemical reduction/oxidation, dehalogenation, separation, soil washing, and solidification/stabilization.
Ex situ thermal treatment (assuming excavation)	Technologies include hot-gas decontamination, incineration, open burn/open detonation, pyrolysis, and thermal desorption.
Containment	Containment includes capping of landfills or contaminated areas.
Other treatment processes	Other technologies include excavation, retrieval, and on- and offsite disposal.
Groundwater, Surface Water, and Leachate	
In situ biological treatment	Technologies include enhanced biodegradation (nitrate and oxygen enhancement with either air sparging or hydrogen peroxide), natural attenuation, and phytoremediation of organics.
In situ physical/chemical treatment	Technologies include air sparging, bioslurping, directional wells, dual-phase extraction, thermal treatment, hydrofracturing, in-well air stripping, and passive/reactive treatment walls.
Ex situ biological treatment (assuming pumping)	Contaminated groundwater, surface water, and leachate may be pumped from its location and treated. Treated water may be returned or disposed of as waste. Treatment technologies include bioreactors and constructed wetlands.
Ex situ physical/ chemical treatment (assuming pumping)	Contaminated groundwater, surface water, and leachate may be pumped from its location and treated. Treated water may be returned or disposed of as waste. Biological treatment technologies include adsorption/absorption, advanced oxidation processes, air stripping, granulated activated carbon/liquid-phase carbon adsorption, groundwater pumping, ion exchange, precipitation/coagulation/flocculation, separation, and sprinkler irrigation.
Containment	Containment technologies include physical/biological barriers and deep-well injection.
Air Emissions/Offgas Treatment	
Air emissions/offgas treatment	Several technologies have been applied for removal of volatile organic compounds from offgas streams, including biofiltration, high-energy destruction, membrane separation, nonthermal plasma, oxidation, scrubbers, and vapor-phase carbon adsorption.

Source: FRTR 2005.

I.3.4.2 Remediation of Representative PRSs

Firing Site E-F. This firing site in TA-15 is described in Section I.2.3.1 and contains scattered surface contamination plus small piles of debris. Surveys showed that most uranium was concentrated within the top 10 to 12 inches (25 to 30 centimeters) of soil and that uranium concentrations dropped by a factor of 23 within 1,000 feet (300 meters) of the firing point. Two piles of debris were each 8 feet (2.4 meters) in diameter and 2 feet (0.6 meters) high.[69]

Waste volumes for this appendix were estimated by assuming that material would be removed from an area having a radius of 1,000 feet (300 meters) to an average depth of 1 inch (2.5 centimeters) and adding the waste from the two debris piles. This results in 9,700 cubic yards (7,420 cubic meters) of waste. Similar to the waste distribution for removal of MDA Z (see Section I.3.3.2.4.3), this waste was assumed to be 40 percent solid waste, 15 percent chemical waste, 40 percent low-activity low-level radioactive waste, and 5 percent mixed low-activity low-level radioactive waste.

Firing Site R-44. This firing site in TA-15 is described in Section I.2.3.2, and contains scattered surface contamination plus some small debris piles. After the Cerro Grande fire, much exposed debris was recovered and disposed.

Waste volumes for this appendix were estimated by assuming that material would be removed from an area having a radius of about 500 feet (152 meters) to an average depth of 1 inch (2.5 centimeters), or 2,420 cubic yards (1,850 cubic meters) of waste. Similar to the waste distribution for removal of MDA Z (see Section I.3.3.2.4.3), this waste was assumed to be 40 percent solid waste, 15 percent chemical waste, 40 percent low-activity low-level radioactive waste, and 5 percent mixed low-specific-activity low-level radioactive waste.

260 Outfall. SWMU 16-21(c)-99 is described in Section I.2.7.5. It is an inactive outfall from Building 260 in TA-16 where machine turnings and high explosive washwater were discharged. An interim measure has been performed to remove contaminated soil. Three areas of contamination remain: (1) the outfall source area (excluding the settling pond and surge beds); (2) the outfall settling pond and surge beds; and (3) canyon springs and alluvium. After completing Phase I, Phase II, and Phase III RFIs, and the interim measure, a corrective measures study has been issued establishing corrective measure alternatives (LANL 2003l). The corrective measure alternatives are listed in **Table I–64** (LANL 2003l).

The final remedy for the 260 Outfall was selected by NMED on October 13, 2006. The selected remedy is a combination of alternatives from the corrective measures study:

- Soil removal and offsite treatment and disposal;
- Pressure grouting the surge beds and extending the existing cap; and
- Installing permeable reactive barriers and stormwater filters to treat sediment, surface water, and alluvial groundwater.

[69] *Firing Site E-F was used more extensively than Firing Site R-44. Some of the debris currently deposited on Firing Site R-44 originated from firing operations at Firing Site E-F.*

Table I–64 Alternative Corrective Measures for the 260 Outfall

Site Area	*Alternative Number* [a]	*Description*	*Estimated Waste Generation*
Outfall source area (excluding settling pond)	I.1	Soil removal and offsite treatment and disposal	131 cubic yards of solid waste
Outfall source area, settling pond, and 17-foot surge bed	II.1	Excavation and offsite disposal of the 17-foot surge bed and replacement/maintenance of the existing cap	52 cubic yards of solid waste
	II.2	In situ grouting of the 17-foot surge bed and maintenance of the existing cap	
	II.3	Maintenance of existing cap and no action for the surge beds	
Canyon springs and alluvial system	III.1	Sediment excavation and offsite disposal, with stormwater filters for springs	13,080 cubic yards of solid waste and 13,080 cubic yards of hazardous waste
	III.2	Natural flushing of sediments coupled with permeable reactive barrier (zero valent iron or granulated activated carbon and calcium sulfate) alluvial groundwater treatment and stormwater filter treatment for springs	
	III.3	Natural/induced flushing of sediments and recovery of spring and groundwater (by interceptor trenches) and treatment in a central treatment system	

[a] NMED selected a final remedy for the 260 Outfall in October 13, 2006. The selected remedy is a combination of the alternatives proposed by LANL staff.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; from feet to meters, multiply by 0.3098.
Source: LANL 2003l.

TA-21 Outfall. This SWMU (21-011(k)) was an inactive NPDES-permitted outfall for liquid waste from former wastewater treatment plants at DP West (see Section I.2.7.6). A voluntary corrective measure was planned to excavate and dispose of contaminated wastes as low-level radioactive waste, excavate and solidify tuff and sediment from hot spots, and place the solidified material in a stabilization cell to be dug near the center of the SWMU (LANL 2002f). The voluntary corrective measure was projected to generate 25 cubic yards (19 cubic meters) of solid waste and 65 cubic yards (50 cubic meters) of low activity low-level radioactive waste. Solidification and onsite stabilization of tuff and sediment were projected to involve 78 cubic yards (60 cubic meters) of material (LANL 2002f). The voluntary corrective measure was subsequently revised and material projected to be solidified onsite was removed. Removal occurred in 2003 (LANL 2003i).

SWMU 73-002 Incinerator Ash Pile. Remediation of the ash pile is complete, including removal of ash and debris waste (see Section I.2.7.11). It was estimated that the pile contained roughly 4,500 cubic yards (3,340 cubic meters) of waste (LANL 2005e). The Investigation Report for Consolidated Unit 73-002-99 and Corrective Action of Solid Waste Management Unit 73-002, at Technical Area 73 was submitted to and approved by NMED (LANL 2006a).

Canyons. Investigations and remediation within LANL canyons are expected to generate about 10 cubic yards (7.6 cubic meters) of solid low-level radioactive waste, 24 cubic yards (18 cubic meters) of mixed low-level radioactive waste, and 9,900 gallons (37,500 liters) of liquid radioactive waste (LANL 2006a).

Security Perimeter Road. Development of a security perimeter road in TA-3 was one of the FY 2005 facility integration projects at LANL that affected existing PRSs; in this case, an electrical equipment storage area (SWMU 61-002), two storage areas in TA-3 (AOC 3-001(i)), and a asphalt landfill (SWMU 03-029) (LANL 2005l). Generation of waste from this project was estimated as about 3,000 cubic yards (2,300 cubic meters) of solid waste and 500 cubic yards (380 cubic meters) of low-level radioactive waste (LANL 2006a). An accelerated corrective action completion report was submitted to NMED on December 15, 2005. Investigation and remediation work included the decontamination and decommissioning of the TA-3 Radio Shop, allowing access to residual petroleum hydrocarbon contamination found while remediating SWMU 61-002 (LANL 2006h). The Security Perimeter Road accelerated corrective action has been completed.

I.3.4.3 Waste Generation Estimates

Compliance with the Consent Order will cause remediation of a large number of PRSs from FY 2007 through FY 2016. There may be several options for remediation, including removing, treating, or stabilizing contamination at a site or controlling exposure to the contamination so risks posed are acceptable. It was assumed that remediation would occur annually, involve activities similar to those described in Section I.3.4.1, and generate similar types of waste as those summarized in Section I.3.4.2. As shown in **Table I–65**, an annual average waste generation rate of 5,200 cubic yards (4,000 cubic meters) was projected. This waste was distributed among different waste types based on consideration of the waste estimates discussed in Section I.3.4.2.

Table I–65 Additional Waste Generation from Remediating Potential Release Sites

Parameter	*Solid Waste*	*Chemical Waste* [a]	*Low-Activity Low-Level Radioactive Waste*	*Mixed Low-Activity Low-Level Radioactive Waste*	*Total Annual Waste*
Annual Volume [b] (cubic yards)	2,900	1,700	630	52	5,200
Shipments	220	140	44	4	410

[a] The chemical waste category includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.
[b] In situ volumes. As-shipped volumes would be larger because of swell of excavated material and packaging inefficiencies.
Note: To convert cubic yards to cubic meters, multiply by 0.76456. Because numbers have been rounded, the sums may not equal the indicated totals.

I.3.5 Waste Transportation and Disposal Assumptions

After removal of waste from the ground, and following classification and sorting, waste must be placed within containers, treated if necessary, and disposed of. Because so much of the waste that would be generated from MDA exhumation and PRS remediation will be soil and debris, it was assumed that material would swell by about 20 percent following removal. That is, removed waste placed into containers was assumed to be 20 percent larger than the in situ volume.

Solid waste was assumed to be sent to a landfill within New Mexico, with a round-trip distance of 260 miles (418 kilometers). Chemical waste would be sent for treatment before disposal. Several treatment sites could be used depending on the hazardous constituents to be treated. A typical site having a roundtrip distance of 332 miles (534 kilometers) was assumed. It was assumed that all contact-handled and remote-handled transuranic wastes would be sent to WIPP.

Low-level radioactive waste could be disposed of onsite or sent to another site. (Onsite disposal capacity for mixed low-level radioactive waste is not currently available.) It was assumed that low-level and mixed low-level radioactive wastes could be sent to any of a number of commercial or DOE sites for treatment or disposal. Two typical sites—one commercial and one DOE—were assumed, having round-trip distances of 1,378 miles (2,153 kilometers) and 1,550 miles (2,500 kilometers), respectively. It was assumed that low-level and mixed low-level radioactive wastes would be optionally all disposed of onsite (assuming an average one-way travel distance of 5.6 miles [9 kilometers]; all shipped to a different DOE site; or shipped partly to a DOE site and partly to a commercial site, consistent with waste acceptance criteria for the commercial site. (It was assumed that all low-level and mixed low-level radioactive wastes could be shipped to the DOE site, but only low-activity and mixed low-activity low-level radioactive waste could be shipped to the commercial site.)

Container and shipping assumptions are listed in **Table I–66** and summarized below.

An 80 percent packing efficiency (percent of container filled with waste) was assumed for solid waste because of short travel distances, relatively low transport and disposal costs, and to keep within assumed weight limit. A 90 percent packing efficiency was assumed for other nonliquid wastes because of much larger travel distances and transport, treatment, and disposal costs. An 80 percent packing efficiency was assumed for liquid wastes because it is expected that only small volumes would be generated from most remediated sites.

A maximum shipment weight of 20 tons (18 metric tons) for chemical, solid, and low-level radioactive waste, was estimated, assuming a waste density of up to 1.08 tons per cubic yard (1.28 metric tons per cubic meter), typical for dirt and rock, assuming 20 percent swell. Low-activity low-level radioactive waste was assumed to be shipped as low-specific-activity material, pursuant to U.S. Department of Transportation requirements, and placed within soft liners to be transported within Intermodals at two soft liners per Intermodal. Mixed low-activity and alpha-contaminated low-level radioactive waste were assumed to be transported in B-25 boxes. This waste may require treatment before disposal. Drums were assumed for all remote-handled transuranic waste.

For contact-handled transuranic waste, fourteen 55-gallon (0.21-cubic-meter) drums were assumed per TRUPACT-II (transuranic waste package transporter II) outer packaging (WIPP 2005) and three TRUPACT-II packages per shipment. Three TRUPACT-II outer packaging were assumed per contact-handled transuranic waste shipment. A shipped waste density of 1.08 tons per cubic yard results in contact-handled transuranic waste shipments comparable to maximum allowable shipment weights for TRUPACT-II packages (DOE 2004c). Remote-handled transuranic waste was assumed to be shipped in RH-72B casks at three drums per cask (Jensen, Devarakonda, and Biedscheid 2001).

Table I–66 Container and Shipment Assumptions

Waste	*Container*	*Container Volume (cubic feet and cubic meters)*	*Packing Efficiency (percent)*	*Number of Containers per Truck*	*Volume per Shipment* [a] *(cubic yards)*
Nonliquid Waste					
Solid	20-cubic-yard rolloff	540/15.3	80	1	16
Chemical	55-gallon drum	7.35/0.21	90	60	14
Low-level radioactive waste – low activity	Soft liners/ Intermodal	260/7.3	90	2	17
Low-level radioactive waste – alpha	B-25 box	90/2.55	90	5	15
Low-level radioactive waste – remote handled [b]	55-gallon drum	7.35/0.21	90	10	2.5
Mixed low-level radioactive waste – low activity	B-25 box	90/2.55	90	5	15
Mixed low-level radioactive waste – alpha	B-25 box	90/2.55	90	5	15
Mixed low-level radioactive waste – remote handled [b]	55-gallon drum	7.35/0.21	90	10	2.5
Contact-handled transuranic waste [c]	55-gallon drum	7.35/0.21	90	42	10
Remote-handled transuranic waste [d]	55-gallon drum	7.35/0.21	90	3	0.8
Mixed contact-handled transuranic waste [c]	55-gallon drum	7.35/0.21	90	42	10
Mixed remote-handled transuranic waste [d]	55-gallon drum	7.35/0.21	90	3	0.8
Liquid Waste					
Industrial [e]	500-gallon tanks	67/1.9	80	2	3.9
Hazardous [e]	500-gallon tanks	67/1.9	80	2	3.9
Low-level liquid radioactive waste [e]	500-gallon tanks	67/1.9	80	2	3.9
Mixed low-level liquid radioactive waste [e]	500-gallon tanks	67/1.9	80	2	3.9

[a] This assumed volume is applied after an in situ volume increase of 20 percent due to swell of removed material.
[b] The quantity of waste that can be delivered in any single shipment will depend on container surface radiation levels and the design and availability of transportation packaging. Duratek cask capacity ranges from 1 to 21 drums (Duratek 2005). A shielded shipping box can contain up to 27 drums. Assumed 10 drums per shipment.
[c] Assumed use of TRUPACT II [transuranic waste package transporter II] packaging.
[d] Assumed use of RH-72B transportation cask.
[e] Assumed liquids are treated at LANL.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; cubic meters to cubic yards, multiply by 1.308; gallons to liters, multiply by 3.7854.

For remote-handled low-level and mixed low-level radioactive waste, a relatively large number of drums per cask (10) were assumed. It was assumed that most remote-handled wastes would not have surface exposure rates significantly above 200 millirem per hour. Duratek casks range in capacity from 1 to 21 drums, although about 40 percent of available casks can hold up to 14 (Duratek 2005). (The calculated weight [3.2 tons] is within the payload limits of typical casks.) The average number of drums per shipment, however, would be smaller than 14 because of operational, cost, and scheduling considerations. (Only a small amount of remote-handled low-level radioactive waste would be exhumed at any time, and it would be too expensive to rent a cask for long periods of time waiting for it to be completely filled before shipment.)

All liquids were assumed to be treated at LANL. Wastes requiring shipment offsite after this treatment should be comparatively small in volume.

It was assumed that once exhumed, solid, chemical, and low-activity and alpha-contaminated low-level and mixed low-level radioactive wastes would be loaded directly into final shipping containers and then loaded onto trucks for transport to a treatment or disposal facility. It was assumed that transuranic and remote-handled low-level radioactive wastes would require additional processing or repackaging before shipment. For example, transuranic wastes must be placed in package configurations compatible with the WIPP waste acceptance criteria. For processing operations, labor hours per unit volume of waste were assumed based on an analysis for the LANL Decontamination and Volume Reduction System (DOE 1999b). Worker radiation doses for waste processing were assumed based on LANL worker radiation experience for 2004 and 2005. Person-hours for loading containers into trucks were assumed based on a review of other analyses (INEEL 2002d, Wolf 2002), and radiation doses were assessed using the RADTRAN, Version 5, computer code (Weiner et al. 2006) based on assumed container surface radiation rates that were compatible with assumptions for waste transportation (see below). It was assumed that, depending on the type of waste, loading would be accomplished using crews of from 3 to 5 persons having average distances ranging from 3.3 to 16 feet (1 to 5 meters) from the waste package. Analytical support activities were also addressed.

Unit (per shipment) dose and risk estimates were then developed for shipments of waste to treatment and disposal facilities. The estimates were performed using the RADTRAN, Version 5, computer code (Weiner et al. 2006) in accordance with the assumptions in Table I–66. Incident-free radiation exposures to shipment crews (two crewmembers per shipment) were estimated assuming that exposure rates at shipment packaging surfaces were at regulatory limits. Population doses were calculated using comparable assumptions. Crew and population risks were calculated assuming a latent cancer fatality (LCF) rate of 0.0006 per person-rem of exposure.

Possible transportation accidents involving radioactive material were assessed assuming a source for different waste types developed from radioactive inventories within MDA G, the LANL MDA for which information is most complete. LCFs for a possible transportation accident were determined by first calculating the dose from an accident to an MEI, and then multiplying this dose by the probability of an accident and by an LCF rate of 0.0006 per person-rem of exposure. Nonradiological accidents (mechanical injury) were estimated using information about accident frequencies (see Appendix K, Section K.6.2, Accident Rates). For shipments of solid waste, a fatality accident rate for New Mexico was used (1.18 fatalities per 100 million kilometers traveled). For shipments of chemical waste, a fatality accident rate for an urban population zone was used (2.32 fatalities per 100 million kilometers traveled).

Transportation dose and risk assessment results are presented on a per shipment basis in **Table I–67**.

I.3.6 Waste, Materials, Shipment, and Personnel Projections Under Options

I.3.6.1 Waste Generation

No Action Option. **Table I–68** summarizes annual waste projections under the No Action Option starting in FY 2007 and continuing through FY 2016. These projections reflect LANL staff estimates of wastes from environmental investigation and remediation that were made before the March 1, 2005 issuance of the Consent Order. The volumes in this table essentially represent in situ volumes of contaminated material. Because much material may consist of contaminated soil or debris, as-shipped volumes were assumed to be 20 percent larger to account for material swell following removal from the ground.

Table I–67 Transportation Dose and Risk Assessment Results [a]

Typical Destination	Waste	Round-Trip Distance (kilometers)	Crew Dose and Risk		Population Dose and Risk		Accidents	
			Person-Rem	LCF	Person-Rem	LCF	Radiological (LCF Fatality)	Nonradiological (fatalities)
DOE Site	Low-specific activity [b]	2,500	0.0014	8.2×10^{-7}	0.00027	1.6×10^{-7}	1.3×10^{-8}	0.000025
DOE Site	LLW and MLLW [c]	2,500	0.012	7.5×10^{-6}	0.0039	2.4×10^{-6}	1.7×10^{-8}	0.000025
DOE Site	RH-LLW and MLLW [d]	2,500	0.011	6.5×10^{-6}	0.0020	1.2×10^{-6}	3.3×10^{-13}	0.000025
Commercial Site	Low-specific activity [b]	2,153	0.0012	7.1×10^{-7}	0.00023	1.4×10^{-7}	9.6×10^{-9}	0.000021
Commercial Site	LLW and MLLW [c]	2,153	0.011	6.4×10^{-6}	0.0033	2.0×10^{-6}	1.4×10^{-8}	0.000021
WIPP	CH-TRU [e]	1,210	0.023	0.000014	0.0073	4.4×10^{-6}	3.3×10^{-11}	0.000014
WIPP	RH-TRU [e]	1,210	0.035	0.000021	0.0092	5.5×10^{-6}	7.7×10^{-13}	0.000014

LCF = latent cancer fatality, LLW = low-level radioactive waste, MLLW = mixed low-level radioactive waste, RH = remote-handled, WIPP = Waste Isolation Pilot Plant, CH = contact-handled, TRU = transuranic waste.

[a] Results are for one-way distances except for nonradiological accidents, which are for round trips.

[b] Waste shipped in Intermodals.

[c] Waste shipped in B-25 boxes.

[d] Waste shipped in drums.

Note: To convert kilometers to miles, multiply by 0.6213. Numbers have been rounded.

Table I–68 Annual Waste Generation Rates for No Action Option (cubic yards)

Waste	Fiscal Year 2007	Fiscal Year 2008	Fiscal Year 2009	Fiscal Year 2010	Fiscal Year 2011	Fiscal Year 2012
Chemical Waste [a]	2,000	1,400	190	–	50	36
Low-Level Radioactive Waste [b]	990	3,600	4,200	31	–	–
Mixed Low-Level Radioactive Waste [b]	130	200	20	–	300	89
Transuranic Waste [c]	100	100	–	–	–	–
Total	3,200	5,300	4,400	31	350	130
Waste	**Fiscal Year 2013**	**Fiscal Year 2014**	**Fiscal Year 2015**	**Fiscal Year 2016**	**Total**	**–**
Chemical Waste [a]	36	36	36	36	3,800	–
Low-Level Radioactive Waste [b]	–	–	–	–	8,800	–
Mixed Low-Level Radioactive Waste [b]	89	89	89	89	1,100	–
Transuranic Waste [c]	–	–	–	–	210	–
Total	130	130	130	130	14,000	–

[a] Assumed an average waste density of 1 gram per cubic centimeter. Assumed to include waste regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.

[b] Assumed to be low-activity and mixed low-activity low-level radioactive waste.

[c] Includes mixed transuranic waste.

Note: To convert cubic yards to cubic meters, multiply by 0.76456. Because numbers have been rounded, the sums may not equal the indicated totals.

Capping Option. Environmental remediation continues as assumed for the No Action Option. In addition, all MDAs are stabilized in place through installation of final evapotranspiration covers. The General's Tanks within MDA A are stabilized using a grout mixture, and other PRSs are remediated. The wastes associated with these assumptions are listed in **Table I–69**. These wastes represent:

- Wastes generated as part of the No Action Option (Table I–68).
- Wastes associated with capping large MDAs according to the schedule in Table I–52.
- Wastes associated with capping the remaining MDAs, assuming that wastes from capping these MDAs are generated in equal annual volumes from FY 2007 through FY 2016.
- Additional wastes associated with remediating PRSs. (Wastes listed in Table I–65 are annually generated.)

Removal Option. Environmental remediation continues as assumed for the No Action Option. In addition, all MDAs are exhumed and other PRSs are remediated. The wastes associated with these assumptions are listed in **Table I–70**. These wastes represent:

- Wastes generated as part of the No Action Option (Table I–68).
- Wastes associated with removing large MDAs according to the schedule presented in Table I–61.
- Wastes associated with removing the remaining MDAs, assuming that wastes from removing these MDAs are generated in equal annual volumes from FY 2007 through FY 2016.
- Additional wastes associated with remediating PRSs. (Wastes listed in Table I–65 are annually generated.)

Removing the MDAs would generate a significant quantity of waste. The largest annual waste generation would occur during FY 2010.

I.3.6.2 Transportation and Disposal of Waste

Annual shipments under the No Action Option are listed in **Table I–71.** Peak shipments of waste would occur in FY 2008.

Table I–69 Capping Option Annual Waste Generation Rates [a, b]

Waste (cubic yards)	Fiscal Year										Total
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Solid waste	4,300	4,300	4,400	5,300	5,800	4,300	4,800	4,300	4,800	4,500	47,000
Chemical waste [c]	4,100	3,500	2,300	2,100	2,200	2,100	2,100	2,100	2,100	2,100	25,000
Low-level radioactive waste	1,800	4,400	5,000	1,600	2,100	780	1,100	780	1,100	900	20,000
Mixed low-level radioactive waste	200	270	90	71	370	160	160	160	160	160	1,800
Transuranic waste	100	100	–	42	26	–	–	–	–	–	280
Total	10,000	13,000	12,000	9,200	11,000	7,400	8,200	7,400	8,200	7,700	93,000

[a] In situ volumes. As-shipped volumes are assumed to be 20 percent larger to account for material swell following removal from the ground.
[b] In addition, about 1,000 gallons of liquid low-level radioactive waste is projected per year from LANL's environmental restoration project, to be shipped to treatment facilities generally on the LANL site.
[c] Includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.
Note: To convert cubic yards to cubic meters, multiply by 0.76456. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–70 Removal Option Annual Waste Generation Rates [a]

Waste	Fiscal Year										Total
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Nonliquid Waste (cubic yards)											
Solid waste	9,200	14,000	25,000	21,000	9,700	9,400	9,400	9,400	9,400	9,200	130,000
Chemical waste [b]	4,600	5,900	10,000	9,100	3,600	2,700	3,200	3,400	2,900	2,700	49,000
Low-level radioactive waste	4,700	12,000	83,000	110,000	96,000	95,000	96,000	96,000	95,000	20,000	710,000
Mixed low-level radioactive waste	250	830	21,000	28,000	14,000	10,000	12,000	12,000	11,000	2,100	110,000
Alpha low-level radioactive waste	–	10,000	81,000	90,000	35,000	31,000	31,000	31,000	31,000	5,700	350,000
Mixed alpha low-level radioactive waste	–	3,300	23,000	23,000	4,300	3,500	3,500	3,500	3,500	630	68,000
Remote-handled low-level radioactive waste	–	–	120	180	180	180	180	180	180	33	1,200
Mixed remote-handled low-level radioactive waste	–	–	13	20	20	20	20	20	20	4	140
Contact-handled transuranic waste	100	450	4,700	5,700	1,700	920	2,800	3,800	1,900	170	22,000
Remote-handled transuranic waste	–	–	23	24	0.57	0.57	0.57	0.57	0.57	0.11	50
Total nonliquid waste	19,000	47,000	250,000	280,000	160,000	150,000	160,000	160,000	160,000	41,000	1,400,000
Liquid Waste (gallons)											
Industrial liquid waste	0	1,000	1,000	28	0	0	0	0	0	0	2,100
Hazardous liquid waste	21	1,100	3,300	3,300	2,500	21	21	21	21	21	10,000
Low-level radioactive liquid waste	1,100	1,300	1,300	1,100	1,100	1,100	1,100	1,100	1,100	1,100	11,000
Mixed low-level radioactive liquid waste	20	20	20	20	20	20	20	20	20	20	200
Total liquid waste [c]	1,100	3,400	5,600	4,400	3,600	1,100	1,100	1,100	1,100	1,100	24,000

[a] In situ volumes. As-shipped volumes are 20 percent larger to account for material swell following removal from the ground.
[b] Includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.

Note: To convert cubic yards to cubic meters, multiply by 0.76456; gallons to liters, multiply by 3.785. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–71 No Action Option Annual Waste Shipments

Waste	*Fiscal Year*										*Total*
	2007	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	
Chemical waste [a]	160	120	16	0	4	3	3	3	3	3	310
Low-level radioactive waste [b]	70	260	290	2	0	0	0	0	0	0	620
Mixed low-level radioactive waste [b]	10	16	2	0	24	7	7	7	7	7	87
Transuranic waste [c]	12	12	0	0	0	0	0	0	0	0	24
Total	250	400	310	2	28	10	10	10	10	10	1,000

[a] Assuming an average waste density of 1 gram per cubic centimeter. Includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.
[b] Assumed to be low-activity and mixed low-activity low-level radioactive waste.
[c] Includes mixed transuranic waste.
Note: Because numbers have been rounded, the sums may not equal the indicated totals.

Annual shipments under the Capping Option are listed in **Table I–72**, while annual shipments under the Removal option are listed in **Table I–73**. Peak shipments under the Capping Option would occur during FY 2008, and under the Removal Option during FY 2010.

I.3.6.3 Cover Materials, Excavated Soil, and Materials Transport

No Action Option. Materials and requirements for transporting these materials would be comparable to those seen in past years at LANL.

Capping Option. Volumes of capping materials, assuming two thicknesses of final cover, are indicated in **Table I–74**, along with total truck shipments through FY 2016. Sources for this cover material would be borrow areas within LANL or its vicinity. In the table, the "tuff" designation refers to fill material such as crushed tuff. The "additional material" designation refers to topsoil, soil amendment, gravel, and similar materials.

Additional materials may include instrumentation for cover infiltration monitoring, cement grout for stabilizing the General's Tanks in place, fencing, or other miscellaneous materials.

Removal Option. The process of exhuming the MDAs would cause movement of large quantities of uncontaminated soil. Soil removed from the vicinity of the MDAs would be stockpiled and returned to the excavations. Additional backfill would be needed to account for the removed waste, plus a layer of topsoil and materials intended to promote vegetative growth. Remaining disposal units at the existing Area G footprint following MDA G removal are assumed to be covered with either a thin or thick cap, as are small contaminated areas or landfills in TA-49.

Material volumes and shipments are summarized in **Table I–75**. The table includes volumes and shipments of bulk material for MDA removal, for capping the remaining disposal units in the existing Area G footprint following MDA G removal, and for capping small landfills and areas of contamination in TA-49 (see Tables I–50 and I–51). In most cases, distances of shipments of material that would be removed, stockpiled, and returned to the excavations would be very short. The additional fill and topsoil could come from borrow areas either on or in the vicinity of LANL.

Table I–72 Capping Option Annual Waste Shipments

Waste [a]	Fiscal Year										Total
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Solid waste	330	330	340	410	450	330	360	330	360	340	3,600
Chemical waste [b]	340	290	190	180	180	180	180	180	180	180	2,100
Low-level radioactive waste	120	310	350	110	150	55	80	55	80	63	1,400
Mixed low-level radioactive waste	16	21	7	6	30	13	13	13	13	13	140
Transuranic waste	12	12	0	5	3	0	0	0	0	0	32
Total	820	970	890	710	810	580	640	580	640	600	7,200

[a] In addition, roughly 1,000 gallons of low-level liquid radioactive waste is projected to be generated per year from LANL's environmental restoration project, to be shipped to treatment facilities on the LANL site. This would be accomplished using less than two full shipments.

[b] Includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.

Note: Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–73 Removal Option Annual Waste Shipments

Waste	*Fiscal Year*										*Total*
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	
Nonliquid Waste											
Solid waste	700	1,100	1,900	1,600	740	720	720	720	720	700	9,700
Chemical waste [a]	380	490	870	760	300	220	270	290	240	220	4,000
Low-level radioactive waste	330	870	5,900	7,600	6,800	6,700	6,800	6,800	6,700	1,400	50,000
Mixed low-level radioactive waste	20	66	1,700	2,200	1,100	820	920	970	870	160	8,900
Alpha low-level radioactive waste	–	810	6,500	7,200	2,800	2,500	2,500	2,500	2,500	450	28,000
Mixed alpha low-level radioactive waste	–	260	1,900	1,800	340	280	280	280	280	50	5,400
Remote-handled low-level radioactive waste	–	–	58	88	86	86	86	86	86	16	590
Mixed remote-handled low-level radioactive waste	–	–	6	10	10	10	10	10	10	2	66
Contact-handled transuranic waste	12	52	550	670	200	110	330	440	220	20	2,600
Remote-handled transuranic waste	–	–	35	37	1	1	1	1	1	1 [b]	76
Total nonliquid waste	1,400	3,600	19,000	22,000	12,000	11,000	12,000	12,000	12,000	3,100	110,000
Liquid Waste											
Industrial liquid waste	–	1	1	–	–	–	–	–	–	–	3
Hazardous liquid waste	–	1	4	4	3						13
Low-level radioactive liquid waste	1	2	2	1	1	1	1	1	1	1	14
Mixed low-level radioactive liquid waste	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]	1 [b]
Total liquid waste	1	4	7	6	5	1	1	1	1	1	30

[a] Includes wastes regulated under RCRA, TSCA, or the New Mexico Solid Waste Act of 1990, or otherwise unacceptable for sanitary landfill disposal.
[b] Shipment contains less than a full load.
Note: Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–74 Materials and Shipments for Capping All Material Disposal Areas [a]

Material	Fiscal Year										Total
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Volumes (cubic yards)											
Minimum											
Tuff	7,100	7,100	57,000	100,000	190,000	7,300	150,000	11,000	160,000	56,000	750,000
Additional material	590	590	6,600	11,000	130,000	610	120,000	930	120,000	41,000	430,000
Rock armor	–	–	230	810	170	–	–	–	–	–	1,200
Retaining wall	–	–	140	140	–	–	–	–	–	–	280
Total material	7,700	7,700	64,000	120,000	320,000	7,900	280,000	12,000	280,000	97,000	1,200,000
Maximum											
Tuff	19,000	19,000	120,000	250,000	520,000	20,000	420,000	30,000	430,000	150,000	2,000,000
Additional material	1,600	1,600	9,900	21,000	130,000	1,700	120,000	2,500	120,000	42,000	460,000
Rock armor	–	–	230	810	170	–	–	–	–	–	1,200
Retaining wall	–	–	370	380	–	–	–	–	–	–	750
Total material	21,000	21,000	130,000	270,000	660,000	22,000	540,000	33,000	550,000	190,000	2,500,000
Shipments											
Minimum											
Tuff	550	550	4,500	8,100	15,000	570	12,000	870	12,000	4,400	59,000
Additional material	46	46	510	870	9,900	48	9,600	72	9,600	3,200	34,000
Rock armor	–	–	14	48	10	–	–	–	–	–	72
Retaining wall	–	–	10	11	–	–	–	–	–	–	21
Total material	600	600	5,000	9,100	25,000	620	22,000	940	22,000	7,600	92,000
Maximum											
Tuff	1,500	1,500	9,500	20,000	41,000	1,600	33,000	2,400	34,000	12,000	150,000
Additional material	130	130	780	1,600	10,000	130	9.600	200	9,700	3,300	36,000
Rock armor	–	–	14	48	10	–	–	–	–	–	72
Retaining wall	–	–	28	29	–	–	–	–	–	–	57
Total material	1,600	1,600	10,000	21,000	51,000	1,700	42,000	2,600	43,000	15,000	190,000

[a] Includes volumes and shipments for capping small areas in TA-49.

Note: To convert cubic yards to cubic meters, multiply by 0.765. Because numbers have been rounded, the sums may not equal the indicated totals.

Table I–75 Materials and Shipments for Removing All Material Disposal Areas

Material	Fiscal Year										
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Total*
Volumes (cubic yards) – MDA Removal plus Thin Cap at Area G [a]											
Remove top layer	850	11,000	62,000	67,000	36,000	33,000	35,000	36,000	34,000	6,700	320,000
Remove additional soil	5,200	12,000	560,000	750,000	470,000	440,000	440,000	440,000	440,000	84,000	3,600,000
Stockpile return	6,100	23,000	610,000	800,000	500,000	470,000	470,000	480,000	470,000	91,000	3,900,000
Additional fill	9,300	34,000	240,000	280,000	160,000	150,000	150,000	150,000	150,000	34,000	1,300,000
Crushed tuff for capping.	3,100	3,100	21,000	30,000	30,000	30,000	30,000	30,000	30,000	8,100	220,000
Total tuff and fill	12,000	37,000	260,000	310,000	190,000	180,000	180,000	180,000	180,000	42,000	1,600,000
Additional material for MDA removal	540	2,200	12,000	13,000	6,800	5,900	6,200	6,400	6,000	1,500	61,000
Additional material for capping	260	260	15,000	23,000	23,000	23,000	23,000	23,000	23,000	4,500	160,000
Total additional material	800	2,500	27,000	36,000	30,000	29,000	29,000	30,000	29,000	6,000	220,000
Total material moved	25,000	8,600	1,500,000	2,000,000	1,200,000	1,100,000	1,200,000	1,200,000	1,200,000	230,000	9,700,000
One Way Shipments – MDA Removal plus Thin Cap at Area G [a]											
Remove top layer	60	780	4,400	4,700	2,500	2,300	2,500	2,600	2,400	470	23,000
Remove additional soil	370	880	40,000	53,000	33,000	31,000	31,000	31,000	31,000	6,000	260,000
Stockpile return	430	1,700	43,000	56,000	36,000	33,000	34,000	34,000	33,000	6,400	280,000
Additional fill	660	2,400	17,000	20,000	11,000	10,000	11,000	11,000	11,000	2,400	95,000
Crushed tuff for capping	240	240	1,600	2,400	2,400	2,400	2,400	2,400	2,400	630	17,000
Total tuff and fill	900	2,600	18,000	22,000	14,000	13,000	13,000	13,000	13,000	3,100	110,000
Additional material for MDA removal	39	160	850	940	480	420	440	460	430	110	4,300
Additional material for capping	20	20	1,200	1,800	1,800	1,800	1,800	1,800	1,800	350	12,000
Total additional material	59	180	2,000	2,700	2,300	2,200	2,200	2,300	2,200	460	17,000
Total material moved	1,800	6,100	110,000	140,000	87,000	81,000	83,000	83,000	82,000	16,000	690,000
Volumes (cubic yards) – MDA Removal plus Thick Cap at Area G [a]											
Remove top layer	850	11,000	62,000	67,000	36,000	33,000	35,000	36,000	34,000	6,700	320,000
Remove additional soil	5,200	12,000	560,000	750,000	470,000	440,000	440,000	440,000	440,000	84,000	3,600,000
Stockpile return	6,100	23,000	610,000	800,000	500,000	470,000	470,000	480,000	470,000	91,000	3,900,000
Additional fill	9,300	34,000	240,000	280,000	160,000	150,000	150,000	150,000	150,000	34,000	1,300,000
Crushed tuff for capping.	8,400	8,400	57,000	83,000	83,000	83,000	83,000	83,000	83,000	22,000	600,000
Total tuff and fill	18,000	42,000	290,000	360,000	240,000	230,000	230,000	240,000	230,000	57,000	1,900,000
Additional material for	540	2,200	12,000	13,000	6,800	5,900	6,200	6,400	6,000	1,500	61,000

Material	*Fiscal Year*										
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Total*
MDA removal											
Additional material for capping	700	700	16,000	24,000	24,000	24,000	24,000	24,000	24,000	4,900	160,000
Total additional material	1,200	2,900	2,800	37,000	30,000	29,000	30,000	30,000	30,000	6,400	220,000
Total material moved	31,000	92,000	1,600,000	2,000,000	1,300,000	1,200,000	1,200,000	1,200,000	1,200,000	240,000	10,000,000
One Way Shipments – MDA Removal plus Thick Cap at Area G [a]											
Remove top layer	60	780	4,400	4,700	2,500	2,300	2,500	2,600	2,400	470	23,000
Remove additional soil	370	880	40,000	53,000	33,000	31,000	31,000	31,000	31,000	6,000	260,000
Stockpile return	430	1,700	43,000	56,000	36,000	33,000	34,000	34,000	33,000	6,400	280,000
Additional fill	660	2,400	17,000	20,000	11,000	10,000	11,000	11,000	11,000	2,400	95,000
Crushed tuff for capping	660	660	4,500	6,500	6,500	6,500	6,500	6,500	6,500	1,700	47,000
Total tuff and fill	1,300	3,000	21,000	26,000	18,000	17,000	17,000	17,000	17,000	4,200	140,000
Additional material for MDA removal	39	160	850	940	480	420	440	460	430	110	4,300
Additional material for capping	55	55	1,200	1,800	1,800	1,800	1,800	1,800	1,800	380	13,000
Total additional material	93	210	2,100	2,800	2,300	2,300	2,300	2,300	2,300	490	17,000
Total material moved	2,300	6,600	110,000	140,000	91,000	86,000	87,000	87,000	86,000	18,000	720,000

MDA = material disposal area.

[a] Refers to capping the remaining disposal units in the existing 63-acre Area G footprint following MDA G removal. Includes small volumes and shipments of materials needed to optionally cap sites in Areas 6 and 12 of TA-49.

Note: To convert cubic yards to cubic meters, multiply by 0.765. Because numbers have been rounded, the sums may not equal the indicated totals.

MDA H. Assuming that remediation of MDA H occurs during the time period covered in this SWEIS, bulk material volumes and shipments projected in this section may be augmented as summarized in Sections I.3.3.2.2.2.

I.3.6.4 Equipment, Emissions, and Personnel Assumptions

This section addresses assumptions for equipment use, airborne emissions of machinery combustion products, personnel requirements for PRS remediation, personnel radiological exposures, and industrial accident risks. To do this, assumptions about hourly personnel and machinery use were developed from industrial cost, personnel, and equipment data provided in catalogs from the R.S. Means Company. In addition, the literature was reviewed for assumptions and experience at other remediation efforts such as those discussed in Section I.3.3.1.3.[70]

Several case studies were developed using the Means data that were applicable to the different remediation efforts addressed in this appendix. For each case study, the Means cost data were used, along with other information in the Means catalogs, to estimate personnel hours and machinery use. The estimated personnel and machinery hours included contingency factor multipliers to account for special conditions at sites where radioactive material is involved. Projected personnel hours were used with assumptions about radiation environments associated with various remediation efforts to estimate personnel radiation doses and risks, as well as industrial accident risks. Projected equipment hours were used along with assumptions about hourly fuel requirements to determine gallons of fuel used. This information was then used with procedures and assumptions outlined in Section 3.3 ("Gasoline and Diesel Industrial Engines") of AP 42, EPA's compilation of air pollutant emission factors (EPA 1995), to estimate air emissions of nonradiological pollutants such as carbon monoxide and nitrogen oxides.

Table I–76 outlines each of the case studies and summarizes the results of the calculations using Means data for each study. In this table, equipment, personnel, and fuel use requirements are summarized on both a per-square-foot basis (as in square feet of area addressed) and on a per-cubic-yard basis (as in cubic yards of contaminated material removed). Contingency factor multipliers are also shown for each case study.

Total equipment hours and fuel use were determined for each of the case studies, and the total releases of pollutants associated with this fuel use (in tons released to the air) are summarized in **Table I–77**. **Table I–78** lists total personnel hours for each case study, as well as the calculated industrial risks resulting from these total personnel hours. Industrial risks for each case study were developed using 5-year-average DOE statistics for construction workers from the Computerized Accident and Incident Reporting System database (DOE 2004d) and information from the U.S. Department of Labor Statistics for the overall construction industry (DOL 2003). Information from these tables was used for each of the options in this appendix as discussed below.

---

[70] *Remediation of MDA H has been addressed in previous NEPA analyses but may occur during the time period covered in this SWEIS. Estimates of equipment and personnel requirements and associated impacts for remediating MDA H were presented in this previous analyses (DOE 2004a).*

Table I–76 Summary of Labor, Equipment Hours, and Fuel Use for Remediation Case Studies

Case Study	*Area (acres)*	*Depth (feet)*	*Volume of Material (cubic yards)*	*Contingency Factor Assumed*	*Labor (hours per square foot)*	*Equipment (hours per square foot)*	*Fuel Use (gallons per square foot)*	*Labor (hours per cubic yard)*	*Equipment (hours per cubic yard)*	*Fuel Use (gallons per cubic yard)*
Case 1Aa – Small area, thin cap	1	3 [a]	6,300	1.5	0.085	0.052	0.32	0.59	0.36	2.2
Case 1Ab – Small area, thick cap	1	8.2 [a]	17,000	1.5	0.17	0.11	0.64	0.43	0.27	1.6
Case 1Ba – Large area, thin cap	20	3 [a]	130,000	1.5	0.075	0.046	0.28	0.52	0.32	1.9
Case 1Bb – Large area, thick cap	20	8.2 [a]	340,000	1.5	0.15	0.090	0.55	0.37	0.23	1.4
Case 2A – Removal of contaminated soil	1	1	1,600	1.5	0.12	0.038	0.20	3.2	1	5.4
Case 3A – Removal of shallow material from a small MDA	1	15	24,000	1.5	1.6	0.52	2.7	2.9	0.93	4.9
Case 3B – Removal of shallow material from a large MDA	20	15	480,000	1.5	1.3	0.42	2.2	2.4	0.76	4
Case 4A – Deeper soil or shaft removal	1	60	48,000	2.0	32	12	72	29	11	64

MDA = material disposal area.

[a] The reference for these case studies is to the thicknesses of the fill material for the caps. Additional materials that would be used for capping (fill for grading, topsoil, and other material) was considered for the estimates. The reference for the remaining case studies is to volume of material removed.

Note: To convert acres to hectares, multiply by 0.40469; feet to meters, multiply by 0.3048; cubic yards to cubic meters, multiply by 0.76459; square feet to square meters, multiply by 0.092903; gallons to liters, multiply by 3.78533. All numbers have been rounded.

Table I–77 Remediation Case Study Total Equipment and Fuel Use and Pollutant Emissions (tons released)

Case Study	Equipment Hours	Fuel Use (gallons)	Nitrogen Oxides	Carbon Monoxide	Sulfur Oxide	Particulate Matter [a]	Carbon Dioxide	Aldehydes	Total Organic Carbon (TOC)
Case 1Aa – Small area, thin cap	2,300	14,000	3.7	9.4	0.24	0.26	150	0.065	0.70
Case 1Ab – Small area, thick cap	4,600	28,000	7.5	19	0.49	0.52	310	0.13	1.4
Case 1Ba – Large area, thin cap	40,000	240,000	66	170	4.3	4.6	2,700	1.1	12
Case 1Bb – Large area, thick cap	79,000	480,000	130	320	8.4	9.0	5,200	2.3	24
Case 2A – Removal of contaminated soil	1,600	8,700	2.3	5.9	0.15	0.16	95	0.041	0.44
Case 3A – Removal of shallow material from a small MDA	23,000	120,000	32	81	2.1	2.2	1,300	0.56	6.0
Case 3B – Removal of shallow material from a large MDA	370,000	1,900,000	520	1,300	34	36	21,000	9.1	98
Case 4A – Deeper soil or shaft removal	530,000	3,100,000	840	2,100	54	58	34,000	15	160

PM_{10} = particulate matter having diameters smaller than 10 micron, MDA = material disposal area.

Note: To convert gallons to liters, multiply by 3.78533; tons to kilograms, multiply by 907.18. Numbers have been rounded.

Table I–78 Remediation Case Study Total Industrial Risks

Case Study	Total Labor Hours	Safety – Construction Industry			Safety – DOE Construction		
		Recordable Injuries	Lost Workdays	Fatalities	Recordable Injuries	Lost Work Days	Fatalities
Case 1Aa – Small Area, Thin Cap	3,700	0.16	1.7	3.8×10^{-4}	0.042	0.14	–
Case 1Ab – Small Area, Thick Cap	7,500	0.32	3.4	7.8×10^{-4}	0.085	0.28	–
Case 1Ba – Large Area, Thin Cap	65,000	2.8	30	6.8×10^{-3}	0.74	2.5	–
Case 1Bb – Large Area, Thick Cap	130,000	5.4	59	0.013	1.5	4.8	–
Case 2A – Removal of Contaminated Soil	5,100	0.22	2.3	5.3×10^{-4}	0.057	0.19	–
Case 3A – Removal of Shallow Material from a Small MDA	70,000	3.0	32	7.3×10^{-3}	0.79	2.6	–
Case 3B – Removal of Shallow Material from a Large MDA	1,100,000	48	520	0.12	13	43	–
Case 4A – Deeper Soil or Shaft Removal	1,400,000	60	650	0.15	16	53	–

MDA = material disposal area.
Note: Numbers have been rounded.

Total personnel hours and radiation dose from MDA and PRS remediation are the sum of those associated with direct remediation efforts (addressed above) and those associated with remedial design and waste processing and loading onto trucks. Remedial design addresses work performed after the optimum remedial action alternative has been selected and prior to the onset of remedial construction. This work includes activities such as project planning, treatability or other studies, and preparation of design documents. A 10-percent factor for remedial design was assumed based on the range of complexity that would be associated with remediating the MDAs and PRSs. Assumptions for waste processing and loading onto trucks are addressed in Section I.3.5.

I.3.6.4.1 No Action Option

Under the No Action Option, a low level of remediation effort would take place. Personnel hours, air emissions, and industrial risks were estimated by determining ratios of waste volumes listed in Table I–68 to unit information derived for Case Study 2A, Removal of Contaminated Soil. (For example, nitrogen oxide [NO_x] emissions from removal of 1,000 cubic yards of soil as part of LANL's environmental restoration project would be 1,000 cubic yards × 5.4 gallons per cubic yard × 2.3 tons per 8,700 gallons consumed, or 1.4 tons (1,300 kilograms) of nitrogen oxides released.)

Worker radiation exposures were determined by estimating total personnel hours engaged in remediation work (using the above methods) and multiplying these hours by an assumed radiation environment of 2.2×10^{-6} rem per hour (the same as the same hourly exposure rate for remediation of the combined PRS area discussed in Section I.3.6.4.3). Personnel hours and radiation exposures for waste processing and truck loading were assessed as addressed in Section I.3.5.

I.3.6.4.2 Capping Option

Under this option, air emissions and personnel hours, exposure rates, and industrial safety risks were conservatively estimated as addressed for the No Action Option and through consideration of:

- Capping several MDAs
- Generating and handling wastes associated with capping the MDAs
- Generating and handling wastes associated with annually remediating several small PRSs such as Firing Site E-F or the 260 Outfall in various locations within LANL
- Generating crushed tuff in the TA-61 borrow pit for MDA capping

For capping, air emissions and personnel hours and industrial safety risks were proportioned to the nominal sizes of the MDAs and landfills using Case Study 1Aa, 1Ab, 1Ba, or 1Bb. Case Studies 1Aa and 1Ab were used for MDAs and landfills covering about 1 acre (0.4 hectare) or less. This included all MDAs (and the Area 12 landfill in TA-49) except for MDAs B, T, C, and G (and the Area 6 landfill in TA-49), for which Case Study 1Ba or 1Bb was used. The case studies imply the following approximate personnel hourly commitments per cubic yard of capping material:

- Case Study 1Aa: 0.6 hours per cubic yard
- Case Study 1Ab: 0.4 hours per cubic yard
- Case Study 1Ba: 0.5 hours per cubic yard
- Case Study 1Bb: 0.4 hours per cubic yard

These rates are within the range of those that have been estimated in the literature. For example, the environmental assessment for MDA H projected about 2.9 to 3.5 person-hours per cubic yard of emplaced material, assuming placement of 2,860 cubic yards of material over 0.4 acre (0.2 hectare) (DOE 2004b). Sandia projected from 0.4 to 0.49 person-hours per cubic yard of cover material added, assuming a cap covering about 2.6 acres (1.1 hectares) of a mixed waste landfill (SNL 2004). Idaho National Laboratory projected about 0.4 person-hour per cubic yard of material emplaced, assuming covering about 100 acres (40.5 hectares) of a legacy radioactive waste disposal site (INEEL 2002a, 2002b).

The radiation environment that may be expected for capping will vary depending on local levels of contamination, the materials disposed of in the MDAs, and other sources of radiation such as adjacent operational areas. The overall radiation environment for capping was assumed from measurements of external exposure rates at MDA T during 2003 (LANL 2004h). This measurement, taken from a TLD at the boundary of MDA T, was about 100 millirem per year above background. This annual exposure rate is equivalent to an hourly exposure rate of 1.14×10^{-5} rem per hour. Using this exposure rate for all MDAs (except for MDA L and the landfills) should be conservative.

For generating and handling wastes associated with capping the MDAs and landfills, and annually remediating several PRSs, Case Study 2A was assumed. For both situations, the general radiation environment was assumed to be the same as for the combined PRS area (2.2×10^{-6} rem per hour; see Section I.3.6.4.3). Personnel hours and radiation exposures for waste processing and truck loading were assessed as addressed in Section I.3.5.

None of the case studies precisely correspond to borrow pit operation. The closest is Case Study 1Bb, placing a thick cap over a 20-acre (8.1-hectare) MDA. Hence, Case Study 1Bb was assumed to represent borrow pit operation.

I.3.6.4.3 Removal Option

Under this option, air emissions and personnel hours, exposure rates, and industrial safety risks were estimated as addressed for the No Action Option and through consideration of:

- Performing complete removal of several MDAs.
- Generating and handling wastes associated with annually remediating several small PRSs such as Firing Site E-F or the 260 Outfall in various locations within LANL. (Rates and risks were determined in the same manner as for the Capping Option.)
- Generating crushed tuff in the TA-61 borrow pit for backfilling MDAs.

Although removals have occurred at LANL and elsewhere, there is little experience with removals as challenging as those of many of the LANL MDAs. Several assessments have been published addressing removal operations at LANL and elsewhere. Most assessments were for postulated removals (DOE 2004b; INEEL 2002a, 2002d; SNL 2004; LANL 1981), while one addressed the completed removal of a chemical waste landfill (SNL 2003). Estimates of personnel requirements (and other factors) were quite variable.

For this appendix, emissions and personnel were estimated by scaling waste volumes removed for each MDA to unit volume factors for these parameters from Case Studies 3A, 3B, and 4A, as summarized in **Table I–79**. (Case Study 2A was again assumed for waste generated from preliminary MDA removal work and for annually remediating several PRSs.) Also shown are the assumed radiation environments associated with removal of the MDAs. Personnel hours and radiation exposure for waste processing and loading were assessed as addressed in Section I.3.5.

To estimate the general radiation environment for worker radiation dose assessments during MDA removal operations, RESRAD Version 6.3 calculations were performed for several MDAs assuming average waste radionuclide concentrations developed from the same inventories as those used for the air emissions assessment (see Section I.5.6.3.2). The primary value of these assessments is to compare options and to identify possible hazardous conditions. Actual removals would occur while using technical and administrative controls to maintain worker doses within prescribed limits and as low as reasonably achievable.

Table I–79 Case Studies Applied to Material Disposal Area Removal

Material Disposal Area [a]	*Case Study*	*Radiation Environment (rem per hour)*	*Material Disposal Area*	*Case Study*	*Radiation Environment (rem per hour)*
A (Eastern Pits) [b]	3A	0.000013	L (Pits) [i]	3A	Not applicable
A (Central Pit) [b]	3A	1.2×10^{-6}	L (Shafts) [i]	4A	Not applicable
A (Tanks) [b]	3A	1.7×10^{-5}	F [j]	3A	2.2×10^{-6}
B [c]	3B	2.4×10^{-6}	Q [k]	3A	2.2×10^{-6}
T (Beds) [d]	4A	2.8×10^{-5}	N [k]	3A	2.2×10^{-6}
T (Shafts) [d]	4A	0.00025	Z [k]	3A	2.2×10^{-6}
U (Beds) [e]	3A	0.00011	R [k]	3A	2.2×10^{-6}
AB (shafts) [f]	4A	0.00025	D [k]	3A	2.2×10^{-6}
C (Pits) [g]	3B	7.1×10^{-5}	E and K [k]	3A	2.2×10^{-6}
C (Shafts) [g]	4A	0.00025	AA [l]	3A	2.2×10^{-6}
G (Pits) [h]	4A	3.6×10^{-5}	Y [m]	3A	2.2×10^{-6}
G (Shafts) [h]	4A	0.00025	–	–	–

[a] For preliminary site work at any MDA, a radiation environment of 2.2×10^{-6} rem per person-hours was assumed using the radiation environment calculated for the combined potential release site area.
[b] The worker exposure environment was assumed from RESRAD calculations.
[c] The worker exposure environment was estimated from RESRAD calculations.
[d] For MDA T beds, the working exposure environment was estimated from RESRAD calculations. For MDA T shafts, operations were assumed to be controlled to maintain individual exposures (assuming 2,000-hour work year) to levels smaller than 500 millirem in a year.
[e] Exposure environment was assumed from RESRAD calculations.
[f] Assumed the same exposure environment as that for the MDA T shafts.
[g] Exposure environments were assumed from RESRAD calculations, with a maximum exposure rate of 0.00025 rem per hour to maintain individual exposures less than 500 millirem in a year.
[h] MDA G pits contain pockets of small, high-activity waste containing cobalt-60 and cesium-137. Assumed that special measures would be taken for these pockets to maintain worker exposures to levels as low as reasonably achievable. Based the average radiation environment for MDA G pits on RESRAD calculations by excluding two small pockets of cobalt-60 and cesium-137. For MDA G shafts, assumed that worker exposure rates would be maintained to levels so that no individual receives more than 500 millirem in a year, assuming 2,000 work hours per year.
[i] MDA L should contain very little radioactive material, although precautions would be required for the presence of toxic and hazardous constituents.
[j] Used the worker exposure environment estimated for the combined PRS area.
[k] Assumed the same worker exposure environment as that for the combined PRS area.
[l] Assumed the same worker exposure environment as that for the combined PRS area.
[m] Worker exposure environment was estimated from RESRAD calculations.

If the radiation environment was not too high as determined from these calculations, the RESRAD calculations were assumed. However, DOE regulations prescribe an upper radiation dose limit of 5 rem (total effective dose equivalent) in a year. Special approval is required before allowing radiation doses to exceed 2 rem in a year, and administrative controls must be imposed to further reduce radiation exposures. The *DOE Standard Radiological Control Manual* indicates that an administrative control level of 500 millirem in a year (or less) should be challenging and achievable (DOE 1999c). Assuming 2,000 work hours per year and a 0.5-rem-per-year average dose level, worker radiation exposures would be limited to an average dose rate of 2.5×10^{-4} rem per hour. This average dose rate was the maximum assumed for removal of any MDA.

In addition, a radiation environment for worker radiation dose assessment (2.2×10^{-6} rem per hour) was estimated for the assumed annual remediation of several small PRSs and MDAs. This radiation environment was determined using RESRAD Version 6.3 calculations assuming average radionuclide concentrations developed from the inventory assumed for the combined PRS area discussed in Section I.5.6.3.2.

Case Study 1Bb was again assumed to represent nonradiological releases and worker industrial risks from operations of the TA-61 borrow pit.

I.3.6.5 Affected Area Assumptions

Remediating the MDAs and PRSs will affect LANL property. In addition to the land area comprising the surface footprints of the MDAs and PRSs, additional area will be temporarily affected by operations supporting remediation. For example, capping an MDA may require temporary use of land for storage of bulk materials. Following completion of the task, the land would be restored. The amount of land that would thus be temporarily affected would depend on regulatory decisions, logistical considerations, and other factors.

MDAs. Temporary support areas associated with capping MDAs may include:

- A project management area, including a management trailer and space for staging equipment;
- An area for parking personal vehicles;
- An area for temporary management or storage of any wastes that may be generated; and
- An area for stockpiling bulk materials such as crushed tuff.

The size of a temporary project management area for any MDA may depend on the magnitude of the job, but should in most cases cover less than 1 acre (0.4 hectare). (The management area envisioned for remediating MDA H under any alternative covered only 0.2 acre (0.1 hectare) [DOE 2004b].) It is also expected that, for most MDAs, there should be no need to site additional personal vehicle parking infrastructure because sufficient nearby parking infrastructure should already exist.

For most MDAs, capping should not involve generation of significant quantities of waste. Hence, temporary waste management areas should (for most MDAs) be far smaller than 1 acre (0.4 hectare). Because most waste so generated will probably be either solid waste or low-activity low-level radioactive waste, storage time should be minimal. Roll-offs and Intermodals staged at a location for receipt of bulk waste would be present for the time required to fill them; when filled, they would be removed and replaced as needed by additional roll-offs and Intermodals. A 20-cubic-yard roll-off has typical dimensions of 8 by 20-22 by 4 feet tall (2.4 by 6.1-6.7 by 1.2 meters tall) (Burris 2005). Given packaging inefficiencies and swell of excavated waste, each roll-off is projected to contain about 13 cubic yards (10 cubic meters) of waste (see Table I–66). Assuming 10-foot (3-meter) side-to-side spacing and 5-foot (1.5-meter) end-to-end spacing, about 450 square feet (41.8 square meters) would be needed to temporarily store about 13 cubic yards (10 cubic meters) of low-activity waste. A site containing 10 roll-offs, or 130 cubic yards (100 cubic meters) of waste, would cover only about 0.1 acre (0.04 hectare).

The largest acreage may be dedicated to temporary storage of bulk materials. For many MDAs, much bulk material could be delivered directly to the worksite. But because of logistical or other considerations, it may be necessary to stockpile capping materials near the work area. Therefore, it was conservatively assumed that capping any MDA could require the temporary storage of 6 months' worth of capping materials.[71] It was estimated by assuming a series of long, parallel rows of spoil piles, each pile roughly triangular in cross section. Because the material was assumed to be delivered and moved using trucks, loaders, and bulldozers, the piles were assumed to each be 10 feet (3 meters) high. The separation between piles was assumed to be 10 feet (3 meters). These assumptions result in an area commitment of 0.2 square feet per cubic foot (0.66 square meters per cubic meter) of stored spoil, considering a 20 percent swell of delivered material following initial excavation.

Temporary support areas associated with removing MDAs may include:

- A project management area, including a management trailer and space for staging equipment.
- An area for parking personal vehicles.
- An area for temporary management or storage of wastes.
- Capacity for storing bulk materials such as excavation spoils, final cover materials, or demolition debris.
- Possible capacity for preliminary classification of exhumed materials by hazard and for staging for further management.
- Possible capacity to process or package some wastes before shipment for further treatment or disposal.
- Possible capacity to characterize the waste in terms of organic, inorganic, and radioactive material content.

Similar to the assumption for capping MDAs, management areas associated with removal of most MDAs are assumed to cover less than 1 acre (0.4 hectare) for each MDA. (Additional areas may be needed for removal of waste from larger MDAs, or for decontaminating equipment.) It is also expected that, for most MDAs, there should be no need to site additional personal vehicle parking infrastructure because sufficient nearby parking infrastructure should already exist.

Areas needed for temporary management or storage of exhumed wastes would be larger than those for MDA capping. Depending on the MDA, waste management support areas may need to address a variety of wastes, including remote-handled waste. Shielded bunkers or similar facilities may be required, as may facilities for decontamination of equipment. However, because the bulk of the material removed from the waste would be very low-activity bulk material, it was again assumed that roughly 0.01 acre (0.004 hectare) would be required to store

[71] Six months' capacity is assumed because, although work is expected to proceed in stages, there may be need for long-term storage of some materials.

about 13 cubic yards (10 cubic meters) of waste. Capacity for temporary storage and management of 3 months' generation of waste was assumed for each MDA.[72]

A significant commitment of land may be associated with temporary storage of bulk materials such as overburden or backfill. Land requirements are assumed to be 0.2 square feet per cubic foot (0.66 square meters per cubic meter) of spoil (stockpiled overburden, removed clean fill, backfill, and topsoil), assuming a 6-month storage capacity and 20 percent material swell.[73]

Additional land commitments may be needed for some MDAs for hazard classification of exhumed materials, waste processing or packaging of some wastes (for example, transuranic or remote handled wastes), or waste characterization (see Section I.3.3.2.8). Needed capacity would depend on regulatory decisions (for example, partial versus complete removal), volumes and characteristics of the exhumed wastes, and other factors. Assuming complete removal of all MDAs, capacity may be needed at several locations within LANL. Extrapolating from the sizes of facilities proposed for the investigation and remediation program for MDA B (Section I.3.3.2.7), complete MDA removal could temporarily involve up to 84 acres (34 hectares).[74]

Additional PRSs. Support commitments for remediating other PRSs will generally be small and, again, temporary, but will vary depending on the PRS and the remediation decision. Temporary support areas may be needed for project management, temporary waste storage, equipment staging, or personal vehicle parking.

I.4 Affected Environment

This section provides summary descriptions of the natural and human environments possibly affected by the options considered in this appendix. Detailed descriptions of these environments within and near LANL are in Chapter 4 of this SWEIS.

I.4.1 Land Resources

Land resources include land use and visual resources. Land use is defined as the way land is developed and used in terms of the kinds of anthropogenic activities that occur (e.g., agriculture, residential areas, industrial areas) (EPA 2006). Visual resources are natural and manmade features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture (DOI 1986).

I.4.1.1 Land Use

Land use at LANL is addressed in Chapter 4, Section 4.1.1, of this SWEIS. Existing land use is depicted in Figure 4–4. MDAs addressed in this appendix are listed in **Table I–80** along with

---

[72] Three months' capacity was assumed because, in most cases, wastes would be stored for only a limited time before shipment and in consideration of RCRA storage requirements, which may be applicable for some wastes.

[73] These assumptions result in a calculated area for temporary storage of bulk materials from MDA H of about 1.3 acres (0.5 hectares), assuming 40 months of excavation, which is similar to the 1.2 acres (0.5 hectares) projected in the environmental assessment for MDA H (DOE 2004a).

[74] Assumed an additional five of each type of support facility (investigation facilities, waste processing facilities, and temporary laboratories). Assumed one each for removal of MDAs C and AB, one each for the remaining MDAs in TA-21, and two each for all MDAs in TA-54. As needed, the capacity could be used to support removal of the remaining small MDAs. From the proposed investigation and remediation of MDA B (Section I.3.3.2.7), this acreage is estimated as 6 (2 acres) + 6 (10 acres) + 6 (2 acres) = 84 acres (34 hectares).

their approximate sizes. The sizes of selected PRSs are also presented. A discussion of land use at each TA listed in Table I–80 is presented below, as well as at TA-61, which contains the principal LANL borrow pit.

Table I–80 Approximate Sizes of Material Disposal Areas and Selected Potential Release Sites

Technical Area	*Material Disposal Area*	*Approximate Size of Material Disposal Area Site (acres)*	*Potential Release Site*	*Approximate Size of Potential Release Site (acres)*
6	F	1.4	–	–
8	Q	0.2	–	–
15	N	0.28	Site E-F	11
15	Z	0.4	Site R-44	6
16	R	11.5	260 Outfall (16-021(c) -99)	0.7
21	A	1.25	–	–
21	B	6.0	–	–
21	T	2.2	–	–
21	U	0.2	–	–
33	D	0.03	–	–
33	E	1.4	–	–
33	K	1.0	–	–
35	X [a]	0.05	–	–
36	AA	1.4	–	–
39	Y	0.2	–	–
49	AB	0.45	–	–
50	C	11.8	–	–
54	G	63 [b]	–	–
54	L	2.6 [b]	–	–
73	–	–	Ashpile	1.2

[a] Although MDA X has been recommended for no further action and will likely not require significant further remediation, it is near several other potential release sites in TA-35.
[b] Listed acreage is for the areas containing the MDAs.
Note: To convert acres to hectares, multiply by 0.4047.

Technical Area 6. TA-6 covers 500 acres (202 hectares), of which only 1 percent is occupied by a gas cylinder staging facility, vacant buildings pending decommissioning, and a meteorological tower. It is south of TA-3, on a mesa between Twomile and Pajarito Canyons. Existing land use includes High-Explosive Research and Development and Reserve. MDA F is within the south-central portion of TA-6 in an area presently designated as Reserve. In the future, MDA F and the southern portion of the area could be redesignated as Experimental Science (LANL 2003f). According to the *Comprehensive Site Plan* for 2001, TA-6 is within the Anchor Ranch Planning Area. Future development is planned for the western half of the Planning Area; thus, development in the immediate vicinity of MDA F is unlikely (LANL 2001c).

Technical Area 8. Also known as the GT or Anchor West Site, TA-8 is at the western end of LANL. It covers 267 acres (108 hectares) and contains the Radiographic Testing Facility and MDA Q. The TA forms a portion of the Experimental Engineering Planning Area at LANL. Work includes high explosive research and development and testing (LANL 2001c). Current land use designations include High-Explosive Research and Development and Reserve; future land use is not expected to change (LANL 2003f). MDA Q is within an area designated as Potential Infill (LANL 2001c).

Technical Area 15. Centrally located within LANL, TA-15 is largely on Threemile Mesa. It is bounded on the north by Pajarito Canyon and on the south by Water Canyon. The entire TA is designated as High Explosive Testing. The future land use designation is likely to remain the same (LANL 2003f). As determined by the *Comprehensive Site Plan* for 2001, MDAs N and Z and Firing Sites E-F and R-44 are within areas classified as Potential Infill (LANL 2001c).

Technical Area 16. TA-16 covers 1,950 acres (789 hectares) at the southwest corner of LANL; it is adjacent to Bandelier National Monument. Land use includes High-Explosive Research and Development, Public and Corporate Interface, Physical and Technical Support, and Reserve. Future land use is expected to remain largely unchanged except that the Public and Corporate Interface area in the western portion of the TA will increase in size and the Physical and Technical Support area will no longer exist (LANL 2003f). MDA R and the 260 Outfall (SWMU 16-021(c)-99) are within the northern portion of the area designated as High-Explosive Research and Development. According to the *Comprehensive Site Plan* for 2001, MDA R covers 11.5 acres (4.7 hectares) and falls within areas designated as Potential Infill and No Development Zone (Hazard). The 260 Outfall is within an area designated as No Development Zone (Hazard) (LANL 2001c).

Technical Area 21. TA-21 covers 312 acres (126 hectares) at the eastern end of DP Mesa, near the central business district of the Los Alamos Townsite. The airport is immediately north of TA-21 across DP Canyon. Much of the TA has been developed, mainly the west-central portion of the TA. Remaining portions consist of sloped areas, some of which would likely not accommodate development. Access to the TA is via DP Road.

TA-21 was identified for possible conveyance to Los Alamos County under Section 632 of Public Law 105-119 (see Chapter 4, Section 4.1.1, of this SWEIS). This TA has been divided into four subtracts for purposes of the land conveyance: TA-21-1 (West), which consists of two units, and TA-21-2 (East). (The subtracts have also been designated A-8, A-15-1, A-15-2, and A-16, respectively. Subtracts A-8, A-15-1, and A-15-2 cover 33.7 acres (13.6 hectares) and either have been or are scheduled to be conveyed to the county. Conveyance of the 252-acre (102-hectare) A-16 subtract has been withdrawn; MDAs A, B, T, and U are within this subtract.

Land use includes Waste Management, Service and Support, Nuclear Materials Research and Development, and Reserve. Future land use is slated as Reserve (LANL 2003f). The MDAs are within two areas designated as No Development Zone (Hazard).

Technical Area 33. Located in the southeastern corner of LANL and also known as the Hot Point Site, TA-33 covers 1,919 acres (777 hectares). It is bounded on the north by TA-70, on the southeast by the Rio Grande, and on the southwest by Bandelier National Monument and the Santa Fe National Forest. TA-33 is designated as Experimental Science and Reserve and is used for experiments that require isolation or do not require daily oversight. In the future, the area used for Experimental Science will likely increase and that for Reserve decrease (LANL 2003f). As determined by the *Comprehensive Site Plan* for 2001, TA-33 falls within the Rio Grande

Development Area. MDAs D, E, and K are all within areas classified as Potential Infill (LANL 2001c).

Technical Area 35. Also known as Ten Site, TA-35 is used for nuclear safeguards research and development; reactor safety research; optical science and pulsed-power system research; and metallurgy, ceramic technology, and chemical plating activities. TA-35 covers 150 acres (61 hectares) in the northern half of LANL on a finger mesa between Mortandad Canyon and Ten Site Canyon. Land use includes Nuclear Materials Research and Development, Experimental Science, Physical and Technical Support, and Reserve. Future land use is expected to be similar except that the Physical and Technical Support land use category will likely be absent (LANL 2003f). TA-35 is part of the Pajarito Corridor West Development Area, one of the most restricted areas at LANL. Infill development at TA-35 is possible to replace the small, temporary structures scattered throughout the area (LANL 2001c).

Technical Area 36. Also known as the Kappa Site, TA-36 has four active firing sites. The TA is in a remote area in the southeastern portion of LANL. The TA is part of the Dynamic Testing Planning Area at LANL, which is the largest LANL planning area, covering 2,777 acres (1,124 hectares) (LANL 2001c). Land use at the TA is nearly exclusively High-Explosive Testing, with small areas of Physical and Technical Support and Reserve. Future land use is expected to be similar except the Physical and Technical Support area may not be present (LANL 2003f). TA-36 is within the Water Canyon Development Planning Area. MDA AA is in an area designated as Potential Infill (LANL 2001c).

Technical Area 39. TA-39 is at the bottom of Ancho Canyon in the south-central part of LANL. Covering 2,444 acres (989 hectares), TA-39 was created when explosives work at TA-15 became too crowded. Like TA-36, TA-39 is part of the Dynamic Testing Planning Area at LANL. Nearly the entire TA is classified as High-Explosive Testing, with small areas of Physical and Technical Support and Reserve. Future land use is expected to be similar (LANL 2003f). TA-39 is within the Water Canyon Development Area. MDA Y in the central portion of the TA in an area designated as Potential Infill (LANL 2001c).

Technical Area 49. TA-49 covers 1,280 acres (518 hectares) and is largely undeveloped. The TA is within the south-central portion of LANL and is bordered on the south by Bandelier National Monument. Land use designations include High-Explosive Testing, Physical and Technical Support, and Reserve; these designations are not expected to change in the future (LANL 2003f). MDA AB is within the Physical and Technical Support land use zone. According to the *Comprehensive Site Plan* for 2001, TA-49 is within the Water Canyon Development Area. The general area containing MDA AB is categorized as Potential Infill, indicating that some future development could take place; however, such development would not occur within the MDA (LANL 2001c).

Technical Area 50. TA-50 covers 62 acres (25 hectares). It is 1.3 miles (2.1 kilometers) southeast of TA-3 along Pajarito Road. Land use designations include Waste Management and Reserve. Only the portion of the TA north of MDA C contains buildings. Future land use categories are projected to be similar except that the Waste Management land use area could be enlarged to include the entire northern part of the TA (LANL 2003f). TA-50 is within the Pajarito Corridor West Development Area as set forth in the *Comprehensive Site Plan* for 2001.

Although the area to the south of Pajarito Road is designated as suitable for Secondary Development, the portion of the TA containing MDA C is designated as No Development Zone (Hazard) (LANL 2001c).

Technical Area 54. TA-54 covers 858 acres (347 hectares). MDAs G and L encompass 68 acres (28 hectares), or 7.2 percent of the TA. The 3-mile (4.8-kilometer) northern border of the site forms the boundary between LANL and San Ildefonso Pueblo lands. The residential area of White Rock borders the site at its eastern boundary. Land use within TA-54 is categorized as Experimental Science, Waste Management, and Reserve. Future land use is likely to be similar except that the area devoted to waste management is predicted to expand such that it forms a continuous band along the TA's southern boundary (LANL 2003f). According to the *Comprehensive Site Plan* for 2001, TA-54 is within the Pajarito Corridor East Development Area. The area containing MDAs G and L is categorized as Potential Infill, indicating that some future development could take place; however, such development would not occur within the MDAs (LANL 2001c).

Technical Area 61. Also known as the East Jemez Site, TA-61 is northeast of TA-3 and covers 297 acres (120 hectares). TA-61 is used for physical support and contains infrastructure facilities, including the Los Alamos County Landfill covering 48 acres (19 hectares). The generalized land use categories for the TA include Physical and Technical Support and Reserve. The 43-acre (17-hectare) area containing the borrow pit is next to East Jemez Road in the eastern portion of the TA in an area designated as Physical and Technical Support. The borrow pit is east of the Royal Crest Manufactured Home Community. Future land use will probably be similar (LANL 2003f). According to the *Comprehensive Site Plan* for 2001, the TA is within the Sigma Mesa Development Area that could undergo considerable future development (LANL 2001c).

Technical Area 73. This TA covers 272 acres (110 hectares) along the northern boundary of LANL next to NM 502 (East Road). The TA comprises the Los Alamos County Airport, which is owned by DOE and managed by the Los Alamos County. Land use consists of Airfield and Reserve; it is not expected to change in the future (LANL 2003f). The ashpit is north of the airport terminal building. Land use along East Road near TA-73 includes offices and other light commercial and retail land uses, as well as several churches, a swimming facility, and a park. TA-73 is part of the Omega West Planning Area. The Los Alamos County Airport is part of the DOE land exchange package (see Chapter 4, Table 4–2) (LANL 2001c).

I.4.1.2 Visual Environment

LANL visual resources are addressed in Chapter 4, Section 4.1.2, of the SWEIS. This section discusses the visual setting of the TAs addressed in Section I.4.1.1.

Technical Area 6. TA-6 is on a mesa between Twomile and Pajarito Canyons. The area is largely undeveloped; however, it contains a gas cylinder staging facility, vacant buildings pending decommissioning, and a meteorological tower. The heavily wooded area is visible from Pajarito Road and from higher elevations to the west along the upper reaches of the Pajarito Plateau rim (NNSA 2003). MDA F is a grassy area of which a portion is fenced. These areas are not readily visible by the public because Twomile Mesa Road, passing to the south of the MDA, is not a public road.

Technical Area 8. TA-8 is between the upper reaches of Pajarito Canyon to the north and TA-16 to the south. Although portions of the TA are forested, the part of the TA containing MDA Q has been cleared and contains a few structures within a grassy area. The site would generally not be visible to the public because trees separate it from West Jemez Road. From higher elevations to the west, TA-8 appears as part of a larger developed area.

Technical Area 15. Situated on Threemile Mesa, TA-15 is bounded on the north by Pajarito Canyon and on the south by Water Canyon. Additionally, the northern part of the TA is dissected by Threemile Canyon and the central portion by Potrillo Canyon. The TA contains scattered facilities within a largely forested area. The dispersed arrangement of facilities reflects the use of the TA for high-explosive research, development, and testing. Due to the isolated nature of TA-15, buildings and structures are generally not visible to the public. If viewed from higher elevations to the west, the TA appears largely as wooded with only a scattering of facilities located throughout. MDAs N and Z and Firing Sites E-F and R-44 present a disturbed appearance that would be indistinguishable from other facilities within TA-15 when viewed from higher elevations to the west.

Technical Area 16. TA-16 is in the southwestern corner of LANL and is bounded on the north by Cañon de Valle and on the south by Water Canyon. Most buildings and structures are in the western part of the TA, with some facilities visible from West Jemez Road. From the mountains to the west, the TA appears as highly developed in the west, with development being replaced by forests in the east. Although portions of MDA R within and immediately adjacent to the High-Explosives Development Area are cleared of forest cover, some of the 11.5-acre (4.7-hectare) site is wooded. The 260 Outfall is generally tree covered.

Technical Area 21. Facilities at TA-21 are on a mesa between Los Alamos Canyon to the south and DP Canyon to the north. Developed portions of the TA present an industrial appearance. Undeveloped portions of the mesa remain vegetated with native grasses, shrubs, and small trees. The canyons are wooded. While portions of the site, particularly the water tower, can be seen from locations along NM 502, the MDAs are not visible. From higher elevations, developed portions of TA-21 have an industrial appearance and would be visible, although the MDAs would appear as cleared or grassy areas (DOE 1999e).

Technical Area 33. TA-33, in the southeast corner of LANL, is bordered by the Rio Grande on the east, TA-39 and TA-70 on the north, and Bandelier National Monument and Santa Fe National Forest on the west. Most of the TA is forested, although three small areas of development are present. As viewed from NM 4, the area would have a natural appearance. MDAs D, E, and K are within these developed areas, each containing buildings, roads, and parking lots; however, these areas are not visible to the public.

Technical Area 35. This TA is part of a highly developed portion of LANL extending along the upper 2.7 miles (4.3 kilometers) of Pajarito Road. This area therefore presents the appearance of a mosaic of industrial buildings and structures interspersed with forests along the mesa. Views of TA-35 are generally blocked by trees and other development along Pajarito Road. Mortandad Canyon is wooded and has a natural appearance when viewed from a distance and from nearby.

Technical Area 36. The largest LANL TA, TA-36 is traversed or bordered by several forested canyons, including Pajarito, Threemile, Potrillo, and Fence Canyons. Although TA-36 is largely undeveloped and forested, that portion of the TA containing MDA AA includes several buildings. MDA AA is an open area, although it is not accessible to the public.

Technical Area 39. Similar to other large TAs within this portion of LANL, TA-39 is largely forested with pockets of development. MDA Y is to the east of Ancho Road within a developed area. As with most other MDAs, the MDA is a cleared area that cannot be viewed by members of the public.

Technical Area 49. Only a small portion of TA-49 is developed, although several roads cut through portions of the site. Most of the TA is made up of scattered trees and shrubs with a grassy understory. Overall, the site has a natural appearance. The MDAs are within the Frijoles Mesa Site, which contains scattered buildings and roads. The MDAs appear little different than surrounding areas in that they are grass covered and contain scattered shrubs and trees.

Technical Area 50. TA-50 is along Pajarito Road. While much of the mesa along which the road passes is forested, TA-50 is one of a series of TAs along the upper 2 miles (3.2 kilometers) of the road within which development has taken place. Thus, this area presents the appearance of a mosaic of industrial buildings interspersed along a forested mesa. Views of the area from a distance are described in Chapter 4, Section 4.1.2, of this SWEIS. TA-50 includes both portions of the mesa and Mortandad Canyon. Development has occurred on that portion of the site north of Pajarito Road, with the remaining portions of the mesa and the canyon south of the road remaining forested. Although near views of TA-50 are industrial in nature, they are available only to site personnel because Pajarito Road is closed to the public. MDA C is along Pajarito Road and appears as a fenced grassy field. Future plans call for a landscape improvement buffer to be planted along Pajarito Road (LANL 2001c).

Technical Area 54. TA-54 is at the eastern end of Pajarito Road and borders both the San Ildefonso Pueblo and White Rock. While buildings and structures of the TA are visible from higher elevations to the west, near views of many TA elements are limited, as Pajarito Road is closed to the public. However, the dominant feature of the site is the white domes of MDA G in the eastern end of the TA. These domes contrast with the natural landscape and can be seen for many miles from locations in the Nambe-Española area and from locations in western and southern Santa Fe (LANL 2004f). They are visible from the lands of the San Ildefonso Pueblo. The remaining portions of MDAs G and L are less visible from a distance, as they do not contain similar structures.

Technical Area 61. TA-61 is in the northern portion of LANL along East Jemez Road. The TA is bordered by Los Alamos Canyon to the north and Sandia Canyon to the south. Although the Los Alamos County Landfill is the largest facility in TA-61, the borrow pit is also a significant feature. The borrow pit is 2 miles (3.2 kilometers) east of the landfill. Although much of TA-61 presents a forested appearance from higher elevations to the west, the borrow pit (and landfill) would be visible as an area devoid of vegetation. Yet the borrow pit is not visible from East

Jemez Road because of its location relative to the road, trees bordering the road, and a small hill on the north side of the pit.

Technical Area 73. This TA is along the northern boundary of LANL next to NM 502 (East Road). The Los Alamos County Airport is north of the road and DP Canyon is south of it. Views of the TA include those from the north across Pueblo Canyon and from East Road. Views from East Road include the airport to the north and undeveloped wooded areas to the south. The airport is visible from the subdivision to the west. A visual assessment of this tract, made in conjunction with the conveyance of land to Los Alamos County, determined that views of the airport have moderate value, while those of DP Canyon have high value (DOE 1999e).

I.4.2 Geology and Soils

Geology, soils, and mineral resources at LANL are addressed in Chapter 4, Section 4.2, of the SWEIS.

Geology. LANL site geology consists primarily of a complex series of interlayered volcanic deposits. As discussed in Section 4.2, the degree of welding, induration, and fracturing of the rocks at LANL plays an important role in slope stability and subsurface fluid flow. These characteristics are important because the MDAs have generally been cut to varying depths into the upper units of the Tshirege Member of the Bandelier Tuff to varying depths. This may provide a groundwater flow conduit between disposed materials and subsurface permeable rocks. Depending on their location and existing constructed surfaces, certain MDAs may be susceptible to erosion and surface failure (LANL 1999b).

Subunits of the Tshirege Member dip gently southeastward on the Pajarito Plateau. The paleotopography of the pre-Tshirege surface may strongly influence the direction of possible groundwater flow and contaminant migration in subsurface units beneath the MDAs. The paleotopography of the pre-Otowi surface may influence the flow direction of potential perched groundwater (DOE 1999a).

Soils. A description of LANL soils was included in the *1999 SWEIS* and is updated in Chapter 4, Section 4.2.3, of this SWEIS. This update includes a description of the soils, the effects of the May 2000 Cerro Grande Fire, and the soil monitoring program. In most cases, environmental restoration activities would not affect native soils because MDAs and PRSs are in areas that have already been disturbed by LANL activities.

Mineral Resources. The only mineral resource being mined at LANL is crushed tuff from the East Jemez Road borrow pit in TA-61. The source material is the Tshirege member of the Bandelier Tuff. Other materials needed to support the corrective action or closure program for LANL MDAs include soil to support vegetation and rock for erosion control. Local offsite sources and excess materials from LANL building construction are available.

I.4.3 Water Resources

Water resources are addressed in Chapter 4, Section 4.3, and Appendix E, Groundwater in the Vicinity of LANL, of the SWEIS. Appendix F, Environmental Sample Data, presents sample information pertaining to water resources.

Water resources in the LANL region include surface waters, sediments, floodplains, and groundwater located onsite, on adjacent properties, and extending to northern New Mexico and southern Colorado. The LANL area includes 15 regional watersheds (see Chapter 4, Figure 4–12), with 12 watersheds crossing LANL boundaries. Water resources were affected by the 2000 Cerro Grande Fire in that it increased the potential for surface runoff and soil erosion in burned areas (see Chapter 4, Section 4.3.1.7). Water resources were the focus of many of the investigations that have been performed at LANL. Several historical investigations pertaining to the LANL MDAs are summarized in the MDA Core Document (LANL 1999b). LANL water resources are a major focus of the Consent Order. Investigations being performed in accordance with the Consent Order are meant to fully characterize the nature, extent, fate, and transport of contaminants that may have entered groundwater and surface water resources at LANL.

Surface Water. Most canyons that drain the LANL site are dry for most of the year. Surface water in the area occurs primarily as short-lived or intermittent reaches of streams. Perennial surface water of varying lengths exists in Sandia, Pajarito, and Water Canyons, and Cañon de Valle. Many streams flow in response to only local precipitation or snowmelt. While there is minimal direct use of the surface water within LANL except by wildlife, streamflow may extend beyond the LANL boundaries where there may be more direct use of the water. LANL programs manage several sources that may impact local water resources, such as liquid effluents discharged through NPDES permitted outfalls, stormwater runoff, sediment transport, and dredge and fill activities or other work within perennial, intermittent, or ephemeral watercourses. LANL personnel routinely monitor surface water, stormwater, and sediments as part of LANL's ongoing environmental monitoring and surveillance program, and the results are published annually.

Sediments occur in and along LANL's canyons and watersheds, primarily as narrow bands of canyon bottom deposits that can be transported by surface water flows, effluent discharges, stormwater runoff, or flooding within canyons. Past LANL activities have caused contamination of sediments both onsite and downstream, occurring primarily because of effluent discharge from LANL outfalls and the transport of contaminated sediments from runoff and effluent flow. Sediments in some watersheds and canyons were transported and redistributed downstream from LANL after the Cerro Grande Fire. An overview of sediment quality and contamination levels is provided in Chapter 4, Section 4.3.1.5, of this SWEIS. Investigation and, if necessary, remediation of contaminated sediment at LANL is being conducted in conformance with the Consent Order and other regulatory criteria.

Floodplains are normally dry land areas that can become inundated with surface waters during a period of runoff due to precipitation or snowmelt. The Cerro Grande Fire impacted the extent and elevation of the floodplains in LANL canyons. Several flood and sediment structures were constructed as part of the emergency response to the fire. Following the fire, floodplain boundaries were remapped for all the major watersheds within LANL, as illustrated in Chapter 4, Figure 4–15, of this SWEIS.

Groundwater. Groundwater beneath the Pajarito Plateau is separated into alluvial groundwater in the canyons, intermediate perched groundwater beneath some of the canyons and the western portion of the plateau at depths of 100 to 750 feet (30.5 to 229 meters), and a regional aquifer at depths of 600 to 1,200 feet below the surface of the plateau. About 350 to 620 feet (107 to 189 meters) of unsaturated tuff, basalt, and low-moisture-content sediments separate the alluvial and perched groundwater zones and the regional aquifer. **Table I–81** summarizes the approximate depths of the regional groundwater table underneath the MDAs considered in this project-specific analysis, as well as the canyon watersheds associated with each MDA (LANL 1999b).

Table I–81 Watersheds and Depth to Regional Water by Material Disposal Area

Technical Area	*Material Disposal Area*	*Watershed/Canyon*	*Depth to Regional Water (feet)*
6	F	Twomile	1,275
8	Q	Pajarito	1,200
15	N	Cañon de Valle	1,170
15	Z	Cañon de Valle	1,200
16	R	Cañon de Valle	1,240
21	A	DP	1,230
21	B	Los Alamos	1,300
21	T	DP	1,240
21	U	DP	1,220
33	D	Rio Grande	910
33	E	Chaquehui	760
33	K	Chaquehui	820
35	X	Ten Site	1,160
36	AA	Potrillo	770
39	Y	North Ancho	590
49	AB	Ancho	1,120
50	C	Ten Site	1,175
54	G	Pajarito, Cañada del Buey	900
54	L	Cañada del Buey	940

Note: To convert feet to meters, multiply by 0.3048.
Source: LANL 1999b.

Effluent discharge, natural spring discharge, and stormwater runoff create surface waters that infiltrate into the alluvium of some canyons to create shallow, unconfined groundwater. Intermediate perched groundwater is often found beneath canyons having alluvial groundwater and usually does not extend laterally beneath the mesas. Intermediate perched zones may be confined or unconfined, and may not be contiguous along the length of a canyon.

Discharge of effluents has resulted in detection of radionuclide contamination in alluvial groundwater samples from DP, Los Alamos, and Mortandad Canyons. Tritium has been found in intermediate-depth wells in Pueblo, Los Alamos, Mortandad, Pajarito, and Water Canyons, and technetium-99 in one well in Mortandad Canyon. Nonradioactive contaminants found in alluvial and intermediate-depth groundwater samples in Pueblo, Los Alamos, Mortandad, Pajarito, Water, Cañon de Valle, and Sandia Canyons include chromium, nickel, molybdenum, perchlorate, nitrate, barium, 1,4-dioxane, and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) (see Chapter 4, Section 4.3.2, of the SWEIS).

Regional groundwater flows toward the east and southeast to the Rio Grande. Little natural recharge occurs along the mesa tops where most LANL facilities and MDAs are located. For the past 5 years, LANL has been drilling and testing wells, monitoring wells, and modeling the subsurface groundwater hydrology as part of its *Hydrogeologic Work Plan* (see Chapter 4, Section 4.3.2, of the SWEIS). Some contamination of the regional aquifer has occurred, as summarized in Section 4.3.2. LANL personnel conduct subsurface modeling addressing contaminant transport pathways near water supply wells.

I.4.4 Air Quality and Noise

Chapter 4, Section 4.4, of the SWEIS presents a detailed discussion of the climate, current air quality, and noise environments at LANL.

I.4.4.1 Climatology and Meteorology

The Los Alamos region has a semiarid, temperate mountain climate (DOE 1999a). Climatological information presented in the *1999 SWEIS*, and as updated for this SWEIS, has been derived from measurements at the official Los Alamos meteorological weather station and tower which is in TA-6. Additional towers are located in TA-41, TA-49, TA-53, and TA-54, and on Pajarito Mountain. The locations of all six towers are shown in Chapter 4, Figure 4–19, of this SWEIS.

Meteorological conditions are influenced by the Pajarito Plateau elevation. For example, temperatures in the Los Alamos area vary with altitude, averaging 5 ^{o}F (3 ^{o}C) higher in and near the Rio Grande Valley and 5 to 10 ^{o}F (3 to 5.5 ^{o}C) in the Jemez Mountains. The Los Alamos region is characterized by seasonable, variable rainfall, with precipitation ranging historically from 10 to 20 inches (25 to 51 centimeters) per year. The normal annual precipitation for Los Alamos from 1961 to 1990 was 19 inches (48 centimeters). Annual precipitation rates within the county decline toward the Rio Grande Valley. For example, the Jemez Mountains receive over 25 inches (64 centimeters) of precipitation annually, while normal precipitation for White Rock has been 14 inches (34 centimeters). About 36 percent of the annual precipitation for Los Alamos County and LANL has resulted from thundershowers that occur in July and August. Los Alamos County wind speeds vary seasonally, but average 7 miles per hour (3 meters per second). (Wind rose information from the LANL meteorological stations is presented in Chapter 4, Section 4.4.1.1, of this SWEIS.) Thunder- and hailstorms are common in Los Alamos County, and lightning can be frequent and intense. Flash flooding is possible in arroyos, canyons, and low-lying areas (DOE 1999a).

Since publication of the *1999 SWEIS*, the LANL region has experienced a notable drought. As discussed in Chapter 4, Section 4.4.1, of this SWEIS, between 1995 and 2004, only 1 year (1997) had above-average precipitation. The drought facilitated the Cerro Grande Fire in May 2000.

A summary of the local climate data for MDAs as measured at the nearest LANL meteorological station from each MDA are presented in **Table I–82**. Mesas are typically sunnier and windier than the canyons or slopes (LANL 1999b).

Table I–82 Comparative Summaries for Los Alamos National Laboratory Meteorological Stations with Nearby Material Disposal Areas

Meteorological Station	*Nearby MDAs*	*Average Temperature (°C)*		*Average Temperature (°F)*		*Precipitation (inches per year)*	*Winds (meters per second)*	*Winds (miles per hour)* [a]
		Min	*Max*	*Min*	*Max*			
TA-6	F, Q, N, Z, R, X, C	1.8	15	35	59	19.69	2.49	5.6
TA-49	Y, AB	3.4	16	38	61	18.68	2.41	5.4
TA-53	A, B, T, U	4.4	17	40	62	15.97	2.9	6.5
TA-54	D, E, K, AA, G, L	0.99	18	34	64	14.57	2.74	6.1

°C = degrees Celsius, °F = degrees Fahrenheit, MDA = material disposal area, Min = minimum, Max = maximum, TA = technical area.
Source: LANL 1999b.

I.4.4.2 Air Quality and Visibility

Air quality considerations include nonradiological air quality in terms of criteria pollutants such as nitrogen dioxide, sulfur dioxide, and particulates; radiological air quality; and visibility. Los Alamos County, including LANL, is in attainment with all state ambient air quality standards and with the National Ambient Air Quality Standards (see Chapter 4, Section 4.4.2.3, of this SWEIS). As addressed in Chapter 4, Section 4.4.3, a long-standing and extensive program has existed at LANL to ensure that possible radiological exposures of members of the public from air emissions are maintained to levels as low as reasonably achievable below all applicable standards. Periodic environmental surveillance and compliance reports document compliance with state, EPA, and DOE standards.

Visibility is measured according to a standard visual range. Visibility has been monitored by the National Park Service at Bandelier National Monument since 1988. Average visibility from 1993 through 2002 ranged from 79 to 113 miles (127 to 182 kilometers) (LANL 2004f).

I.4.4.3 Noise, Air Blasts, and Vibration

The LANL noise, air blast, and vibration environment is discussed in Chapter 4, Section 4.4.5, of this SWEIS. Background sounds, vehicular traffic, routine operations, and high-explosives testing contribute to noise levels. Air blasts (air pressure waves or overpressures) are intermittent, accompanying an explosive detonation, and may be heard by workers and the public. Most ground vibrations are from aboveground explosives research.

Sound intensity is expressed in decibels (dB) above the standard threshold of hearing. Noise levels at frequencies corresponding to maximum human sensitivity are used to set human limits for auditory protection. These frequencies are called A-weighted (after middle A and its harmonics), and the sound intensity scale used for this purpose is given in dBA units.

Occupational exposures to noise are compared against a Threshold Limit Value established by the Occupational Safety and Health Administration. The Threshold Limit Value is the sound level to which a worker may be exposed for a specified work period without probable adverse effects on hearing. The Threshold Limit Value for continuous noise is 85 dBA over 8 hours.

The Threshold Limit Value for impulse (impact) noise over 8 hours is not fixed because the daily allowed number of impulses depends on the level of each impulse. No individual impulse should exceed 140 dBA. An action level of 82 dBA for both continuous and impulse noise over an 8-hour workday has been established at LANL. Use of protective equipment is recommended above the action level (DOE 2004b).

I.4.5 Ecological Resources

This section addresses the ecological setting (that is, terrestrial resources, wetlands, and protected and sensitive species) of each of the technical areas listed in **Table I–83**. Also addressed are the potential transport and uptake of wastes by plants and animals. Although there are reaches of perennial streams on LANL, no fish species have been found within the LANL boundaries.

Table I–83 Summary of Material Disposal Area and Potential Release Sites Vegetation Zones

Technical Area	*Site*	*Vegetation Zone*
Material Disposal Area		
6	F	Ponderosa pine
8	Q	Grassland
15	N	Ponderosa pine
15	Z	Grassland
16	R	Ponderosa pine
21	A	Ponderosa pine
21	B	Ponderosa pine
21	T	Ponderosa pine
21	U	Ponderosa pine
33	D	Juniper savannah
33	E	Pinyon-Juniper woodland
33	K	Pinyon-Juniper woodland
35	X	Ponderosa pine
36	AA	Pinyon-Juniper woodland
39	Y	Pinyon-Juniper
49	AB	Ponderosa pine
50	C	Ponderosa pine
54	G	Pinyon-Juniper woodland
54	L	Pinyon-Juniper woodland
Potential Release Site		
15	Firing Site E-F	Grassland
15	Firing Site R-44	Ponderosa pine
16	260 Outfall (16-021(c)-99)	Ponderosa pine
61	Borrow pit	Ponderosa pine
73	Ashpile	Ponderosa pine

Discussions of threatened and endangered species concentrate on those species for which Areas of Environmental Interest have been established. These include the Mexican spotted owl, bald eagle, and southwestern willow flycatcher. Areas of Environmental Interest have been established in accordance with a habitat management plan. An Area of Environmental Interest essentially consists of a core zone containing important breeding or wintering habitat and a buffer zone around the core area. The buffer protects the area from disturbances that would degrade the value of the core zone (LANL 1998b). Ecological resources of LANL as a whole are described in Chapter 4, Section 4.5, and vegetation zones are shown in Chapter 4, Figure 4–25, of this SWEIS.

Ecological Resources of Technical Areas

Technical Area 6. TA-6 is located primarily within the Ponderosa Pine Forest vegetation zone, although areas along the north-facing slope of Sandia Canyon are included in the Mixed Conifer Forest zone. Vegetation typical of the Ponderosa Pine Forest zone includes ponderosa pine (*Pinnus ponderosa* P&C Lawson), gambel oak (*Quercus gambelii* Nutt.), New Mexico locust (*Robinia neomexicana* Gray), and pine dropseek (*Blepharoneuron tricholepis* [Torr.] Nash). Located within the Ponderosa Pine Forest zone, MDA F is a grassy area of which portions are fenced; thus, its use by wildlife would be limited largely to birds, small mammals, and reptiles. Large mammals are excluded from much of the MDA because of fencing. The Cerro Grande Fire impacted TA-6 at severity levels varying from high to low-unburned. The portion of the TA containing MDA F burned at a low-unburned severity level (DOE 2000b). There are no wetlands within TA-6, although a narrow band of riparian vegetation exists along portions of the stream channel of Twomile Canyon.

The southeastern portion of TA-6 is within the core and buffer zones of the Pajarito Canyon Mexican spotted owl Areas of Environmental Interest. TA-6 does not fall within the Area of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000c). MDA F is not in either the core or buffer zone of the Mexican spotted owl.

Technical Area 8. TA-8 falls primarily within the Ponderosa Pine Forest vegetation zone; however, the portion of the TA within which MDA Q is located is categorized as Grassland. Although the Cerro Grande Fire did not affect much of TA-8, its northeastern portion burned at a low-unburned severity level and a small area in the extreme northeast corner at a high severity level. That portion of the TA containing MDA Q burned at a low-unburned severity level (DOE 2000b). There are no wetlands or aquatic resources within the immediate vicinity of MDA Q, and no portion of TA-8 falls within any of the LANL Areas of Environmental Interest.

Technical Area 15. As is the case for TA-8, TA-15 is primarily located within the Ponderosa Pine Forest vegetation zone; however, areas within the central and southern part of the TA are classified as Grasslands. The Cerro Grande Fire affected about half of TA-15, burned at a low-unburned severity level. At this level, seed sources are expected to remain viable (DOE 2000b). MDA N and Firing Site E-F are located within the Grassland vegetation zone; however, all sites are grassy areas located near buildings and roads. One linear wetland is located in TA-15 within Threemile Canyon; however, it is not close to any MDA or firing site. This wetland is 0.3 acre (0.1 hectare) in size and contains Baltic rush (*Juncus balticus* Willd.) and a number of grasses (ACE 2005).

Portions of TA-15 are within the Pajarito Canyon, Threemile Canyon, and Water Canyon-Cañon de Valle Mexican spotted owl Areas of Environmental Interest. Core areas generally include the canyons, while buffer zones include some of the mesas. The areas containing the two firing sites do not include either the core or the buffer zones for any of the spotted owl Areas of Environmental Interest. However, MDAs N and Z are within the buffer zone of the Water Canyon-Cañon de Valle Area of Environmental Interest, with a small portion of MDA Z within the core zone. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any portion of TA-15 (LANL 2000c).

Technical Area 16. Vegetative cover within TA-16 is largely ponderosa pine; however, an area of grassland occurs within the west-central part of the TA, and a mixed conifer forest occurs along north-facing slopes of Cañon de Valle and Water Canyon. Most development within TA-16 has occurred within the Ponderosa Pine Forest vegetation zone. Although the western part of the TA was not burned during the Cerro Grande Fire, most of the remaining area burned at a low-unburned severity level. However, the central part of the TA burned at a medium severity level (DOE 2000b). At this level, seed stocks can be adversely affected and erosion can increase because of the removal of vegetation and ground cover (DOE 2000b). Within the Ponderosa Pine Forest vegetation zone, MDA R and the 260 Outfall burned at a low-unburned severity level. Excepting those portions of MDA R and the outfall that are within and immediately adjacent to the High-Explosives Processing Area, both PRSs are in forested areas that provide habitat for species common to mixed conifer forests, including large mammals.

Two wetlands have been identified within TA-16; however, they are located a considerable distance to the east of MDA R and the 260 Outfall. These wetlands total 0.04 acre (0.02 hectare) in size and contain Baltic rush and various grasses (ACE 2005).

Only the eastern portion of TA-16 is within the Water Canyon-Cañon de Valle Mexican spotted owl Area of Environmental Interest. Additionally, a very small area on the northern border of the TA is within the buffer zone of the Pajarito Canyon Areas of Environmental Interest. MDA R and the 260 Outfall are not included in either Area of Environmental Interest. No part of the TA is included within Areas of Environmental Interest for the southwestern willow flycatcher or bald eagle (LANL 2000c).

Technical Area 21. About 20 percent of the TA is developed. Although most of TA-21 is within the Ponderosa Pine Forest vegetation zone, the more easterly portion of Los Alamos Canyon is within the Pinyon-Juniper Woodland zone. Wildlife within undisturbed portions of the TA would be typical of those two zones (DOE 1999a). The Cerro Grande Fire did not directly affect TA-21 (DOE 2000b). The MDAs are fenced grassy fields (except those portions of MDAs A and B that are covered with asphalt); thus, wildlife would be limited to birds, small mammals, and reptiles. Large mammals are excluded from the MDAs because of fencing. No wetlands have been identified within TA-21 (ACE 2005).

TA-21 is entirely within the Los Alamos Canyon Area of Environmental Interest, with the southern and eastern portions included within the core zone. The MDAs are located within developed areas of TA-21 that are within both the core and buffer zones of the Los Alamos Canyon Areas of Environment Interest (LANL 2000c). TA-21 does not include any portion of the Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Technical Area 33. Although TA-33 is mostly within the Pinyon-Juniper Woodland vegetation zone, the eastern part of the TA is within the Juniper Savannah zone at lower elevations near the Rio Grande River. The TA is largely undeveloped. None of TA-33 was affected by the Cerro Grande Fire (DOE 2000b). Although only one small (0.01-acre [0.004-hectare]) wetland dominated by cattails (*Typha* spp.) is within the TA, the TA borders the region's most important aquatic resource, the Rio Grande (ACE 2005). MDAs D and K are within the Pinyon-Juniper Woodland vegetation zone, while MDA E is within the Juniper Savannah vegetation zone. All three MDAs are located away from the wetland and river.

Being located near the Rio Grande River, the eastern portion of TA-33 is within portions of the White Rock Canyon bald eagle Area of Environmental Interest. Yet of the three MDAs within the TA, only MDA D is within this Area of Environmental Interest; however, the MDA is within the core zone. Because bald eagles winter along White Rock Canyon adjacent to the Rio Grande, the Area of Environmental Interest is considered occupied from November through March.

Technical Area 35. TA-35 is entirely within the Ponderosa Pine Forest vegetation zone, but is a highly developed area. Yet the portions of the TA falling within Mortandad Canyon are in a natural state and thus contain wildlife typical of ponderosa pine forests. TA-35 burned at a low-unburned severity level during the Cerro Grande Fire (DOE 2000b). The only wetland present within TA-35 is located in the northwest corner of the TA and is an extension of a wetland primarily located in TA-55. This wetland is 1.2 acres (0.5 hectare) in size; coyote willow (*Salix exigua* Nutt.), cattail, Baltic rush, and various sedges (*Carex* spp.) are some of the species present (ACE 2005).

TA-35 is within the Pajarito Canyon and Sandia-Mortandad Canyon Mexican spotted owl Areas of Environmental Interest. While the southern portion of the TA is within the buffer zone of the former Area of Environmental Interest, the entire TA is within either the buffer or core zone of the latter Area of Environmental Interest.

Technical Area 36. TA-36 is the largest TA at LANL and encompasses both Pinyon-Juniper Woodland and Ponderosa Pine Forest vegetation zones. The TA is largely undeveloped and provides habitat suitable for species typical of both zones. Only the very northern portion of TA-36 was burned during the Cerro Grande Fire, at a low-unburned severity level (DOE 2000b). Although MDA AA is generally within the Pinyon-Juniper Woodland vegetation zone, it is within a developed portion of the TA. It therefore provides minimal wildlife habitat. Although not situated in the immediate area of MDA AA, a series of nine wetlands are within TA-36 along Pajarito Canyon. These wetlands total 15.2 acres (6.2 hectares). Plants found within these wetlands include coyote willow, Baltic rush, sedges, common spike rush (*Eleocharis palustris* (L.) Roemer & Schultes), American speedwell (*Veronica americana* Schwein. ex Benth), and cattail. There are no aquatic resources near MDA AA.

TA-36 includes portions of the buffer and core zones of the Pajarito Canyon, Threemile Canyon, and Water Canyon-Cañon de Valle Mexican spotted owl Areas of Environmental Interest. However, MDA AA is not within any of these three Areas of Environmental Interest (LANL 2000c).

Technical Area 39. Although most of TA-39 is in a Pinyon-Juniper Woodland vegetation zone, the northwestern part of the TA includes an area of grassland and ponderosa pine forest on the north-facing slopes of Water and Ancho Canyons. Because the area is largely undeveloped, wildlife typical of each vegetation zone is expected. TA-39 was not impacted by the Cerro Grande Fire (DOE 2000b). MDA Y is within the Pinyon-Juniper Woodland portion of the TA; however, it is a cleared area along Ancho Road that provides little wildlife habitat. There are no wetlands or aquatic resources in TA-39.

The northern portion of TA-39 includes both buffer and core zones of the Water Canyon-Cañon de Valle Mexican spotted owl Area of Environmental Interest. MDA Y is located in the central portion of the TA and does not fall within this Area of Environmental Interest (LANL 2000c).

Technical Area 49. TA-49 contains three separate vegetation zones—Ponderosa Pine Forest, Pinyon-Juniper Woodland, and Grassland. In general, Ponderosa Pine Forest is found on north-facing canyon slopes, while Pinyon-Juniper Woodland is present in the eastern quarter of the TA and Grassland occupies the remainder of the area.

The TA is largely in a natural state with a few scattered buildings at the Frijoles Mesa Site. Wildlife using the TA would include species typical of each vegetation zone. TA-49 was largely unaffected by the Cerro Grande Fire because only the northern edge of the TA burned at a low-unburned severity level (DOE 2000b). MDA AB is in the Frijoles Mesa Site in the central portion of the TA and is presently within the Grassland vegetation zone. The separate MDA AB areas are grass covered with scattered shrubs and trees. There are no wetlands within TA-49.

The northern part of TA-49 is within both the buffer and core zones of the Water Canyon-Cañon de Valle Mexican spotted owl Area of Environmental Interest. It does not include portions of the Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher. The northern elements of MDA AB are within the buffer zone of the Mexican spotted owl Area of Environmental Interest (LANL 2000c).

Technical Area 50. TA-50 is within the Ponderosa Pine Forest vegetation zone. Although most of the area north of Pajarito Road has been developed, the area south of the road is in a more natural state. During the Cerro Grande Fire, the entire TA burned at a low-unburned severity level (DOE 2000b). Wildlife within undeveloped portions of the TA would be typical of ponderosa pine forests (DOE 1999a). MDA C is a relatively large grassy area that is fenced. Wildlife would be limited to small mammals, birds, and reptiles. There are no wetlands within TA-50.

TA-50 is within both the core and buffer zones of the Pajarito Canyon Mexican spotted owl Area of Environmental Interest and the buffer zone of the Sandia-Mortandad Canyon Area of Environmental Interest. MDA C falls within the buffer zone of both Mexican spotted owl Areas of Environmental Interest. TA-50 does not include portions of the Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000c).

Technical Area 54. TA-54 is primarily within the Pinyon-Juniper Woodland vegetation zone; however, a ponderosa pine forest occurs on the north-facing slope of Cañada del Buey. Wildlife using the TA would include species typical of both vegetation zones. Although most of the area was untouched by the Cerro Grande Fire, the northwestern portion of the TA burned at a low-unburned to medium severity level. At a medium severity level, seed stocks can be adversely affected and erosion can increase because of the removal of vegetation and ground cover (DOE 2000b). MDAs G and L are disturbed areas having minimal ground cover, and each is enclosed by a fence. Thus, wildlife would be limited to small mammals, birds, and reptiles. Large mammals are excluded from the MDAs because of fencing. Although a series of wetlands occur along Pajarito Canyon (see the description of TA-36), none are found within any of the MDAs (Marsh 2001).

A portion of TA-54 is within the core and buffer zones of the southwestern willow flycatcher Areas of Environmental Interest; however, the Area of Environmental Interest is restricted to the canyon and does not include any part of the MDAs. Areas of Environmental Interest for the Mexican spotted owl and bald eagle do not encompass any part of TA-54 (LANL 2000c).

Technical Area 61. TA-61, including the borrow pit, falls within the Ponderosa Pine Forest vegetation zone. Although wildlife within undeveloped portions of the TA would be typical of ponderosa pine forests, the borrow pit lacks cover and therefore suitable habitat for wildlife. Most of TA-61 was unaffected by the Cerro Grande Fire. However, the very eastern portion of the TA, including the borrow pit area, burned at a low-unburned severity level (DOE 2000b). There are no wetlands or aquatic resources within the borrow pit site. However, the largest contiguous wetland on LANL, the Sandia wetland, is south of the Los Alamos County Landfill. This wetland is dominated by cattails. In 2000, it encompassed 3.5 acres (1.4 hectares), a 48 percent reduction in size from 1996; presently, it covers 3 acres (1.2 hectares) (Bennett, Keller, and Robinson 2001; ACE 2005).

TA-61 is within the buffer and core zones of both the Los Alamos Canyon and Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest. The borrow pit is within the buffer zone of the former and the core zone of the latter (LANL 2000c). TA-61 does not fall within the Area of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000c).

Technical Area 73. TA-73 is covered by ponderosa pine forest and pinyon-juniper woodland in the east. Wildlife using the TA would include species typical of both vegetation zones such as mule deer and elk (DOE 1999a). The TA was not burned by the Cerro Grande Fire (DOE 2000b). There are no perennial surface watercourses within the TA. There are no wetlands in TA-73 (ACE 2005).

TA-73 is within the Los Alamos Canyon Mexican spotted owl Area of Environmental Interest. A small section of the southeastern part of the TA is within the core zone, while the remaining portions of TA-73 are within the buffer zone. TA-73 does not encompass any part of the Areas of Environmental Interest for the southwestern willow flycatcher or bald eagle (LANL 2000c).

Potential Transport and Uptake of Wastes

The ecological setting of the MDAs affects the potential for transport and uptake of radioactive and chemical constituents. Animals may burrow into disposal units, excavating contaminated materials and providing conduits for moisture to the waste. Plants can grow roots into disposal units, incorporating contaminants that may be dispersed to surface soil when the plants defoliate. Plants can also reduce erosion of disposal unit covers and remove moisture from the soil that could otherwise percolate into disposal units. Typical plant species common to the Pajarito Plateau have average measured root depths ranging from less than 0.3 feet (0.1 meters) to greater than 5 feet (1.6 meters). Typical indigenous burrowing animals have average measured burrow depths ranging from about 0.3 feet (0.1 meters) to nearly 10 feet (3.0 meters) (LANL 1999b).

I.4.6 Human Health

Chapter 4, Section 4.6, of this SWEIS discusses measures taken at LANL to maintain the quality of human health for both workers and the public. Chapter 4, Figures 4–26 and 4–27 illustrate radiation doses to populations and maximally exposed individuals from 1993 through 2005.

I.4.7 Cultural Resources

Cultural resources are human imprints on the landscape and are defined and protected by Federal laws, regulations, and guidelines. Cultural resources within LANL and its region are classified as archaeological resources, historic buildings and structures, and traditional cultural properties. Cultural resources at LANL are addressed in Chapter 4, Section 4.7, of this SWEIS. This section summarizes the cultural resources of each of the technical areas addressed in Section I.4.1.1. Cultural resources are not expected within the MDAs themselves because all MDAs are highly disturbed areas.

I.4.7.1 Archaeological Resources and Historic Buildings and Structures

Technical Area 6. Twelve archaeological resource sites have been identified within TA-6. These sites include rock features, an artifact scatter, a one- to three-room structure, structures, wagon road segments, water control features, and a fence. Four of the 12 archaeological sites are eligible for listing in the National Register of Historic Places, 5 are of undetermined status, and 3 are not eligible. There is one historic structure eligible for listing in the National Register of Historic Places, the “concrete bowl” in TA-6. There are seven cultural resource sites in the vicinity of MDA F.

Technical Area 8. TA-8 contains 11 archaeological sites, including lithic scatters, a wagon road segment artifact scatters, a lithic and ceramic scatter, and a historic structure. Of these sites, four are eligible for listing in the National Register of Historic Places, 1 is of undetermined eligibility, 1 is not eligible, and 5 have not been evaluated for their eligibility. Six historic buildings in TA-8 are eligible for listing in the National Register of Historic Places. Three are located near MDA Q. Only one cultural resource site is in the vicinity of MDA Q.

Technical Area 15. TA-15 contains numerous cultural resource sites; thus, this section identifies only those sites within about a 1,000-foot (305-meter) radius of each MDA and firing site. There are 9 archaeological sites in the vicinity of MDA N, 7 sites in the vicinity of MDA Z, 11 sites in the vicinity of Firing Site E-F, and 3 sites in the vicinity of Firing Site R-44. These sites include Pueblo roomblocks, a plaza Pueblo, a water control structure, one- to three-room structures, cavates, a lithic scatter, and a rock shelter. Of these features, thirteen are eligible for listing in the National Register of Historic Places, 4 are not eligible, and 14 have yet to be formally assessed for their eligibility. Two historic buildings in TA-15 are eligible for listing in the National Register of Historic Places. One of these buildings is within the R-44 SWMU. However, there are 26 additional significant buildings that have yet to be assessed for National Register of Historic Places eligibility.

Technical Area 16. Although TA-16 contains a fairly large and diverse number of cultural resource sites, only two are in the vicinity of MDA R and the 260 Outfall. One site is a lithic scatter of undetermined prehistoric affiliation. One site is an archaeological site that has not been formally evaluated for National Register of Historic Places eligibility, but is considered not eligible for listing. However, there is a historic process building that is eligible and is situated about 1,300 feet (400 meters) south of MDA R and the 260 Outfall. There are also other archaeological sites and National Register of Historic Places-eligible buildings within the TA, but none are in the vicinity of MDA R or the 260 Outfall.

Technical Area 21. Five archaeological sites have been identified within TA-21. These sites include a cavate, a rock shelter, trails or stairs, and an enclosure. These sites are eligible for listing on the National Register of Historic Places. One of the historic trails passes close to MDA B. Sixteen buildings and structures eligible for listing in the National Register of Historic Places are located within TA-21, a number of which are near the MDAs.

Technical Area 33. Similar to TA-15, TA-33 contains numerous cultural resource sites. Thus, the following discussion addresses only those resources in the vicinity of each MDA. There is one archaeological site near MDA D, six near MDA E, and three near MDA K. Archaeological sites in the vicinities of the MDAs include Pueblo roomblocks, one- to three-room structures, a lithic scatter, a cavate, rock shelters, and rock features. Four of these sites are eligible for listing in the National Register of Historic Places, one is not eligible, and two are of undetermined eligibility. Seven National Register of Historic Places-eligible buildings and structures are in TA-33. Additionally, there are other potentially significant historic buildings that have not yet received eligibility assessments.

Technical Area 35. TA-35 does not contain any known archaeological sites, but does include one building eligible for listing in the National Register of Historic Places. There are other potentially significant historic buildings that have not been assessed for National Register of Historic Places eligibility.

Technical Area 36. Because TA-36 contains numerous archaeological sites, only those resources within the vicinity of MDA AA are addressed. The three cultural resource sites identified near MDA AA include a one- to three-room structure, a rock shelter, and lithic and ceramic scatters. None of the sites have been formally assessed for eligibility for listing in the National Register of Historic Places; however, without further evaluation, one is deemed to be eligible and the other two are deemed to be of undetermined eligibility. One structure, north of MDA AA, is eligible for listing on the National Register of Historic Places. There are other potentially significant historic buildings that have not been assessed for National Register of Historic Places eligibility.

Technical Area 39. TA-39 is the second largest TA at LANL and contains numerous archaeological sites; thus, only those in the vicinity of MDA Y are addressed. Seven archaeological sites are in or near MDA Y. These resources include lithic and ceramic scatters, rock features, cavates, and a rock shelter. None of the sites have been formally determined to be eligible for listing in the National Register of Historic Places; however, they are all deemed eligible or potentially eligible for listing. To date, no building or structure in TA-39 has been formally determined eligible for listing in the National Register of Historic Places. However, there are other potentially significant historic buildings that have not yet been reviewed for eligibility.

Technical Area 49. As with other large TAs on LANL, TA-49 contains numerous archaeological sites; thus, only those resources in the vicinity of MDA AB are summarized in this section. Forty-four archaeological sites are near MDA AB and include rock art, rock features, rock shelters, lithic scatters, one- to three-room structures, Pueblo roomblocks, and plaza Pueblos. Twelve of the 44 cultural resource sites have been formally declared eligible or potentially eligible for listing on the National Register of Historic Places, 1 is not eligible, and 31 are of undetermined status. Two buildings eligible for listing in the National Register of Historic Places are in TA-49; both are in the general vicinity of MDA AB. There is one additional potentially significant historic building that has not yet been assessed for eligibility.

Technical Area 50. TA-50 contained a single archaeological site and historic structure south of MDA C that was eligible for listing on the National Register of Historic Places. This site has been excavated. Currently, there are no buildings or structures in TA-50 eligible for listing. However, there are several potentially significant historic buildings that have yet to be reviewed for National Register of Historic Places eligibility.

Technical Area 54. Because TA-54 has many cultural resource sites, only those resources within the vicinity of MDAs G and L are addressed. There are 22 cultural resource sites near MDA G and 10 near MDA L. Of the cultural resource sites near MDA G, 7 have been excavated within the MDA area and 1 partially excavated within Zone 4. Fifteen of the sites are eligible for listing on the National Register of Historic Places. The 10 sites near MDA L are also eligible for listing on the National Register of Historic Places. Sites include lithic scatters, rock art, rock shelters, cavates, Pueblo roomblocks, plaza Pueblos, one- to three-room structures, and pit structures. Twenty-eight sites are eligible for listing in the National Register of Historic Places. A number of prehistoric sites were within MDA G; however, these were examined by archaeologists before its development. No buildings or structures in TA-54 have been evaluated for National Register of Historic Places eligibility. There are, however, four potentially significant historic buildings within TA-54.

Technical Area 61. TA-61 contains six archaeological sites. These sites include a trail and stairs, a number of cavates, and a historic structure. Four of the archaeological sites are eligible for listing in the National Register of Historic Places. Two sites are of undetermined eligibility. There are no cultural resources in the immediate vicinity of the borrow pit. No buildings or structures within TA-61 are eligible for listing in the National Register of Historic Places.

Technical Area 73. Nine archaeological sites have been identified within TA-73, including lithic and ceramic scatters, a cavate, a one- to three-room structure, a Pueblo roomblock, garden plots, and trails or stairs. Four of the archaeological sites are eligible for listing in the National Register of Historic Places. Two are not eligible, and three are of undetermined status. None of the cultural resource sites within TA-73 are near the ashpile. Two historic buildings within

TA-73 are eligible for listing on the National Register of Historic Places. One of these, a storage building, is in the vicinity of the ashpile. There are several other potentially significant historic buildings within TA-33 that have yet to be assessed for National Register of Historic Places eligibility.

I.4.7.2 Traditional Cultural Properties

A traditional cultural property is a significant place or object associated with historical and cultural practices or beliefs of a living community rooted in the community's history and is important in maintaining the community's continuing cultural identity. Within LANL's boundaries, there are ancestral villages, shrines, petroglyphs, sacred springs, trails, and traditional use areas that could be identified by Pueblo and Athabascan communities as traditional cultural properties. See Chapter 4, Section 4.7.3, for a discussion of traditional cultural properties. Some of the cultural resources addressed above may also be considered important in maintaining the continuing cultural identity of the local pueblo communities and so are considered traditional cultural properties.

I.4.8 Socioeconomics and Infrastructure

Socioeconomics and infrastructure are addressed in Chapter 4, Section 4.8, of this SWEIS and summarized below.

I.4.8.1 Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics of a region. The number of jobs created could affect regional employment, income, and expenditures. Job creation is characterized by (1) construction-related jobs that tend to be short in duration and transient, and thus less likely to impact public services; and (2) operation-related jobs that would last longer and could thus create additional service requirements. Chapter 4, Section 4.8.1, of this SWEIS summarizes, in the LANL region, economic characteristics, demographic characteristics, regional income, housing, local transportation, and the growth in recent years of the LANL-affiliated workforce. LANL currently has about 13,500 employees. These employees have had a positive economic impact on northern New Mexico.

I.4.8.2 Infrastructure

Site infrastructure includes the physical resources required to support the construction and operation of LANL facilities (see Chapter 4, Section 4.8.2). Utility infrastructure encompasses the electrical power, natural gas, steam, and water supply systems at LANL. Electrical service to LANL is supplied through a cooperative arrangement with Los Alamos County, the Los Alamos Power Pool. DOE operates a natural-gas-fired steam and electrical power generating plant within TA-3, capable of producing up to 20 megawatts of power. The natural gas system includes a high-pressure main and distribution system to Los Alamos County and pressure-reducing stations at LANL buildings. Over 90 percent of the gas used at LANL is used for heating. The Los Alamos water production system consists of 14 deep wells, 153 miles (246 kilometers) of main distribution lines, pump stations, and storage tanks. The system supplies potable water to all of the county, LANL, and Bandelier National Monument.

I.4.9 Waste Management

LANL has a well-developed infrastructure and extensive facilities for managing radioactive, toxic, and hazardous materials. Many facilities are in TA-50 and TA-54 and include treatment of liquid radioactive and hazardous wastes; solid radioactive waste through measures such as dewatering or compaction; hazardous wastes (particularly characteristic wastes) through methods such as neutralization or reaction to eliminate reactivity concerns; and high explosive-contaminated material, often by burning. LANL has facilities to characterize the radioactive and hazardous content of the waste. Some wastes are stored onsite, including some low-level radioactive, TSCA, and hazardous wastes, as well as transuranic wastes. Stored transuranic wastes are being retrieved for repackaging and shipment to WIPP. Additional information is in Chapter 4, Section 4.9, of this SWEIS.

Solid waste disposal capacity will exist at LANL on a temporary basis. LANL and Los Alamos County have both used a solid waste landfill located within TA-61. Established in 1974, the landfill must close to comply with solid waste management regulations administered by NMED (LANL 2005d). The landfill is expected to operate through fall 2008 (Finfrock 2008). A solid waste transfer station located at the existing county landfill is to open at that time. Access to the landfill is via East Jemez Road (LANL 2005d). LANL nonhazardous waste will be processed through this new transfer station, and municipal and LANL waste will be transported to a location outside of Los Alamos County. Waste will be collected, processed, and transferred into larger trucks before being shipped offsite. Management and operation of the transfer station will be by Los Alamos County (LANL 2005a).

The only operating low-level radioactive waste disposal facility at LANL is at Area G in TA-54. Disposal of mixed low-level radioactive waste is not authorized, although disposal of waste containing PCBs occurs. Low-level radioactive waste disposal operations will be expanded initially into Zone 4 of TA-54, an expansion of about 30 acres (12 hectares), and then as necessary into Zone 6 of TA-54 (72 acres total). This expansion was addressed in Volume II (*Project-Specific Siting and Construction Analyses*) of the *1999 SWEIS* (DOE 1999a) (see Appendix H, Section H.3). The disposal units at Zone 4 would contain shafts for wastes requiring special controls (such as remote-handled-waste or wastes containing biological hazards or PCBs), as well as several pits or trenches for routine wastes. Assuming a delivery rate of 2,600 to 3,900 cubic yards (2,000 to 3,000 cubic meters) of waste per year, Zone 4 should be able to provide disposal capacity for 40 to 60 years (LANL 2005h).

I.4.10 Transportation

Motor vehicles are the primary means of transportation at LANL (see Chapter 4, Section 4.10). Principal access routes to each of the MDAs and PRSs listed in Table I–80 are listed in **Table I–84**. The principal access road to the TA-61 borrow pit is East Jemez Road.

Table I–84 Principal Access Routes to Material Disposal Areas and Selected Solid Waste Management Units

TA	MDA or SWMU	Principal Access	Comments
6	MDA F	Twomile Mesa Road	Terminates in TA-40 to the west; intersects with Anchor Ranch Road and West Jemez Road (NM 501) to the east.
8	MDA Q	Anchor Ranch Road	Intersects with West Jemez Road to the southwest.
15	MDA N	R-Site Road	Intersects with Anchor Ranch Road to the west. Anchor Ranch Road intersects with West Jemez Road to the southwest.
15	MDA Z SWMUs E-F, R-44		Intersects with R-Site Road to the north.
16	MDA R	K-Site Road	Intersects with Anchor Branch Road.
16	SWMU 260 Outfall	K-Site Road	Intersects with Anchor Ranch Road.
21	MDAs A, B, T, U	DP Road	Intersects just to the west of TA-21 with NM 502 in the Los Alamos Townsite.
33	MDAs D, E, K	NM 4	
35	MDA X and other nearby SWMUs	Pecos Drive	Intersects with Pajarito Road in TA-50.
36	MDA AA	Potrillo Drive	Intersects with Pajarito Road in TA-18.
39	MDA Y	NM 4	
49	MDA AB	Frijoles Mesa Drive	Intersects with NM 4 to the west.
50	MDA C	Pajarito Road	Passes through TA-50 and intersects with NM 501 (East and West Jemez Roads) to the east and NM 4 to the west.
54	MDAs G and L	Mesita del Buey Road	Intersects with Pajarito Road in the northern area of TA-54. Pajarito Road intersects with NM 501 (East and West Jemez Roads) to the east and NM 4 to the west.
73	Ashpile	East Road	

TA = technical area, MDA = material disposal area, SWMU = solid waste management unit, NM = New Mexico.

Figure I–25 shows many of the principal transportation routes within LANL. Materials such as concrete or fill dirt could be delivered using NM 4 to the west or NM 502 to the east. Waste and materials moved within LANL would be transported mainly over NM 501 (East and West Jemez Roads), NM 502, NM 4, and Pajarito Road. Much of the waste sent offsite from LANL for treatment or disposal may be transported over NM 502 to the east (**Figure I–26**). NM 502 intersects with NM 30 in San Ildefonso. NM 30 passes north to Española. NM 502 continues east, interesting with US 285/84. US 285/84 is routed north to Española and south to Santa Fe, where it intersects with I-25. A new Santa Fe bypass connects with US 285/84 north of Santa Fe and passes to the northwest of Santa Fe, connecting with I-25 west of Santa Fe. I-25 connects with I-40 in Albuquerque to the south.

The primary route designated by the State of New Mexico for radioactive and other hazardous material shipments to and from LANL is the 40-mile (64-kilometer) corridor between LANL and I-25 at Santa Fe. This route passes through the Pueblos of San Ildefonso, Pojoaque, Nambe, and Tesuque and along the northern segment of Bandelier National Monument (DOE 1999a).

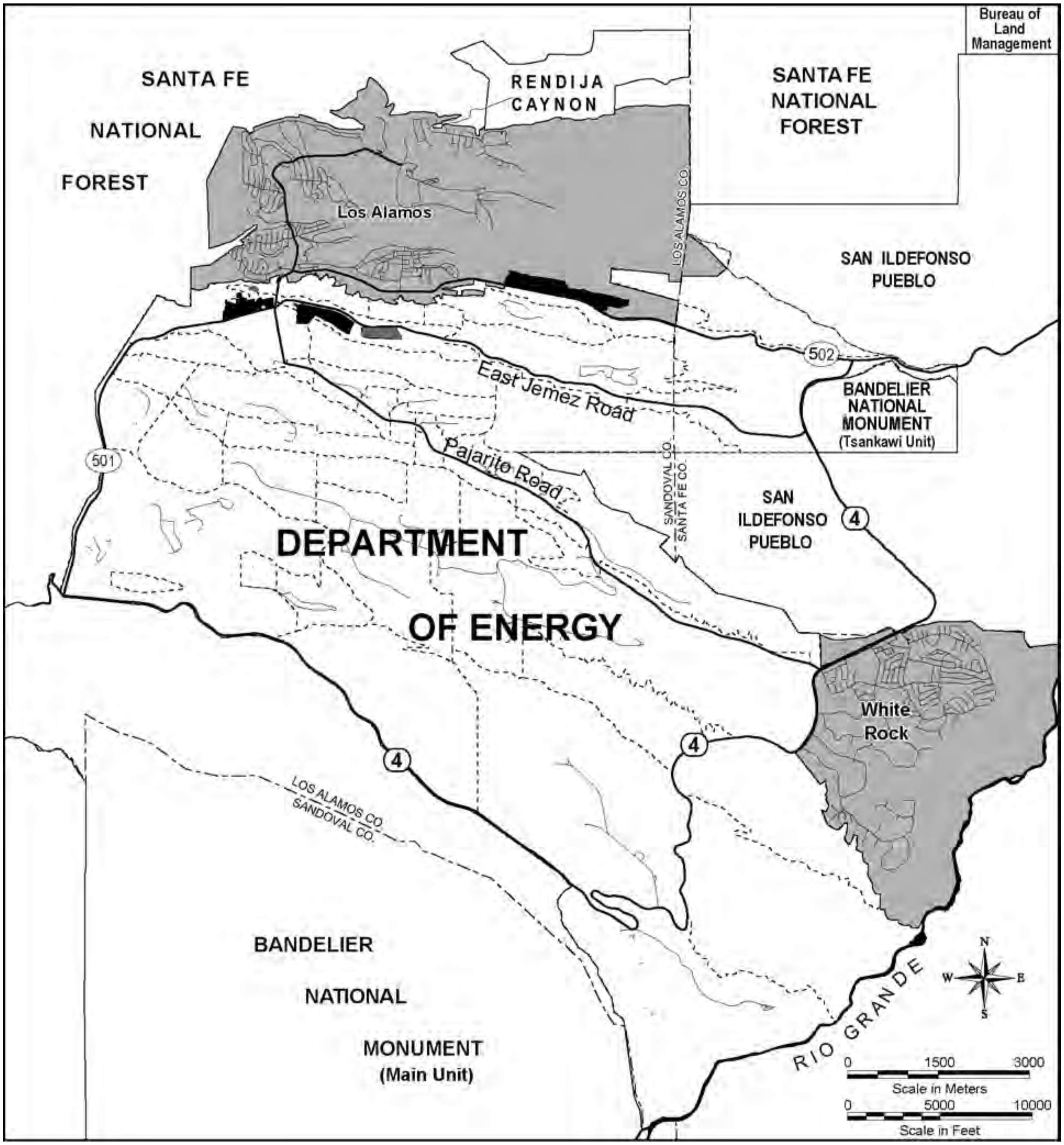


Figure I–25 Major Transportation Routes within Los Alamos National Laboratory

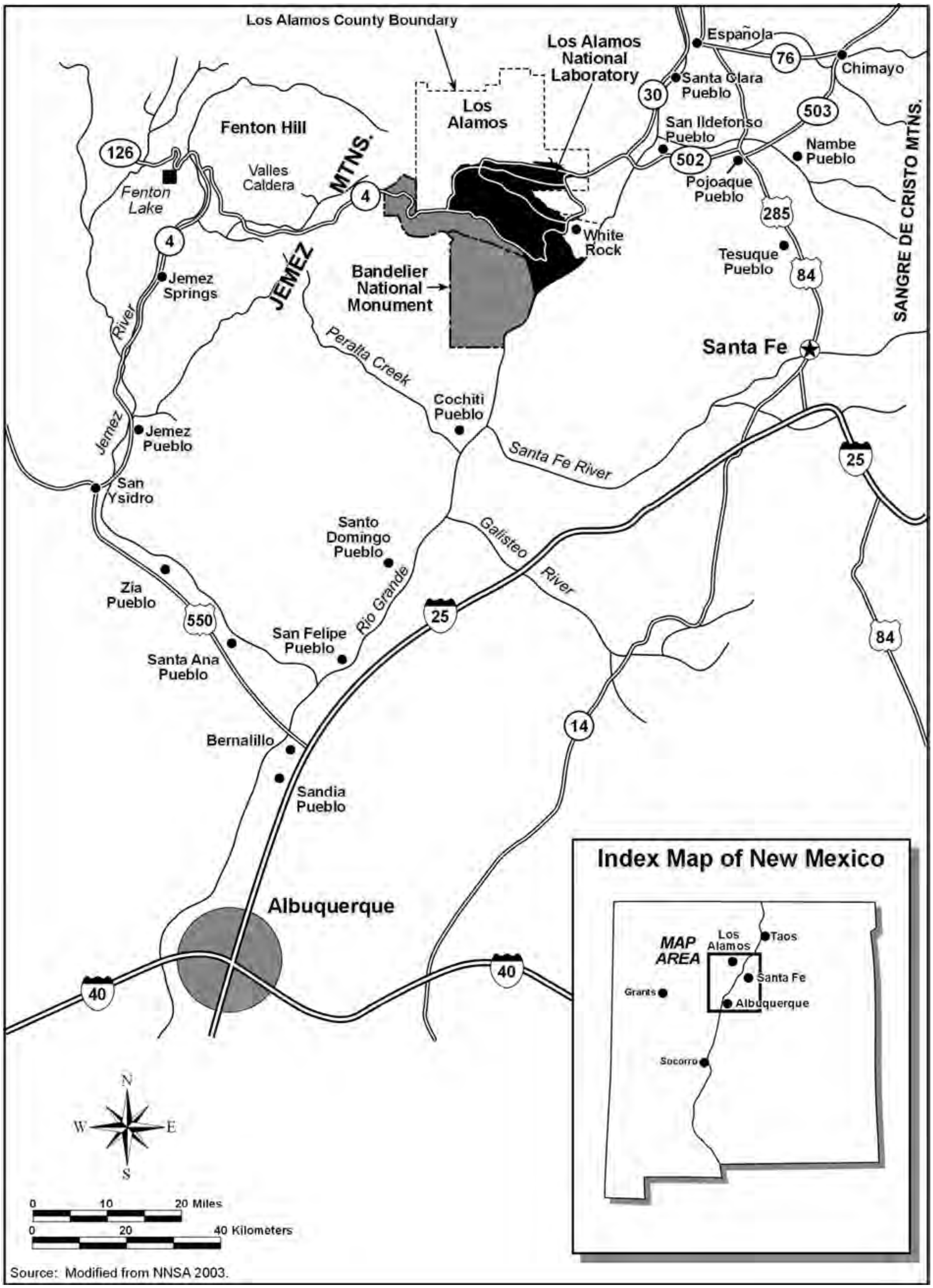


Figure I–26 Major Transportation Routes Outside of Los Alamos National Laboratory

I.4.11 Environmental Justice

As summarized in Chapter 4, Section 4.11, of this SWEIS, a majority of residents (54 percent) in the eight potentially affected counties surrounding LANL designated themselves as minorities in the 2000 Census. Hispanics and American Indians composed approximately 91 percent of the minority population. The percent of low-income population residing in these counties was reported to be approximately 13 percent in the 2000 census, compared to nearly 18 percent of the total population of New Mexico.

Estimates of transportation impacts are based on an assumed route from LANL heading east on NM 502 and south toward I-25 passes through San Ildefonso, Pojoaque, Nambe, and Tesuque Pueblo lands.

The Pueblo of San Ildefonso is a minority-dominated community and had a median household income of $30,457 in the 2000 census. About 12.4 percent of the families lived below the poverty level. The median household income in Pojoaque was $34,256, with 11.3 percent of families living below the poverty level (DOE 2004b).

I.5 Environmental Consequences

The major options considered in this appendix are No Action, Capping, and Removal. As the LANL environmental restoration project continues, so do operational and decommissioning activities at LANL. These activities may have environmental benefits and detriments, and will generate wastes requiring treatment and disposal. DD&D of structures in TA-18 and TA-21 is addressed in Appendix H, Sections H.1 and H.2. Wastes projected from recovery of transuranic waste from storage are addressed in Section H.3. Total wastes from all sources are addressed in Chapter 5, Section 5.9, of this SWEIS.

I.5.1 Land Resources

Resources include land use and the visual environment (physical characteristics, air quality, light pollution).

I.5.1.1 No Action Option

Under the No Action Option, LANL would continue its environmental restoration project at levels as described for the Expanded Operations Alternative in the *1999 SWEIS* (DOE 1999a).

I.5.1.1.1 Land Use

Continuing LANL's environmental restoration project would reduce the amount of land and property at LANL that is contaminated with radioactive or hazardous constituents. There would be a wider range of options for future use of this land and property. However, many, if not most, of the PRSs being addressed under LANL's environmental restoration project are near other operating facilities. Operation of these facilities, and the missions conducted within the TAs containing these facilities, are largely independent of remediation actions for individual PRSs. Therefore, continuing the environmental restoration project would probably not change many basic restrictions such as control of access to LANL and particular TAs. Restrictions would probably continue consistent with security or safety needs. Nonetheless, within the context of the overall LANL mission and that for particular TAs, continuing the environmental restoration project could result in expanded options for some lands and property.

I.5.1.1.2 Visual Environment

Continuing LANL's environmental restoration project should generally improve visual resources as older structures and signage warning of possible hazards are removed for lack of need, and areas are revegetated. But there could be some temporary, short-term reductions in the visual environment. For example, vegetative covers over small portions of land being remediated may be removed. But this visual effect would be temporary until vegetation is restored. Small quantities of dust could be generated, which could slightly reduce visual quality. But dust generation would be localized and temporary and could be mitigated.

But the large domes at Area G in TA-54 would remain until operations associated with the domes (such as transuranic waste storage) are completed. The domes contrast with the natural landscape and can be seen from the Nambe-Española area, from areas in western and southern Santa Fe, and from lands of the San Ildefonso Pueblo. Recovery of aboveground stored waste is planned for completion by the end of FY 2012. DD&D of structures in Area G will be performed in three phases during FY 2010, FY 2012, and FY 2014, to be completed early in FY 2015 (see Appendix H, Section H.3, of this SWEIS).

I.5.1.2 Capping Option

I.5.1.2.1 Land Use

Site Investigations. Consent Order investigation programs such as well installation and monitoring will not change the designated land use in the TAs where the investigations take place. Wells or other monitoring equipment should not require significant dedication of land once installed. However, there may be temporary commitments of land to construct the investigation systems. For example, installation of a well may require temporary clearing of several hundred square feet of vegetation. But this resource commitment would be short lived. Following well installation, the affected land would be allowed to return to its original condition.

Remediation of MDAs. Because the Capping Option would stabilize rather than remove existing contamination, future use of the MDAs would remain restricted. At present, most MDAs are open areas that are fenced and excluded from any use other than safely maintaining inventories of waste. In the future, the MDAs would continue to be surveyed and maintained to protect public health and safety and the environment.

Although 37 acres (15 hectares) of TA-21 either have been or will be conveyed to Los Alamos County, conveyance of most of TA-21 has been deferred. Many of the structures in TA-21 will be removed (see Appendix H, Section H.2). Yet because capping would stabilize rather than remove existing contamination, development within the TA would be restricted. The MDAs are within areas designated as No Development Zone (Hazard). This designation is expected to continue under the Capping Option.

Capping the MDAs within TA-54 would result in no significant change to current restrictions on accessing the land comprising the MDAs. Overall, those portions of TA-54 currently used as waste management areas would still be used for that purpose. If some of the transuranic waste currently stored in the Area G shafts is left in place (see Section I.3.3.2.1.2.2), then long-term institutional controls (which include land use restrictions, signage, and other controls) may be needed, as called for in 40 CFR Part 191.

The Capping Option would maintain the commitment of roughly 110 acres (45 hectares) of land as waste disposal areas. In addition, the Capping Option would involve the temporary commitment of land to support capping activities; following capping, the land would be remediated as needed and made available for other uses. As addressed in Section I.3.6.5, temporary support areas may include project management areas, areas for parking personal vehicles, areas for temporarily storing any wastes that may be generated, and areas for stockpiling bulk materials. Project management areas are expected to be small, involving total commitment of only a few acres for all MDAs. For most MDAs, personal vehicles could probably be parked at existing facilities; little additional parking capacity should be needed. Because capping MDAs is expected to generate only small quantities of waste, only a few acres would be temporarily affected as waste storage areas.

The largest temporary commitment of land would be for temporary storage of bulk capping materials. Assuming that capping requires the temporary storage of a 6-month supply of materials at each MDA, then 37 to 81 acres (15 to 33 hectares) of land could be temporarily affected.[75]

Remediation decisions at the MDAs may involve a combination of measures (some portions capped; some portions removed). Activities at TA-21 will include DD&D as well as MDA remediation, which may in combination temporarily affect up to 130 acres (53 hectares).

Remediation of Other PRSs. Removal of contamination at PRSs such as Firing Sites E-F and R-44 at TA-15 would probably not result in significant changes in land use. Remediating the firing sites would not independently change the operational mission assigned to TA-15, and the land use classification would remain High-Explosive Testing. Remediating the 260 Outfall would result in no change in land use; TA-16 is expected to remain as LANL's high explosive processing area, with attendant security restrictions. Similarly, action to remediate groundwater and surface water contamination within canyons (or elsewhere) would not by itself change current land use within the TAs containing these canyons.

Remediation of PRSs may directly affect several acres of land on an annual basis, assuming that remediation involves removal of contamination from the affected area. Additional acreage may be temporarily committed to support remediation. For example, removal operations at surface contamination sites such as firing sites may require the temporary establishment of management areas (including management trailers) or waste storage and processing areas. Remediation of subsurface volatile organic compound plumes will require temporary commitment of small quantities of land for extraction or offgas treatment systems. Installation of subsurface barriers such as slurry walls or permeable reactive barriers will require temporary areas for project

[75] *Includes capping contaminated areas in TA-49.*

management, equipment parking, and bulk materials storage. Possible installation of groundwater pump-and-treat systems may require a temporary commitment of land for equipment installation. Operation of the systems would require temporary dedication of land for pumping equipment, treatment systems, plumbing, and temporary water storage.

Borrow Pit. Use of the borrow pit on East Jemez Road in TA-61 as a source for capping materials would result in no changes to the current land use category for the TA (Physical and Technical Support and Reserve).

I.5.1.2.2 Visual Environment

Site Investigations. Consent Order investigation programs will have some visual impacts. There would be temporary clearing or vegetation disruption to construct the investigation systems. Installing a well may require temporary clearing of several hundred square feet of land. But visual impacts would be short lived. Cleared or disrupted areas would be allowed to return to their original condition. Site monitoring and sample collection systems would be unobtrusive.

Remediation of MDAs. Capping the MDAs would have short-term visual impacts. It would require stripping or disrupting the existing vegetative cover over the MDAs, placing cover materials in compacted lifts, and providing for revegetation. But not all land would be affected at the same time, and many of the MDAs are not readily visible by the public.

The Capping Option would involve placement of final covers on up to 110 acres (45 hectares) of LANL property containing MDAs and landfills. However, because capping would take place over a period of 10 years of different times within different TAs, a much smaller area would be affected during any single year. In addition to presenting a disturbed appearance, there could be temporary visual impacts of suspended dust. These impacts could be mitigated using water sprays or other techniques.

In addition, there would be areas temporarily affected by support operations needed to construct the caps. In addition to small project management areas for MDAs requiring remediation, there would be areas used by site workers for parking personal vehicles, as well as areas used for temporary management of waste or demolition debris, or temporary storage of bulk materials such as crushed tuff. These areas would have an industrial appearance. However, it is probable that most of the areas so affected would be in previously disturbed areas, and because most MDAs are near existing LANL facilities, parking areas may already largely exist, meaning no change in existing appearance.

The average affected will depend on regulatory decisions, operational needs, and related LANL activities. Remediation decisions for the MDAs may involve a combination of measures. Activities at TA-21 will include DD&D as well as MDA remediation, which may temporarily impact up to 130 acres (53 hectares).

After capping is completed for most MDAs, there would be only minor changes in visual resources. Once the MDAs are capped, those visible from higher elevations to the west would have the same grassy appearance as they had before capping began. Support areas would be remediated as needed. But similar to the No Action Option, there would be a noticeable improvement at Area G within TA-54, where a grassy field would eventually replace the visually intrusive white domes. This replacement would improve views from the Jemez Mountains, the Pueblo of San Ildefonso, and as far away as the towns of Española and Santa Fe.

If some of the transuranic waste currently stored in the Area G shafts is left in place (see Section I.3.3.2.1.2.2), then long-term institutional controls may be needed as called for in 40 CFR Part 191. Passive institutional controls would include markers or other devices intended to warn against unauthorized intrusion into the disposal area, and these markers or devices, which would be designed to be long lasting, may be visible at a distance.

Remediation of Other PRSs. Visual impacts associated with remediating other PRSs would depend on their location and the nature and extent of the contamination. For example, the firing sites in TA-15 are in a restricted, wooded area. Because removal of contamination would involve surface recovery rather than excavation, minimal damage to existing vegetation would probably occur. Remediating the 260 Outfall would require partial clearing and excavating some areas. Any visual impacts of dust or particulate matter that may be suspended from remediation operations could be mitigated. Remediation of subsurface volatile organic compound plumes would require installation of vapor removal and treatment systems that would be small and visually unobtrusive. Installation of subsurface barriers such as slurry walls or permeable reactive barriers would require temporary disruption of land, but affected land could be revegetated as needed. Possible use of groundwater pump-and-treat systems may result in a temporary industrial appearance at the remediation sites, given the possible need for pumping equipment, treatment systems, plumbing, and temporary water storage. These systems should be relatively compact, however.

In any event, several acres of land may be annually visually affected through continued remediation of dozens of LANL PRSs. Individual affected areas would be generally small, and many would be in locations not routinely accessed by the public. Once remediation is complete, the affected areas would quickly return to a similar appearance, when viewed from afar, to that before remediation was initiated.

Borrow Pit. Visual impacts may be associated with operation of the borrow pit in TA-61 to provide fill for MDA capping. Quantities of fill and other materials needed to cap the MDAs would be large. To obtain the required fill, the small hill that currently screens the pit from observation from East Jemez Road may require removal. Thus the pit, which is a cleared area several acres in size, may become visible from East Jemez Road. There could also be visual impacts of suspended dust from borrow pit operation. These impacts could be mitigated using water sprays or other techniques. (See Section I.5.4.2.1 for an estimate of the quantities of dust raised from borrow pit operation.)

I.5.1.3 Removal Option

I.5.1.3.1 Land Use

Site Investigations. Impacts on land use under the Removal Option would be the same for site investigations as under the Capping Option.

Removal of MDAs. Under the Removal Option, there would be fewer restrictions on land use than under the Capping Option. Capping the MDAs is expected to cover about 110 acres (45 hectares) of land, which would be retained as exclusion areas for radioactive waste. Removing the MDAs could free the land occupied by the MDAs for other purposes. Any buffer area surrounding the MDAs could also be used for other purposes.

But implementation of the Removal Option may not cause major changes in the designated uses of the TAs containing MDAs. Operating or inactive contaminated facilities would remain near MDAs C, G, and L. Assuming complete removal at MDAs A, T, and U, there may be residual stabilized contamination after other, nearby, structures are removed (see Appendix H, Section H.2). After removal of MDA AB, other nearby PRSs in TA-49 may remain. A similar situation exists at the other, smaller, MDAs. While future use of the remediated sites is not yet known, it is likely that the land would be reused to support existing and future LANL missions.

The Removal Option would involve the temporary commitment of land to support removal operations; following removal, the land would be remediated as needed and be made available for other uses. Temporary support areas may include project management areas; areas for parking personal vehicles; areas for temporary storage of waste; capacity for storing bulk materials such as excavation spoil; and capacity for waste hazard identification, waste processing, or characterization. Project management area requirements will be probably small for most MDAs. Larger area commitments may be needed for removal of large MDAs such as MDA C or G. For most MDAs, personal vehicles could probably be parked at existing facilities. However, removal of MDA G could require a large work force, which may require development of additional capacity for vehicle parking.

It is expected that removing the MDAs could require up to 63 acres (25 hectares) for temporary storage or management of mostly low-activity bulk waste. Assuming that removing the MDAs requires the temporary storage of a 6-month supply of spoil, then the Removal Option would temporarily affect up to 99 acres (40 hectares) of land for bulk material storage. An additional 10 to 22 acres (4 to 9 hectares) would be temporarily affected for capping remaining disposal units in Area G and small areas in TA-49. Also, 84 acres (34 hectares) may be needed to site several hazard identification, waste processing, or characterization facilities around LANL. However, because removal would take place over a period of 10 years at different times within different TAs, smaller areas than those estimated above would be affected annually.

Remediation decisions for the MDAs may involve a combination of measures. Remediation will be coordinated with other LANL activities such as DD&D. Combined DD&D and MDA remediation at TA-21 may temporarily affect up to 130 acres (53 hectares).

Remediation of Other PRSs. The Removal Option is expected to have the same effect on land use for other LANL PRSs as the Capping Option.

Borrow Pit. The Removal Option is expected to have the same effect on land use for the TA-61 borrow pit as the Capping Option.

I.5.1.3.2 Visual Environment

Site Investigations. Visual impacts of the Removal Option would be the same for site investigations as under the Capping Option.

Remediation of MDAs. Under the Removal Option, many of the larger MDAs may be exhumed under enclosures similar to those used for transuranic waste recovery at TA-54. (The investigation and remediation program at MDA B will be conducted under enclosures.) These enclosures would be visible from greater distances than would the MDAs under the Capping Option, but their presence would be temporary. After waste removal is completed, the enclosures would be removed and the backfilled excavations revegetated. MDAs not exhumed under enclosures would present a disturbed appearance while removal takes place. However, after removal is complete, the excavations would be backfilled and revegetated.

As under the Capping Option, implementation of the Removal Option would temporarily visually affect land used to support removals. Support activities could include management and staging areas; waste inspection, treatment, packaging, and storage areas; equipment decontamination areas; parking areas for worker vehicles; and areas for bulk storage of materials such as exhumed soil. The amount of acreage so affected would depend on regulatory decisions, operational needs, and other LANL infrastructure and activities. Remediation decisions for the MDAs may involve a combination of measures, as contemplated for MDA B within TA-21. DD&D and MDA remediation within TA-21 may temporarily impact up to 130 acres (53 hectares).

The Removal Option would probably cause smaller visual impacts of suspended dust than the Capping Option. Waste removal at the larger MDAs may occur within enclosures, and air exhausted from these structures would be filtered.

Remediation of Other PRSs. The Removal Option is expected to have the same visual impacts for other LANL PRSs as the Capping Option.

Borrow Pit. Visual impacts may be associated with operation of the borrow pit in TA-61 to provide backfill for the excavated MDAs. Quantities of fill would be large and comparable to those required under the Capping Option (see Section I.5.1.2.2). To obtain the required fill, the small hill that currently screens the pit from observation from East Jemez Road may require removal. Thus the pit, a cleared area several acres in size, may become visible from East Jemez Road. The potential for visual impacts of suspended dust would be comparable to those under the Capping Option.

I.5.2 Geology and Soils

Resource areas of interest are: (1) the possibility of geological effects on MDAs and other PRSs; (2) soil contamination; and (3) the need for soil, rock, and similar materials for MDA remediation. Site investigations conducted under the Consent Order, as well as LANL surveillance and maintenance programs for nuclear environmental sites, should have little or no effect on these resource areas.

I.5.2.1 No Action Option

Under the No Action Option, concerns identified at the MDAs and all other PRSs at LANL from erosion or other mass-wasting processes would be addressed. But action to address the long-term protection of the MDAs from erosion and other possible mass-wasting damage would not occur consistent with the schedules in the Consent Order.

The environmental restoration project would continue to address contamination in soil or other media at the LANL PRSs. But the activities of LANL environmental restoration project activation would not necessarily be consistent with the schedules or priorities of the Consent Order.

The TA-61 borrow pit would continue to operate at existing levels.

I.5.2.2 Capping Option

Geological Effects. Covers for the MDAs would be contoured and provided with runon and run-off control measures consistent with their design. In addition, soils adjacent to or beneath the waste may be affected by construction of vertical or subwaste horizontal containment walls. The final designs of the covers would follow completion of the corrective measure studies being performed for the Consent Order. The corrective measure studies would include conceptual models of each MDA that would consider long-term geologic processes such as cliff retreat.

Soil Contamination. Other than that existing as a gas or vapor, contamination within the subsurface of the MDAs and in the immediate vicinities would be fixed in place. Capping would not by itself address any contamination existing as vapor within soil, such as volatile organic compounds or tritium as a gas or vapor. However, soil vapor volatile organic compounds can be removed and treated using unobtrusive equipment that would be compatible with the installed evapotranspiration covers (see Section I.3.3.2.2.4). Remediation of the firing sites, the outfalls, and other PRSs would address existing soil contamination at these PRSs.

Borrow Pit. Under the Capping Option, the MDAs would be capped in place using evapotranspiration covers. To construct these covers, from 750,000 to 2,000,000 cubic yards (570,000 to 1,500,000 cubic meters) of crushed tuff may be needed through 2016, assuming that all such material is obtained from the TA-61 borrow pit. (From 370,000 to 930,000 cubic yards (280,000 to 710,000 cubic meters) of crushed tuff would be needed through 2011.) The site containing the borrow pit covers 43 acres (17 hectares). Assuming an excavation depth of 50 feet (15 meters), excavating 750,000 cubic yards (570,000 cubic meters) of tuff would create a hole 9.3 acres (3.8 hectares) in size, while excavating 2,000,000 cubic yards (1,500,000 cubic meters) of tuff would create a 50-foot (15-meter) hole roughly 25 acres (10 hectares) in size.

Alternatively, the required fill for the MDA covers may be partially obtained from offsite sources, at additional cost and transportation impacts. In addition to fill, construction of the MDA covers through 2016 would require 440,000 to 460,000 cubic yards (340,000 to 350,000 cubic meters) of additional rock, gravel, topsoil, and other bulk materials from local sources. The total quantity of crushed tuff, rock, and other bulk materials needed through 2016 would range from 1.2 to 2.5 million cubic yards (0.92 to 1.9 million cubic meters).

I.5.2.3 Removal Option

Geological Effects. Complete removal of the MDAs would eliminate concern about the susceptibility of the MDAs to erosion or other geological processes. For partial removal of MDAs, there would be residual, but reduced, concerns because high-concentration pockets of contamination would be removed.

Soil Contamination. This option would greatly reduce existing soil contamination in the vicinity of the MDAs. Contamination existing as a soil or gas would also be largely eliminated. Remediation of the firing sites, outfalls, sediments in canyons, and other PRSs would address existing soil contamination at these PRSs.

Borrow Pit. Under the Removal Option, the waste in all MDAs considered in this appendix would be removed. Roughly 1,300,000 cubic yards (990,000 cubic meters) of backfill would be needed to replace the excavated waste and contamination, as well as 61,000 cubic yards (47,000 cubic meters) of rock, gravel, topsoil, and other bulk materials obtained from local sources. In addition, from 190,000 to 510,000 cubic yards (150,000 to 390,000 cubic meters) of crushed tuff would be needed for capping the remaining disposal units at the existing Area G footprint in TA-54, plus 160,000 cubic yards (120,000 cubic meters) of additional bulk materials from local sources. Roughly 31,000 to 84,000 cubic yards (24,000 to 64,000 cubic meters) of crushed tuff, and 2,600 to 7,000 cubic yards (2,000 to 5,400 cubic meters) of additional materials may be needed to cap other landfills, and contaminated areas such as those in Areas 6 and 12 of TA-49. A total of 1.6 to 1.9 million cubic yards (1.2 to 1.5 million cubic meters) and about 220,000 cubic yards (170,000 cubic meters) of rock, gravel, and other bulk materials would be needed, or about 1.8 to 2.2 million cubic yards (1.4 to 1.7 million cubic meters) of combined tuff, rock, and other bulk materials.

Assuming that the crushed tuff would be obtained from the TA-61 borrow pit, then removal of up to 1,900,000 cubic yards (1,500,000 cubic meters) of material from the pit would create a 50-foot (15-meter) hole, 24 acres (9.7 hectares) in size. The demands on the borrow pit would be comparable to those under the Capping Option and could, again, be reduced by obtaining some backfill from other local sources.

I.5.3 Water Resources

Possible impacts on surface water and groundwater resources would be addressed as part of any required corrective measure evaluation to be performed for MDAs and other PRSs in accordance with the Consent Order. A corrective measure evaluation for an MDA would consider alternatives, including capping and removal, two bounding options for MDA remediation that are considered in this appendix.

I.5.3.1 No Action Option

I.5.3.1.1 Surface Water

Under the No Action Option, surface water quality would be gradually improved as continuing corrective measures are performed on LANL PRSs. There would be fewer risks to surface water because sources of contamination in soil and sediments would be stabilized in place or removed.

I.5.3.1.2 Groundwater

Gradual improvements to groundwater quality would occur.

Investigative and monitoring programs have long existed at LANL to assess the presence of contaminants, and to obtain information needed to predict impacts on water resources. Investigations have addressed radionuclide transport beneath pits at MDA G, tritium transport around disposal shafts at MDA G, volatile organic compound transport at MDA L and MDA G, and plutonium transport at MDA T. Investigations intended to characterize vadose zone hydrologic conditions have included injection well tests, natural tracer analyses, chloride measures, stable isotope measurements, and in situ moisture monitoring (LANL 1999b).

In compliance with an earlier version of DOE's Radioactive Waste Management Order, DOE 435.1 (DOE 2001), a performance assessment and a composite analysis were issued in 1997 for the Area G low-level radioactive waste disposal facility in TA-54 (LANL 1997). The performance assessment addresses all waste projected to be disposed of at Area G following September 25, 1988, while the composite analysis addresses all sources of radioactive material within the disposal area that may cause impacts on a hypothetical future member of the public. The performance assessment and composite analysis are of interest because of the large inventory of radionuclides within Area G. The results of the analyses are summarized in **Table I–85** and represent projected exposures to members of the public over the next 1,000 years (LANL 1997).

Table I–85 Material Disposal Area G Performance Assessment and Composite Analysis Summary Results

Inventory	*Analysis*	*Location*	*Calculated Peak Dose (millirem per year)*	*Performance Objective (millirem per year)*
Performance assessment	Air pathway	Cañada del Buey	6.6×10^{-2}	10
Composite analysis	All pathways	Cañada del Buey	5.5 [a]	30 to 100
Performance assessment	Groundwater protection	White Rock Pajarito Canyon	4.5×10^{-5} [b]	4
Performance assessment	All pathways	White Rock Pajarito Canyon	1.0×10^{-4}	25
Composite analysis	All pathways	White Rock Pajarito Canyon	7.2×10^{-3} [c]	30 to 100

[a] This dose was determined at an assumed receptor location in Cañada del Buey assuming airborne suspension and transport of surface contamination from biotic intrusion into buried waste.
[b] From Section 4.1.2 of LANL 1997, the peak annual dose within 1,000 years was 4.5×10^{-5} millirem, occurring at 700 years at the Pajarito Canyon location of maximum projected groundwater concentration. Beyond 1,000 years, the peak annual dose was 1.4×10^{-5} millirem, occurring at 4,000 years at a location 330 feet (100 meters) downgradient of MDA G.
[c] From Section 4.2.1 of LANL 1997, the dose of 7.2×10^{-3} millirem was determined at an assumed receptor location in Pajarito Canyon, and includes a 1.9×10^{-7} millirem dose from hypothetical ingestion of groundwater. A dose of 1.2×10^{-5} millirem was determined at a location 330 feet (100 meters) downgradient of MDA G, and includes a 4.6×10^{-6} millirem dose from hypothetical ingestion of groundwater.
Source: LANL 1997.

With respect to the groundwater pathway, the model used for the analyses considered transport of contaminants from leachate vertically downward through the vadose zone to the regional aquifer or laterally to the perched alluvial groundwater in Pajarito Canyon, where the contaminants may be transported downward to the regional aquifer. For the performance assessment, doses for the groundwater pathway were determined at hypothetical receptor locations at the LANL boundary near White Rock, at a point 330 feet (100 meters) east-southeast of MDA G, and in Pajarito Canyon. For the composite analysis, doses for the groundwater pathway were determined at the locations of maximum projected concentration downgradient of MDA G and in Pajarito Canyon (LANL 1997). The doses were calculated assuming the continuation of the existing temporary disposal covers at Area G.

The performance assessment and composite analysis for Area G are being revised. Work being done at LANL to develop conceptual models of the hydrogeology and numerical models of groundwater flow under the Pajarito Plateau will be incorporated into the revised performance assessment and composite analysis and will be applicable to future modeling efforts such as those used to develop remediation alternatives for the MDAs in corrective measure evaluations. Many of the more recent efforts to develop these conceptual models were published in an August 16, 2005, online publication of *Vadose Zone Journal*. Journal articles are summarized in Appendix E of this SWEIS.

Researchers developing improved conceptual models have postulated low rates of downward migration based on low rates of infiltration (for example, 0.04-0.08 inches [1-2 millimeters] per year) at LANL mesa tops, particularly in the eastern part of LANL (Birdsell et al. 1999, 2000, 2005; Kwicklis et al. 2005). A newly generated infiltration map for the Los Alamos area has been constructed using estimates of infiltration at points in upland areas, as well as estimates of streamflow losses and gains along canyon bottoms (Kwicklis et al. 2005). Although infiltration rates of less than 0.08 inches (2 millimeters) per year were estimated for mesa tops, larger infiltration rates were estimated at higher elevations in the Sierra de los Valles (for example, greater than 25 millimeters per year in mixed conifer areas to greater than 7.9 inches (200 millimeters) per year for areas having aspen). Canyon bottom infiltration rates depend on the size and elevation of the canyon's watershed and on the history of effluent discharge. Canyon infiltration rates can range from those that are not significantly different from surroundings mesa tops to several hundred millimeters per year (Kwicklis et al. 2005).

Either by increased matrix flow or fracture flow, flow focusing can cause flow and contaminant migration to increase above that otherwise predicted. For example, LANL staff point out that although mesa tops exhibit low infiltration, rates can become high in mesa top areas that contain faults or have become "disturbed" in some manner (for example, areas covered with asphalt or located in drainage diversions). Such anomalous (non-"background") infiltration rates should be considered in risk assessments of disturbed areas (Kwicklis et al. 2005). In the more extreme cases, the net infiltration rate has been estimated to be as high as 12 inches (300 millimeters) per year (Birdsell et al. 2005).

(Birdsell et al. 2005) describes conditions, and the results from disturbances, at two dry mesas, Mesita del Buey and Frijoles Mesa. At Mesita del Buey, downward fluxes vary with depth and across the mesa and are estimated to range from 0.001 to 0.2 inches (0.03 to 6 millimeters) per year. The estimates were made using volumetric moisture content and chloride data (Newman 1996) from four boreholes and from numerical modeling (Birdsell et al. 2000). Further, the four boreholes have depth intervals where fluxes are smaller than 1 millimeter per year. Chloride-based residence times range from 1,300 to 17,000 years (Newman 1996). These estimates of flux and residence time indicate very little water movement.

But there is evidence that dry mesa conditions can change when the water balance is perturbed; for example, when water is added to the soil from wastewater lagoons or stormwater diversion ditches. Focused runoff from an asphalt pad near a borehole on Mesita del Buey caused ponding in a localized area. Moisture content measurements in the borehole showed increasing water content as deep as 24 meters (roughly 80 feet) in less than 10 years after the ponding was initiated (Birdsell et al. 2005).

Dry conditions at Frijoles Mesa are similar to those at Mesita del Buey (that is, estimated infiltration rates are 0.3 to 2 millimeters per year, based on chloride data from a 210-meter borehole). At MDA AB on Frijoles Mesa, hydrodynamic testing was performed in 1960 and 1961 at the bottoms of numerous deep shafts that had been backfilled with sand and crushed tuff. One area at MDA AB was paved with asphalt in 1961 in an attempt to minimize surface contamination. But the asphalt inhibited evapotranspiration and dammed surface water along its edge. In 1975, the asphalt pad over a backfilled shaft collapsed, leaving a 6 × 7 × 4 foot (1.8 × 0.9 × 1.2 meter) hole in the asphalt and underlying fill, and probably causing the standing water seen in Core Hole 2. After the standing water was bailed dry, the asphalt developed cracks; estimates of leakage through the cracked pad ranged from 2.4 to 15 inches (60 to 388 millimeters) per year. Standing water was again observed in Core Hole 2. Data from two other boreholes in 1994 indicated elevated water contents to a depth of 18 meters (roughly 60 feet). In contrast, background water-content profiles measured in five boreholes around the site showed tuff water content below about 10 feet (3 meters) to be less then ten percent. Numerical simulations for MDA AB based on an infiltration rate of 2.4 inches (60 millimeters) per year during the period 1961 through 1994 showed a reasonable fit to a water content profile obtained in 1994 (LANL 1992b, Birdsell et al. 1999, 2005). In 1998 and 1999, Core Hole 2 was grouted and abandoned, the asphalt was removed, and the site regraded and capped with an evapotranspiration cover (see Section I.2.5.3). Since then, the upper 20 feet (6 meters) of soil beneath the cover appear to be slowly drying (Levitt et al. 2005, Birdsell et al. 2005).

The field and laboratory study by Nyhan et al. (LANL 1984) at Area T illustrated that water can move rather efficiently through the tuff at mesa tops, and that mobile contaminants can move quickly in response to the water flux. Roughly 1.2 million gallons (4,600 cubic meters) of water were disposed of in Absorption Pit 1 at Area T over a 2-month period (LANL 1984).

Subsurface contaminant data collected beneath the absorption beds show evidence of contaminant transport associated with fractures, while subsurface data collected in boreholes adjacent to the beds showed none. The general assumption is that fracture transport occurred while the beds actively received liquid waste, and that the contaminants associated with the fractures are remnants of previous fracture flow episodes. The data support the idea that some fractures in the nonwelded to moderately welded tuff will flow when the matrix is saturated (Birdsell et at. 2005).

Flow focusing of some form may have caused the apparent observed movement of radionuclides from disposal units at Area G in TA-54. As cited in the MDA G investigative work plan, five radionuclides (americium-241, plutonium-238, plutonium-239, uranium, and cobalt-60) were found at depths exceeding 80 feet (24 meters) in four RFI boreholes at MDA G. Tritium was found in one borehole to a depth of 130 feet (40 meters) (LANL 2004c).

To conclude, MDAs are disturbed areas, and this, or flow focusing, may have caused or contributed to the observed elevated water content in subsurface soils and movement of contaminants at some MDAs. Uncertainty about the long-term infiltration rates at MDAs leads to uncertainty about the long-term performance of the MDAs. The result is uncertainty about possible future human risk from groundwater contamination, assuming nothing is done to reduce long-term infiltration into the MDAs. Deep contamination may be evidence of accelerated contaminant migration, due to possible fast paths (vertical fractures) or areas of increased infiltration and matrix flow, or both. The No Action Option would leave the MDAs vulnerable to these uncertainties.

I.5.3.2 Capping Option

I.5.3.2.1 Surface Water

Site Investigations. Investigations conducted under the Consent Order will provide additional information about the identity and extent of contaminants in groundwater and surface waters and information needed to predict impacts on water resources. The investigations may cause small risks to surface water quality because of generation of purge water as part of well sampling. However, this purge water would be retained and managed as required in the Consent Order, indicating that impacts on surface water of the investigation programs would be minimal.

Remediation of MDAs. Installing final covers at the MDAs would cause short-term risks to surface waters. Industrial equipment would disturb land, disrupting existing covers and presenting opportunities for runoff and erosion to transport soil and small levels of contamination to canyons. In addition, capping the MDAs would require the import of large quantities of tuff and surface amendment, some of which could be eroded into canyons. These risks would be reduced and mitigated using best management practices consistent with documented stormwater pollution prevention plans.

Despite possible short-term detriments, the Capping Option is expected to improve surface water quality compared to the No Action Option. A final cover is being designed consistent with the update of the performance assessment and composite analysis for the Area G low-level radioactive waste disposal facility. The final cover will extend over MDA G. Features of the final cover to resist biological intrusion would reduce the potential for contact by burrowing animals. Because of this, and because the final covers would overlie existing levels of surface contamination at MDA G, surface water pathways should be correspondingly protected from runoff and erosion of surface contamination. The design and installation of the final covers for the other MDAs would similarly minimize surface water runon and runoff and erosion and would similarly protect surface water resources.

Remediation of Other PRSs. Continued progress would be made in remediating PRSs at various locations within LANL. There would be less contamination in soils and sediments that could present a risk to surface water quality.

Borrow Pit. Expanded use of the borrow pit in TA-61 has the potential for affecting surface water quality in Sandia Canyon. To preclude significant impacts, the expanded use would be consistent with a stormwater pollution prevention plan that would be prepared for the expanded use. Runoff control structures or features would be installed as needed, and operational or administrative controls would be implemented consistent with the plan.

I.5.3.2.2 Groundwater

Site Investigations. Site investigations under the Consent Order are expected to have little or no impact on groundwater quality.

Remediation of MDAs. Placement of final covers over the MDAs, which would be among the alternatives considered in corrective measure evaluations for MDAs performed under the Consent Order,[76] would reduce risks to groundwater quality. Work on developing final covers has progressed over many years. Some of the considerations and tradeoffs to be weighed are addressed in Appendix C of the *MDA Core Document* (LANL 1999b). Technical and regulatory guidance on design, installation, and monitoring of alternative final landfill covers, including evapotranspiration covers, has been issued by the Interstate Technology and Regulatory Council (ITRC 2003b).

The long-term effectiveness of a final cover in reducing infiltration into the disposed waste at Area G or any of the other MDAs will depend on its design and construction, considering the natural processes that will affect its performance. Conventional covers, often called RCRA covers, include a resistive barrier layer as the primary barrier to percolation into underlying wastes. Alternative covers, often called evapotranspiration covers, depend on water storage and evapotranspiration. They have received increasing regulatory acceptance, particularly for arid locales. A few examples of research into use of alternative covers include the EPA Alternative Cover Assessment Project that has been ongoing since 1998 (DRI 2002a, 2002b; Roesler, Benson, and Albright 2002); test plots at LANL (Breshears, Nyhan, and Davenport 2005; Nyhan 2005); and a recently constructed cover over a uranium mill tailings site at Monticello, Utah (Waugh et al. 2001). Case studies addressing the use of evapotranspiration covers at landfills covering a range of climatic conditions are presented at a website hosted by EPA's Technology Innovation Program.

One of the studies cited in the EPA *Alternative Cover Assessment Project Report* is the Alternative Landfill Cover Demonstration at Sandia National Laboratories in Albuquerque, New Mexico. This Sandia project is performing side-by-side tests of six test plots, each 330 feet (100 meters) long and 43 feet (13 meters) wide, and each comprising a different cover design, including an evapotranspiration cover design (Dwyer 2001).

The LANL field demonstration was initiated in 1981 with the goals of developing barriers against biological intrusion and systems for groundwater and surface water management. In 1984, test sections of two cover designs were constructed. The cover sections have been monitored with respect to water balance, vegetation cover, rooting patterns, geotextile liner deterioration, preferential flow paths, and soil properties. It was determined, among other things, that the structure, bulk density, and effective permeability of cover layers can be altered over

[76] *A corrective measure evaluation performed for MDA G in TA-54 would be coordinated with the update to the performance assessment and composite analysis that is currently under preparation. This update would consider the application of a final evapotranspiration cover over the disposal units, and would also update information about the site and the contents of the disposal units.*

time by pedogenic processes, root intrusion, animal burrowing, and other disturbances (Breshears, Nyhan, and Davenport 2005). Another set of test plots at LANL investigated the total water balance within four unvegetated evapotranspiration covers having varying slopes. Evaporation usually increased with increasing slope, while interflow and seepage usually decreased with increasing slope (Nyhan 2005).

Evapotranspiration landfill covers can limit infiltration if properly designed, constructed, and maintained. Technical and regulatory guidance for design, installation, and monitoring of evapotranspiration landfill covers has been issued by the Interstate Technology and Regulatory Council (ITRC 2003b). If there are fast paths under waste facilities through which water and contaminants move episodically, covers may significantly inhibit that kind of transport by limiting the rapid water infiltration that drives it. However, the design of a successful cover will depend on systematic planning against processes that can degrade its performance over time. Accurate predictions of percolation rates through landfill covers will depend on knowledge of soil water storage and evapotranspiration. These elements will be influenced by the hydraulic properties of the soil used in the covers and by the properties of covering vegetation. Changes in vegetation can affect cover performance, and mineralogical and textural changes to the soil due to pedogenic processes can change the water retention properties of the soil layer. The potential for extreme weather events should be considered. Cover designs should also incorporate features to limit adverse changes caused by animal and root intrusion. Another consideration is the potential for long-term subsidence caused by slow decomposition and consolidation of the waste within the disposal units.

Remote-Handled Transuranic Waste Option. The option of leaving some remote handled transuranic waste in place would need to be protective of water resources, and such protection would be addressed as part of analyses performed for this option. In addition to future assessments performed as part of corrective measure evaluations under the Consent Order, inventories of transuranic and associated radioactive material would be included in composite analyses for Area G performed in compliance with DOE Order 435.1 (DOE 2001). These composite analyses address all radiological pathways involving potential release of radioactive material to an uncontrolled area, including pathways involving possible transport of contaminants by surface water and groundwater. And as noted in Section I.3.3.2.1.2.2, if required, an assessment pursuant to 40 CFR Part 191 may be performed. Such an assessment would address possible movement of contaminants from the disposal area by both surface water and groundwater.

Remediation of Other PRSs. Remedial actions conducted under the Consent Order will either improve groundwater quality or reduce risks to it from LANL PRSs. The scope of any remediation program for any watershed cannot be fully defined at this time, although potential remediation alternatives could range from no action to more significant activities such as in situ bioremediation, permeable reactive barriers, or groundwater pump-and-treat systems.

Borrow Pit. Operation of the TA-61 borrow pit should have no impact on groundwater quality.

I.5.3.3 Removal Option

I.5.3.3.1 Surface Water

Surface water quality would be improved compared to the No Action Option.

Site Investigations. Investigations conducted under the Consent Order may cause small risks to surface water quality because of generation of purge water from well sampling. But this purge water would be retained and managed as required in the Consent Order. Hence, impacts on surface water of the investigation program would be minimal.

Remediation of MDAs. Under the Removal Option, contamination in most LANL MDAs would be removed. Assuming that the contamination is removed to screening levels, surface water could remain at slight risk. Complete removal would eliminate the great bulk of the contamination at the MDAs. The contamination at the MDAs would be subsequently treated and disposed of either on or offsite. (By either method, disposal would be consistent with groundwater and surface water protection criteria and goals at the disposal facilities.) Partial removal of waste from MDAs would result in smaller risks to surface water resources than either the No Action or the Capping Option. After waste is partially removed from the MDAs, residual contamination would be stabilized and capped.

Removal of the waste and contamination at the MDAs would entail small, short-term risks to surface waters. Excavated waste may spill or release liquids. Industrial equipment would disturb land, disrupting existing covers and causing opportunities for runoff and erosion to transport soil and small levels of contamination into canyons. Removal of the MDAs would require the import of very large quantities of tuff and surface amendment, some of which could be eroded into canyons. These risks would be reduced and mitigated using techniques, including safe waste management procedures, contamination control, monitoring, and best management practices.

Remediation of Other PRSs. As part of the Removal Option, continued progress would be made in remediating PRSs within LANL. There would be less contamination in soils and sediments that could present a risk to groundwater or surface water quality.

Borrow Pit. Because the amount of material to be removed under the Removal Option is comparable to that under the Capping Option, impacts on surface water quality would be comparable.

I.5.3.3.2 Groundwater

Site Investigations. Similar to that under the Capping Option, there should be few, if any, impacts on or risks to groundwater from conducting site investigations under the Consent Order.

Remediation of MDAs. Because the bulk of the contamination in most MDAs would be removed, groundwater risks would be greatly reduced, although some slight risk may remain from any remaining contamination meeting screening levels. In addition, the filled, compacted excavation may still experience larger infiltration rates (for a time) than undisturbed areas, which might further drive migration of deeper contaminants that are beyond the reach of the excavation.

Partial removal of waste from MDAs, such as that contemplated for MDA B, would result in smaller risks to groundwater resources than either the No Action or Capping Options. Residual contamination in the MDAs would be stabilized and capped.

Remediation of Other PRSs. Improvements in groundwater quality from implementation of the Consent Order would be the same as those addressed for the Capping Option.

Borrow Pit. Similar to the Capping Option, operation of the TA-61 borrow pit should have little to no effect on groundwater quality.

I.5.4 Air Quality and Noise

I.5.4.1 No Action Option

I.5.4.1.1 Air Quality

Continuing LANL's environmental restoration project may have small impacts on air quality. Pollutants would be emitted from operation of waste management facilities supporting environmental restoration, as well as from vehicles and construction equipment. Combustion products would be emitted from thermal treatment of any high explosives recovered as part of the environmental restoration project. These releases, however, would probably be small compared with those that would occur as part of ongoing LANL operations and DD&D activities involving safe destruction of high explosives.

Pollutant releases from heavy equipment operation for contaminated material recovery during environmental restoration were estimated for the No Action Option using the procedures outlined in Section I.3.6.4, for which emissions were related to the volumes of wastes projected to be generated. Calculated total release of nitrogen oxides (NO_x), carbon monoxide (CO), sulfur oxides (SOx), particulate matter with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}), carbon dioxide (CO_2), aldehydes, and total organic compounds are presented in **Table I–86** in units of tons.

Table I–86 No Action Option Projected Pollutant Releases to Air from Heavy Machinery Operation

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
NO_x	4.6	7.7	6.3	0.045	0.51	0.18	0.18	0.18	0.18	0.18
CO	12	19	16	0.11	1.3	0.45	0.45	0.45	0.45	0.45
SO_x	0.30	0.50	0.41	0.0029	0.033	0.012	0.012	0.012	0.012	0.012
PM_{10}	0.32	0.54	0.44	0.0032	0.036	0.013	0.013	0.013	0.013	0.013
CO_2	190	310	260	1.8	21	7.3	7.3	7.3	7.3	7.3
Aldehydes	0.080	0.13	0.11	0.00079	0.0089	0.0032	0.0032	0.0032	0.0032	0.0032
TOCs	0.86	1.5	1.2	0.0086	0.10	0.034	0.034	0.034	0.034	0.034

NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Small levels of dust (and particulate matter) would be released to the air, as well as small quantities of radionuclides. These releases are not expected to result in emissions that would exceed applicable standards. The major sources of criteria pollutants at LANL have not been historically from the environmental restoration project (see Chapter 4, Section 4.4.2.2, of this SWEIS). Continuing environmental restoration should not, therefore, result in major changes to existing compliant conditions. Nonetheless, there would be continued release of small quantities of volatile organic compounds to the air from some MDAs.

Trends have shown reductions in annual doses to the public from release of radionuclides to the air. Continuing these programs should therefore neither reverse these trends nor cause noncompliance with NESHAP.

I.5.4.1.2 Noise

Continuing the LANL environmental restoration project should result in some levels of sound perceived as noise. This would result from operation of construction equipment and vehicles. Vehicle noise would result from operation of personal vehicles and from transport of wastes and other materials. Under the No Action Option, the total number of one-way waste shipments from the environmental restoration project is estimated at about 1,000 through FY 2016. The largest number of one-way shipments (400 or about 1.6 per working day) is projected to occur in FY 2008. Therefore, the noise from continuing the current program should be similar to that resulting from the past several years in which environmental restoration has taken place at LANL.

I.5.4.2 Capping Option

I.5.4.2.1 Air Quality

Site Investigations. Site investigations under the Consent Order should have few, if any, impacts on LANL air quality.

Remediation of MDAs and Other PRSs. The Capping Option may have temporary impacts on air quality. Compared to the No Action Option, the Capping Option would require the use of additional heavy equipment that would result in additional air emissions. Pollutants including nitrogen oxides, carbon monoxide, sulfur oxide, PM_{10}, carbon dioxide, aldehydes, and total organic compounds are summarized in **Tables I–87** and **I–88** in units of tons released to the air. Table I–87 lists pollutants released for the entire Capping Option. Table I–88 lists pollutants for capping the existing Area G footprint and for capping MDAs A, B, T, and U in TA-21. Quantities released were calculated using the procedures outlined in Section I.3.6.4.

In addition, dust (and particulate matter) would be dispersed into the air from grading, earthmoving, and compaction. This could occur at the MDAs being remediated and at locations where sources of capping materials would be excavated. Dust and particulate emissions would be mitigated, however, by standard dust control measures such as water sprays.

Small levels of radionuclides may be discharged into the air from capping the MDAs because of small quantities of radionuclides and other contaminants in soil. Construction activities that abrade and loosen the soil would help to promote release. But these levels would be small and temporary. Capping would be accompanied, as needed, by installation of soil vapor extraction systems to address phases of volatile organic compounds at some MDAs (see Section I.3.3.2.2.4). As needed, vapor withdrawn from soil using the extraction systems would be treated using carbon absorption, catalytic oxidation, or other technologies.

Table I–87 Capping Option Projected Pollutant Releases to Air from Heavy Machinery Operation

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Minimum-Thickness Cap										
NO_x	20	23	52	77	190	15	160	18	160	64
CO	49	57	130	200	470	39	400	45	410	160
SO_x	1.3	1.5	3.4	5.0	12	1.0	10	1.2	11	4.1
PM_{10}	1.4	1.6	3.6	5.4	13	1.1	11	1.2	11	4.4
CO_2	790	920	2,100	3,100	7,600	620	6,500	730	6,600	2,600
Aldehydes	0.34	0.40	0.91	1.4	3.3	0.27	2.8	0.31	2.9	1.1
TOCs	3.7	4.3	9.8	15	35	2.9	30	3.4	31	12
Maximum-Thickness Cap										
NO_x	24	27	69	120	270	20	220	25	230	87
CO	61	68	170	310	690	50	560	63	570	220
SO_x	1.6	1.8	4.5	8.0	18	1.3	14	1.6	15	5.7
PM_{10}	1.7	1.9	4.8	8.5	19	1.4	16	1.8	16	6.1
CO_2	980	1,100	2,800	5,000	11,000	810	9,000	1,000	9,300	3,500
Aldehydes	0.42	0.48	1.2	2.1	4.8	0.35	3.9	0.44	4.0	1.5
TOCs	4.5	5.1	13	23	51	3.8	42	4.8	43	16

NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Grouting the General's Tanks in MDA A may result in release of small quantities of pollutants into the air, principally from operation of equipment and vehicles. Activities preliminary to grouting may result in a one-time release of small quantities of hydrogen or other gases as noted in Section I.3.3.2.2.5. Similarly, if some transuranic wastes are left in TA-54 under the option discussed in Section I.3.3.2.1.2.2, there may be some small release of pollutants into the air as part of stabilization activities (for example, grout encapsulation or in situ vitrification). Stabilization activities may result in small releases of pollutants from operation of heavy equipment. If vitrification is considered, the process would generate water vapor and organic combustion products that would be drawn into an offgas treatment system.

Otherwise, under the Capping Option, continued remediation of PRSs may release small quantities of radionuclides into the air and cause public exposures to radiation. Public doses from such releases are estimated in Section I.5.6.2.2.

Table I–88 Projected Pollutant Releases to Air from Heavy Machinery Operation from Capping Area G and Combined Material Disposal Areas A, B, T, and U

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Area G [a]										
Minimum-Thickness Cap										
NO_x	–	–	–	–	150	–	150	–	150	48
CO	–	–	–	–	370	–	370	–	370	120
SO_x	–	–	–	–	9.4	–	9.4	–	9.4	3.1
PM_{10}	–	–	–	–	10	–	10	–	10	3.4
CO_2	–	–	–	–	5,900	–	5,900	–	5,900	2,000
Aldehydes	–	–	–	–	2.5	–	2.5	–	2.5	0.85
TOCs	–	–	–	–	27	–	27	–	27	9.2
Maximum-Thickness Cap										
NO_x	–	–	–	–	200	–	200	–	200	68
CO	–	–	–	–	510	–	510	–	510	170
SO_x	–	–	–	–	13	–	13	–	13	4.4
PM_{10}	–	–	–	–	14	–	14	–	14	4.7
CO_2	–	–	–	–	8,200	–	8,200	–	8,200	2,700
Aldehydes	–	–	–	–	3.5	–	3.5	–	3.5	1.2
TOCs	–	–	–	–	38	–	38	–	38	13
Material Disposal Areas A, B, T, and U										
Minimum-Thickness Cap										
NO_x	–	–	4.1	33	22	0.16	–	–	–	–
CO	–	–	10	82	55	0.41	–	–	–	–
SO_x	–	–	0.27	2.1	1.4	0.010	–	–	–	–
PM_{10}	–	–	0.29	2.3	1.5	0.011	–	–	–	–
CO_2	–	–	170	1,300	890	6.5	–	–	–	–
Aldehydes	–	–	0.072	0.57	0.38	2.8×10^{-3}	–	–	–	–
TOC	–	–	0.77	6.1	4.1	0.030	–	–	–	–
Maximum-Thickness Cap										
NO_x	–	–	7.9	59	37	0.32	–	–	–	–
CO	–	–	24	180	110	0.95	–	–	–	–
SO_x	–	–	11	79	50	0.41	–	–	–	–
PM_{10}	–	–	0.81	6.0	3.8	0.032	–	–	–	–
CO_2	–	–	320	2,400	1,500	13	–	–	–	–
Aldehydes	–	–	170	1,200	770	6.3	–	–	–	–
TOCs	–	–	1.6	12	7.4	0.062	–	–	–	–

NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.

[a] Refers to capping the existing Area G footprint in TA-54, which includes MDA G.

Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Borrow Pit. Projected annual releases of pollutants from operation of heavy equipment at the TA-61 borrow pit, using procedures outlined in Section I.3.6.4, are listed in **Table I–89**.

Table I–89 Capping Option Projected Pollutant Releases to Air from Technical Area 61 Borrow Pit Heavy-Machinery Operation

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Minimum Thickness Cap										
NO_x	2.7	2.7	22	39	71	2.7	57	4.2	59	21
CO	6.7	6.7	54	99	180	6.9	140	11	150	53
SOx	0.17	0.17	1.4	2.5	4.6	0.18	3.7	0.27	3.8	1.4
PM_{10}	0.19	0.19	1.5	2.7	5.0	0.19	4.0	0.29	4.1	1.5
CO_2	110	110	880	1,600	2,900	110	2,300	170	2,400	850
Aldehydes	0.046	0.046	0.38	0.69	1.2	0.048	1.0	0.073	1.0	0.37
TOCs	0.50	0.50	4.1	7.4	13	0.52	11	0.79	11	3.9
Maximum Thickness Cap										
NO_x	7.3	7.3	45	94	200	7.5	160	11	160	57
CO	18	18	110	240	490	19	400	29	410	140
Sox	0.47	0.47	3.0	6.1	13	0.49	10	0.74	10	3.7
PM_{10}	0.51	0.51	3.2	6.6	14	0.52	11	0.80	11	4.0
CO_2	290	290	1,800	3,800	8,000	300	6,400	460	6,500	2,300
Aldehydes	0.13	0.13	0.80	1.6	3.4	0.13	2.7	0.20	2.8	1.0
TOCs	1.4	1.4	8.6	18	37	1.4	30	2.2	30	11

NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Potential dust levels at the borrow pit were estimated using Equation 1 from *Compilation of Air Pollutant Emission Factors*, *Volume 1: Stationary Point and Area Sources*, Section 13.2.4, "Aggregate Handling and Storage Piles (EPA 1995). An average wind speed of 2.9 meters per second and an average moisture content of 3.4 percent was assumed.[77] Also, assuming that the material would be "dropped" twice (once when piled and once when placed in a truck); assuming no controls or mitigation measures; and assuming an 8.2-foot (2.5-meter) cap at all MDAs, the largest release (1,000 pounds [450 kilograms]) of PM_{10} would occur during FY 2011. Emissions of dust and particulates would be mitigated, however, using standard dust control measures such as water sprays.

Localized emissions of criteria pollutants, particulates, and dust would be further reduced if some material was obtained from other sources.

I.5.4.2.2 Noise

Site Investigations. Site investigations under the Consent Order would cause very small noise impacts from activities such as well installation.

[77] *A moisture content of 3.4 percent was assumed from Table 13.2.4-1 of AP42 (EPA 1995). It is typical for exposed ground of western surface coal mines.*

Remediation of MDAs and Other PRSs. The Capping Option would have increased noise impacts as compared to the No Action Option. Heavy equipment would be used during site preparation and for earthmoving. The noise would depend on the equipment design and its quantity—that is, the scale of operation would depend on the size of the worksite. Issues would include the effect of noise on workers, other LANL personnel, or the public in the vicinities of the worksites. Workers would be equipped with hearing protection if the work produced noise levels above the LANL action level of 82 dBA. These measures, as well as adherence to other safe operating procedures such as training and designated worker exclusion areas, should preclude serious injuries from noise exposures. Regarding persons near the worksite, noise levels would depend on the characteristics of the equipment, separation distance, and presence of physical features that can attenuate noise, such as topography or vegetation. Heavy equipment such as front-end loaders and backhoes would produce intermittent noise levels at 73 to 94 dBA at 50 feet (15 meters) from the worksite under normal working conditions (DOE 2004b). Considering physical features, noise levels from this equipment could return to background levels within about 1,000 feet from the noise source.

Accompanying this noise would be that from trucks shipping waste to on- and offsite destinations and deliveries of cover materials. Assuming all solid waste under the Capping Option is shipped offsite, the total number of one-way shipments from FY 2007 through FY 2016 would increase from about 1,000 under the No Action Option to 7,200. Waste shipments under the Capping Option would average about 3 per day, assuming 250 working days per year. The largest number of one-way waste shipments (970 shipments) would occur during FY 2008. One-way shipments of crushed tuff, rock, gravel, and other capping materials would total from 92,000 to 191,000 over 10 years, or an average of 9,200 to 19,100 per year (37 to 76 trucks per day), depending on the thickness of cover. This increase in one-way truck traffic should be small compared with normal vehicle traffic in the LANL area. For example, a September 2004 study recorded vehicular traffic counts at several locations in the LANL region (KSL 2004). Average weekday traffic counts for selected locations were (KSL 2004):

- 9,502 vehicles per day on East Jemez Road near its intersection with NM 4
- 4,984 vehicles per day on Pajarito Road near its intersection with NM 4
- 12,185 vehicles per day on NM 502 (East Road) west of its intersection with NM 4
- 16,866 vehicles per day on Diamond Drive just south of its intersection with East Jemez Road
- 6,019 vehicles per day on West Jemez Road just south of its intersection with Camp May Road

Traffic on East Jemez Road may be heard in the trailer park on East Jemez Road. Traffic passing by the trailer park could include shipments of solid waste to the transfer station at the county landfill, and shipments of crushed tuff from the TA-61 borrow pit. (However, shipments of solid waste generated by LANL's environmental restoration project have historically been sent directly to an offsite landfill. Hence, use of the transfer station by LANL's environmental restoration project may be minimal.) The number of trucks would depend not only on the quantities of wastes shipped, or tuff delivered, but on routing decisions (for example, trucks stopping at the borrow pit from East Jemez Road may, once loaded, continue in the same direction or return in the original direction).

If all industrial solid waste under the Capping Option passes through the transfer station at the county landfill, then about 3,600 trucks containing this waste could transit East Jemez Road over 10 years, averaging 360 per year.[78] If all tuff used for capping the MDAs were to originate from the TA-61 borrow pit, and all shipments passed the trailer park, then approximately 59,000 to 155,000 one-way shipments would transit East Jemez Road over 10 years. This would average 5,900 to 15,500 per year. The largest number of one-way shipments would occur during FY 2011, when from 15,000 to 41,000 trucks containing tuff would transit East Jemez Road. Adding solid waste shipments to these tuff shipments could result in a little more than 41,000 one-way shipments in FY 2011 on East Jemez Road, or 165 trucks every working day. This increased truck traffic may be compared to the average number of vehicles on East Jemez Road (11,181 vehicles per day on workdays), as measured near the trailer park in September 2004 (KSL 2004). Assuming all trucks pass the trailer park twice (coming and going), this would be an increase of 3 percent in the number of vehicles traveling the road on a daily basis.

I.5.4.3 Removal Option

I.5.4.3.1 Air Quality

Site Investigations. Site investigations under the Consent Order are expected to have little to no impacts on air quality.

Remediation of MDAs and Other PRSs. The Removal Option may have short-term effects on air quality. Dust and particulate matter would be generated as part of MDA exhumation, backfilling, and final restoration. Release of dust into the air would be controlled using standard techniques.

This alternative would greatly reduce, if not eliminate, the potential for long-term release of volatile organic compounds from the MDAs.

The Removal Option would require use of additional vehicles and construction equipment compared with the Capping Option. Therefore, air emissions from these sources would be increased compared with the Capping Option. Estimated releases from FY 2007 through FY 2016, and from FY 2007 through FY 2011, are listed in **Tables I–90** and **91** in units of tons. The releases were estimated using the procedures outlined in Section I.3.6.4, and no reductions in release were considered for removal operations that could occur under enclosures (see below). The releases estimated in Table I–90 are for complete removal of all MDAs and other remediation activities conducted under the Removal Option, as well as capping the remaining disposal units in the existing Area G footprint, plus some small areas in TA-49. Releases estimated in Table I–91 are for complete removal of MDA G and for combined MDAs A, B, T, and U. A thick cap was assumed for both tables. Partial removal of waste and contamination from MDAs would result in reduced emissions.

---

[78] *This is unlikely because solid waste is normally sent directly to an offsite industrial landfill.*

Table I–90 Removal Option Projected Pollutant Releases to Air from Heavy-Machinery Operation [a]

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
NO_x	30	64	2,000	2,900	2,500	2,400	2,500	2,600	2,500	470
CO	74	160	5,100	7,300	6,400	6,100	6,300	6,400	6,200	1,200
SO_x	1.9	4.1	130	190	160	160	160	170	160	30
PM_{10}	2.0	4.4	140	200	180	170	180	180	170	33
CO_2	1,200	2,600	82,000	120,000	100,000	99,000	100,000	100,000	100,000	19,000
Aldehydes	0.51	1.1	35	51	44	43	44	45	43	8.2
TOCs	5.5	12	380	550	480	460	470	480	470	88

NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.
[a] Includes releases projected from placing a thick evapotranspiration cap over the remaining disposal units, at Area G, and over small areas in TA-49.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Table I–91 Projected Pollutant Releases to Air from Heavy-Machinery Operation from Removal of Material Disposal Areas G and Material Disposal Areas A, B, T, and U

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
MDA G [a]										
NO_x	–	–	1,600	2,400	2,400	2,400	2,400	2,400	2,400	440
CO	–	–	3,900	6,100	6,100	6,100	6,100	6,100	6,100	1,100
SO_x	–	–	100	160	160	160	160	160	160	29
PM_{10}	–	–	110	170	170	170	170	170	170	31
CO_2	–	–	64,000	98,000	98,000	98,000	98,000	98,000	98,000	18,000
Aldehydes	–	–	27	42	42	42	42	42	42	7.7
TOCs	–	–	300	450	450	450	450	450	450	83
MDAs A, B, T, and U [b]										
NO_x	–	28	310	370	85	0.10	–	–	–	–
CO	–	7.1	780	930	210	0.24	–	–	–	–
SO_x	–	1.8	20	24	5.5	6.2×10^{-3}	–	–	–	–
PM_{10}	–	2.0	22	26	5.9	6.6×10^{-3}	–	–	–	–
CO_2	–	1,200	13,000	15,000	3,400	3.9	–	–	–	–
Aldehydes	–	0.5	5.4	6.5	1.5	1.7×10^{-3}	–	–	–	–
TOCs	–	5.3	58	70	16	1.8×10^{-2}	–	–	–	–

MDA = material disposal area, NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.
[a] Includes releases projected from placing a thick evapotranspiration cap over the remaining disposal units in the existing Area G footprint.
[b] Includes projected releases from MDA U for completeness. No additional remediation is expected for MDA U.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Based on the above projected releases, minor to moderate increases in short-term concentrations of criteria pollutants could occur near MDA remediation activities. For MDA G removal, concentrations at the site boundary near White Rock may exceed the 1-hour and 8-hour ambient standards for carbon monoxide, and the 24-hour and annual standards for nitrogen dioxide. Also, concentrations at the site boundary near the Los Alamos townsite for combined removal of MDAs A, B, T, and U may exceed the 1-hour ambient standard for carbon monoxide and the

24-hour standard for nitrogen dioxide. Tailpipe emissions of PM_{10} from removal of MDA G would be more than 80 percent of ambient standards, conservatively assuming no reductions in release of particulate matter from use of enclosures. Appropriate management controls and scheduling would be used to minimize impacts on the public and to meet regulatory requirements.

The operation causing the largest release would be complete removal of MDA G.

The Removal Option may cause radiological exposures to the public from dispersion of radioactive material into the air and transport by wind to locations occupied by humans. Excavating, sorting, characterizing, and classifying the waste removed from the larger MDAs may be performed within enclosures (see Sections I.3.3.2.6 and I.5.6.3.2). Enclosures may not be needed for many MDAs, particularly the small ones, or for remediating other PRSs. Enclosures may be used for removal of the larger MDAs because of the types and quantities of the wastes to be exhumed and the proximity of the MDAs to occupied areas.

Exposures to the public were estimated by: (1) establishing a source term for release from each MDA, and (2) assuming that releases into the air would be transported to locations occupied by members of the public using standard sector-averaged Gaussian plume dispersion models and joint distribution frequencies appropriate for the LANL area. Estimated radiological doses are presented in Section I.5.6.3.2.

Borrow Pit. Operation of heavy equipment at the borrow pit is conservatively projected, using the procedures outlined in Section I.3.6.4, to release pollutants listed in **Table I–92**.

Table I–92 Removal Option Projected Pollutant Releases to Air from Technical Area 61 Borrow Pit Heavy Machinery Operation [a]

Pollutant (tons)	Fiscal Year									
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
NO_x	6.6	16	110	130	90	86	88	89	87	21
CO	17	40	280	340	230	220	220	220	220	53
SO_x	0.43	1.0	7.1	8.8	5.9	5.6	5.7	5.7	5.6	1.4
PM_{10}	0.46	1.1	7.7	9.4	6.3	6.0	6.1	6.2	6.1	1.5
CO_2	270	640	4,500	5,500	3,700	3,500	3,600	3,600	3,500	860
Aldehydes	0.12	0.28	1.9	2.4	1.6	1.5	1.5	1.6	1.5	0.37
TOCs	1.3	3.0	21	25	17	16	17	17	16	4.0

NO_x = nitrogen oxides, CO = carbon monoxide, SO_x = sulfur oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, CO_2 = carbon dioxide, TOCs = total organic compounds.

[a] Includes releases projected from placing a thick evapotranspiration cap over the remaining disposal units at Area G, and over small areas in TA-49.

Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Dust levels at the borrow pit were estimated using the methods discussed in Section I.5.4.1.1, assuming complete removal of waste and contamination from MDAs, and assuming that all material needed to backfill the excavated MDAs would be obtained from this borrow pit. The TA-61 borrow pit was also assumed to be the source for crushed tuff for capping the remaining disposal units within the existing Area G footprint and the small areas in TA-49. Assuming no controls or mitigation measures, the largest release of PM_{10} (700 pounds [320 kilograms]) would occur during FY 2010. Emissions of dust and particulate matter would be mitigated, however, using dust control measures such as water sprays.

Localized emissions of criteria pollutants, particulates, and dust would be further reduced if some material was obtained from other sources.

I.5.4.3.2 Noise

The Removal Option could have larger noise impacts compared with the Capping Option. The Removal Option would require more heavy equipment than the Capping Option, and there would be increased vehicle traffic. Both factors would increase background noise near the work areas.

With respect to vehicular traffic, assuming all waste generated under the Removal Option is shipped offsite, the total number of one-way waste shipments from FY 2007 through FY 2016 would be approximately 109,000, an average of 10,900 per year. The largest number of one-way waste shipments (about 22,000 shipments) would be during FY 2010. Shipments of backfill and topsoil would number up to 160,000 shipments over 10 years, or an average of 16,000 per year.[79] Thus, the Removal Option could increase traffic noise at LANL compared to the Capping Option.

Trucks on East Jemez Road may be heard in the trailer park. If all solid waste from the Removal Option passes through the transfer station at the county landfill (which is unlikely, given the existing practice of sending solid waste from environmental restoration directly to an offsite landfill), then about 9,700 one-way shipments containing this waste could transit East Jemez Road over 10 years, or about 970 per year. This averages 3.9 trucks per working day. If all crushed tuff for the Removal Option came from the TA-61 borrow pit, up to 142,000 one-way shipments of crushed tuff would transit East Jemez Road through FY 2016, assuming a thick cap for Area G and TA-49. This averages 14,200 per year (57 per working day). The largest number of shipments would occur during FY 2010, when about 26,000 one-way shipments of crushed tuff could transit East Jemez Road. As noted for the Capping Option, this increase in traffic can be compared to the average vehicular traffic on East Jemez Road of 11,181 vehicles per day during weekdays (KSL 2004). Adding solid waste shipments through the transfer station, the total shipments on East Jemez Road during the peak year, FY 2010, would approach 56,000 two-way shipments, or roughly 220 trucks per day. Assuming these trucks passed the trailer park twice each day (going and coming), this would be a 2 percent increase in the number of vehicles traveling the road on a daily basis.

I.5.5 Ecological Resources

I.5.5.1 No Action Option

LANL's environmental restoration project would continue to reduce ecological risks associated with the legacy of past LANL operations. As noted in the *1999 SWEIS*, the remaining contamination is the primary contributor to ecological health risk (DOE 1999a). In the *1999 SWEIS*, ecological risk was estimated to be very small, and no significant adverse impacts on

[79] *Includes material for backfilling and covering removed MDAs, and capping the remaining disposal units in the existing Area G footprint, plus small areas in TA-49. A thick cap is assumed.*

ecological and biological resources were projected under the Expanded Operations Alternative. The No Action Option for this appendix represents a continuation of the *1999 SWEIS* Expanded Operations Alternative. Completion of site investigations and cleanups translates to a reduction in ecological risk.

As LANL's environmental restoration project activities are undertaken, limited, short-term impacts on ecological resources are likely. The extent, duration, and intrusive nature of the remedial activity would affect the magnitude of the ecological impacts. Disturbed areas would be revegetated to restore ecological conditions. Because negative impacts are expected to be limited to short durations, the overall impact on ecological resources would be positive as contamination is removed from the environment.

I.5.5.2 Capping Option

Site Investigations. Under the Capping Option, installation of exploratory and monitoring wells (or similar investigative features) in compliance with the Consent Order would cause some impacts such as clearing of vegetation. Well drilling equipment would typically be mounted on trucks that must be positioned at the drilling locations. Well installation could require several days or more. Following well installation, vegetation would return. Sampling of wells would require periodic, but brief, occupation of the sampling locations.

Remediation of MDAs and Other PRSs. Under the Capping Option, terrestrial resources would be disturbed as the MDAs were cleared of vegetation and then capped. At most MDAs, this activity would have minimal direct impact because the MDAs are generally grassy areas enclosed by fencing. However, siting and operation of temporary support facilities could disrupt some nearby habitat over the short term, and noise and human presence during remediation could also disturb wildlife in nearby areas. Proper maintenance of equipment and restrictions preventing workers from entering adjacent undisturbed areas would be implemented, as appropriate, to lessen impacts on ecological resources. Once the MDAs are capped and revegetated, they would provide habitat similar to that existing before remedial actions were implemented: they would be fenced, grassy areas. In the case of MDA G, the current industrial environment could be replaced by an open grassy area more attractive to wildlife. This would be the case whether or not any transuranic waste currently in subsurface storage in TA-54 would be left in place.

Regarding other PRSs, because partial clearing would often be needed, such as at the 260 Outfall, there would be a loss of habitat with an accompanying loss or displacement of wildlife. Upon completion of remedial actions, the sites would be revegetated. In the long, run the sites containing the PRSs would return to a more natural condition absent further development to support LANL operations. Many PRSs such as firing sites in TA-15 may not require substantial clearing to remove contamination; thus, impacts may be restricted to short-term effects resulting from noise and increased human presence as the sites are remediated. Similar conclusions would be derived for other possible corrective reviews such as operation of volatile organic compound removal or groundwater treatment systems.

The Capping Option would have minimal impact, if any, on wetlands or aquatic resources. None of the MDAs contain such resources, as well as few, if any, of the other PRSs. Best management practices would be implemented to prevent erosion and any subsequent sedimentation of downstream wetlands or ephemeral streams.

Although some of the MDAs fall within the core and buffer zones of the Mexican spotted owl (see Section I.4.5), direct impacts on this species are not expected from remediation activities, including capping. This sensitive species would not likely be present because of the disturbed nature of the sites. Additionally, remediation activities would not result in habitat loss. Indirect impacts on the Mexican spotted owl from noise are possible where MDAs are in or near Areas of Environmental Interest. Remedial action could in some cases generate noise levels that would be greater than 6 dBA above background levels. A LANL biological assessment determined that provided reasonable and prudent alternatives were implemented, work at MDAs N, Z, A, and AB may affect, but is not likely to adversely affect, the Mexican spotted owl. Reasonable and prudent alternatives include muted back-up indicators on heavy equipment, keeping disturbance and noise to a minimum, avoidance of unnecessary disturbance to vegetation including not removing trees having a diameter at breast height larger than 8 inches (20 centimeters), reseeding and erosion protection, and ensuring that any new lighting meets the requirements of the New Mexico Night Sky Protection Act. Also, activities involving heavy equipment would not be permitted between March 1 and May 15, or until the completion of surveys for spotted owls. If owls were determined to be present, work restrictions would be extended until August 31. Remediation of other areas evaluated in the biological assessment was determined to not affect the Mexican spotted owl (LANL 2006b). The U.S. Fish and Wildlife Service (USFWS) has concurred with this assessment (see Chapter 6, Section 6.5.2).

Although MDA D is within the Area of Environmental Interest for the bald eagle, no undeveloped habitat would be disturbed. A LANL biological assessment determined that remediation activities would likely result in noise levels exceeding 6 dBA above background levels in the core zone. The biological assessment concluded that provided reasonable and prudent alternatives were implemented, remediation activities may affect, but would not likely adversely affect, the bald eagle. Reasonable and prudent alternatives include reducing noise levels, not removing trees having a diameter at breast height greater than 8 inches (20 centimeters) (that is, roost trees), and providing erosion protection and prompt reseeding of disturbed areas. For other MDAs evaluated in the biological assessment, remediation activities were determined to not affect the bald eagle (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Although TA-54 includes a portion of the southwestern willow flycatcher Area of Environmental Interest, MDAs G and L are no closer than about 450 feet (137 meters) from the core habitat. Thus, there would be no direct loss of foraging or nesting habitat. Also, a LANL biological assessment determined that noise levels should not exceed 6 dBA above background levels in the core zone. Provided reasonable and prudent alternatives were implemented, the biological assessment concluded that the project may affect, but would not likely adversely affect, the southwestern willow flycatcher. Reasonable and prudent alternatives include designing all lighting so that it would be confined to the site, keeping disturbance and noise to a minimum, implementing appropriate erosion and runoff controls, avoiding unnecessary disturbance to vegetation (including wetland vegetation) and re-vegetating when needed with native plant species, and continuing to perform annual surveys adjacent to the project area before and during remediation. The biological assessment determined that the other remediation projects that were evaluated would not affect the southwestern willow flycatcher (LANL 2006b). The USFWS has concurred with this assessment (see Chapter 6, Section 6.5.2).

Ecological risks from contaminants being reintroduced into the environment by ecological processes would be reduced. Caps over MDAs would be designed to prevent or reduce intrusion by roots or burrowing animals. The capped sites would be maintained in grassy states; shrubs and trees would be prevented from becoming established. Penetration of the waste by burrowing animals would be prevented by the design of barriers within final MDA covers. Ecological risks from contaminants at other PRSs (for example, the 260 Outfall and the firing sites) would be eliminated, if not reduced, because contamination would be stabilized, if not removed.

Borrow Pit. A portion of the 43 acres (17.4 hectares) containing the borrow pit is wooded. Greatly increased withdrawal of material from the pit may require clearing of additional acreage, thus eliminating wildlife habitat in the cleared areas. Expansion of the cleared area could also result in the removal of undeveloped buffer and core habitat for the Mexican spotted owl. Although the area is not within Areas of Environmental Interest for the bald eagle, the loss of potential foraging habitat could affect this species. The southwestern willow flycatcher Area of Environmental Interest is over 2.5 miles (4 kilometers) from the borrow pit; thus, impacts to this species are unlikely. Because expansion of the borrow pit was not evaluated in the DOE biological assessment (LANL 2006b), such an assessment, as well as consultation with the USFWS, would have to be undertaken before the expansion took place.

I.5.5.3 Removal Option

Site Investigations. Under the Removal Option, installation of exploratory and monitoring wells (or similar investigative features) in compliance with the Consent Order would cause some temporary environmental impacts such as clearing of vegetation.

Remediation of MDAs and Other PRSs. Impacts on ecological resources under the Removal Option would be similar to those described for the Capping Option. Although little habitat exists within the MDAs themselves, siting and operation of temporary remediation support facilities could disrupt some nearby habitat over the short term, and noise and human presence could disturb wildlife. This would probably occur whether removals are complete or partial. Yet once remediation actions are complete, the sites would be recontoured and revegetated. Because wastes would have been removed from the MDAs, there would be few restrictions on the types of plants that could be reintroduced. This would permit the establishment of more natural conditions that would, in turn, provide additional habitat for area wildlife.

Although remedial actions would create a disruptive environment for local wildlife in the short term, long-term impacts would be beneficial. With the removal of wastes and contamination from the MDAs and PRSs, deep-root penetration and burrowing animals would not reintroduce contamination to the environment. Thus, this option would result in long-term benefits because of reductions in contaminants.

Borrow Pit. Operation of the borrow pit would cause impacts on ecological resources that would be comparable to those under the Capping Option.

I.5.6 Human Health

This resource area addresses possible health impacts on workers and the public. Workers could be impacted by exposure to radionuclides or hazardous chemicals. Impacts on the public could result from future exposure to radionuclides from either PRS radionuclide releases or from future accidental occupation of DOE property resulting from temporary disruptions in institutional control.

Impacts on workers and the public could also result from transportation of waste or materials or from possible accidents at remediation sites. Possible transportation accidents are addressed in Section I.5.10; while accidents at remediation sites are addressed in Section I.5.12.

I.5.6.1 No Action Option

This option would continue the current program of environmental restoration.

I.5.6.1.1 Worker Impacts

There would be continuing risks to workers from exposure to ionizing radiation and hazardous chemicals. It is unlikely that these risks would be significantly larger, if at all, than current impacts and risks (see Section I.4.6). Worker radiation doses associated with the No Action Option were estimated using the procedures outlined in Sections I.3.5 and I.3.6.4. Personnel radiation exposures were estimated by calculating worker hours required to remove contaminated material and then multiplying these hours by an assumed average radiation dose environment. To these exposures were added those from waste processing and loading onto trucks. From FY 2007 through FY 2016, the total worker dose using this procedure was estimated to be 0.25 person-rem, or an LCF risk of 1.5×10^{-4}. From FY 2007 through FY 2011, the total worker dose was estimated to be 0.24 person-rem, or an LCF risk of 1.4×10^{-4}. In addition, workers could receive radiation doses from proximity of the PRSs being addressed to other LANL radiation sources. The total dose experienced by an environmental restoration worker could range up to several tons of millirem per year.

I.5.6.1.2 Public Impacts

There would be essentially no risk to the public from waste disposed of in the MDAs and contamination in the other PRSs for as long as DOE maintains control of the property and continues its surveillance and monitoring programs. But at some time in the future, there could be lapses in institutional controls and surveillance and monitoring programs. If this occurs, the largest risks to the public would result from accidental improper or unauthorized use of the property. Analyses for operation of low-level radioactive waste disposal facilities have long included assessments of radiological impacts on persons (inadvertent intruders) that have temporarily used property for activities such as housing construction or backyard gardening. In these assessments, intruders are assumed to excavate into the waste, thus contacting it and bringing it to the surface where it could be incorporated into the soil. Exposures could occur while the waste is inadvertently excavated and afterwards as persons use the property contaminated with radionuclides or organic or inorganic chemicals.

Inadvertent intruder scenarios are commonly addressed in performance assessments for low-level radioactive waste disposal facilities, including those performed for Area G in TA-54 (LANL 1997). Impacts on potential future inadvertent intruders have also been addressed as part of a No Action Alternative for the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a). As addressed in Section I.3.3.2.1.2.2, this No Action Alternative (not proposed or adopted by DOE) considered leaving all buried and stored transuranic waste in place at DOE generator-storage sites, including LANL. Impacts on intruders were assessed and included impacts of nonretrieval of remote-handled waste such as that in shafts 200 through 233 in Area G in TA-54.

I.5.6.2 Capping Option

I.5.6.2.1 Worker Impacts

There would be somewhat increased radiological doses received by site workers compared to the No Action Option. Worker doses from implementing the site investigations program under the Consent Order should be very small. Compared to the No Action Option, additional worker doses could result from capping the MDAs and annually remediating several PRSs. Using the procedures for estimating worker doses outlined in Sections I.3.5 and I.3.6.4, for FY 2007 through FY 2016, the total additional worker dose ranged from 9.7 to 13 person-rem, depending on whether a thin or thick cap was emplaced. This worker dose corresponds to an LCF risk ranging from 5.8×10^{-3} to 7.8×10^{-3}. For FY 2007 through FY 2011, the total additional worker dose ranged from 4.6 to 6.3 person-rem, and the LCF risk ranged from 2.8×10^{-3} to 3.8×10^{-3}.

In addition, small radiation doses to workers may result from actions associated with grouting the General’s Tanks in MDA A or optionally stabilizing in place the transuranic waste currently stored in shafts 200-232 in Area G.[80] Operation of the TA-61 borrow pit to support MDA capping would not cause radiation exposures to borrow pit workers.

Risks to workers from possible exposure to hazardous or toxic chemicals would continue to be minimized through training, administrative controls, monitoring, and proper use of equipment.

I.5.6.2.2 Public Impacts

Site Investigations. Site investigation under the Consent Order should have no effects on public health.

Remediation of MDAs. Although the waste and contamination in the MDAs would remain in place, future risks to the public would be reduced. The improved covers would reduce infiltration of water into the waste, which would reduce the potential for release of radionuclides and hazardous constituents into the environment. The improved covers would also reduce the

[80] *In neither case are large worker doses expected. For example, the contents of a buried 50,000-gallon tank were mixed and removed at Oak Ridge National Laboratory using a fluidic pulse jet mixing system similar to the system considered for the General’s Tank in MDA A. Although the tank contained sludge that had a larger inventory of activation and fission products than that expected to be in the General’s Tanks (the sludge was, in fact, considered to be remote-handled material), the total radiation dose received by workers for the entire removal project was 1.23 person-rem, which was smaller than the planned dose of 4 person-rem estimated in the projected ALARA (as low as reasonably achievable) plan (ORNL 1998).*

potential for dispersion of contaminated materials currently existing as hotspots in soil, and as brought to the surface from burrowing animals.

The Capping Option would generally result in increased thicknesses of rock, tuff, and soil over the MDAs. This would reduce the risk to future potential inadvertent intruders. A larger thickness of cover implies less chance of contaminated material being contacted from future inadvertent intrusion into disposal units; if the contaminated material is contacted, less would be brought to the surface for dispersal and possible human exposure.

However, capping the MDAs would require the use of heavy equipment that would result in emissions of air pollutants, including criteria and hazardous contaminants. Particulate matter would be dispersed into the air from grading, earthmoving, and compaction at the MDA sites. These emissions could result in minor-to-moderate increases in short-term concentrations of criteria pollutants near the MDAs.

Remediation of Other PRSs. The Capping Option would result in removal of contaminated materials at numerous PRSs. At other PRSs, existing contamination would be fixed in place. Recovery of contamination at various PRSs at LANL may cause small quantities of radionuclides being released to the air that would cause public exposures to radiation. These exposures were estimated using the procedures described in Section I.5.6.3.2. The results of this assessment are an annual MEI dose of up to 7.5×10^{-3} millirem and an annual population dose of up to 1.8×10^{-2} person-rem. Operation of heavy equipment to remove contamination would release small quantities of nonradioactive pollutants into the air.

Borrow Pit. Operation of the borrow pit will entail the use of heavy equipment that would cause the emission of pollutants such as those addressed in Section I.5.4.2.1. In addition, particulate matter would be dispersed into the air from excavating bulk materials for MDA capping. These emissions may result in increases in short-term concentrations of pollutants near the boundary of the borrow pit.

I.5.6.3 Removal Option

I.5.6.3.1 Worker Impacts

Possible risks to site workers from the site investigations program from possible exposure to radiation or chemically toxic or hazardous materials would again be small.

Regarding remediation of MDAs and PRSs, the Removal Option would result in larger radiation doses to site workers than the Capping Option. Worker doses were estimated using the procedures outlined in Sections I.3.5 and I.3.6.4. Compared to the No Action Option, for FY 2007 through FY 2016, the total additional worker dose was estimated as 1,400 person-rem, assuming a thick cap over the remaining disposal units in the existing Area G footprint, and over small areas in TA-49. This results in an LCF risk of 0.84. For FY 2007 through FY 2011, the total additional worker dose was estimated as 580 person-rem, resulting in an LCF risk of 0.35. These estimates reflect the assumption of complete removal of waste from MDAs. Partial removal of waste from MDAs would result in smaller doses and risks to workers. Doses and risks could be reduced in practice using standard radiation protection techniques. The bulk of the doses and LCF risks would be from complete removal of MDA G. Operation of the borrow pit to support MDA removal would not result in radiation doses to borrow pit workers.

Compared with the Capping Option, the Removal Option could result in increased risks to site workers from exposure to hazardous or toxic chemicals. These risks would be minimized through training, administrative controls, monitoring, and proper use of equipment.

I.5.6.3.2 Public Impacts

The Removal Option would reduce long-term risks to members of the public from either contaminants released slowly over time or inappropriate uses of the sites assuming temporary future accidental breakdowns in institutional control. The bulk of the contamination within and near the MDAs would be removed, and remaining contamination would be stabilized in place. Contamination at other PRSs would also be removed or stabilized in place.

Site Investigations. The site investigations programs under the Consent Order should not affect public health.

Radiological Emissions from Remediation of MDAs and Other PRSs. MDA removal would cause short-term radiological doses to the public from release of radionuclides into the air. To estimate these radiological doses:

- Transport through the air pathway to the public was modeled using the Clean Air Act Assessment Package – 1988 (CAP88-PC), Version 3.0. (See Appendix C of the SWEIS for further information on the CAP88-PC model.)

- Radiological doses and risks to the public were modeled using exposure and environmental transfer assumptions embedded in CAP88-PC. Exposures included external exposures from immersion in a radiological plume, inhalation and ingestion exposures, and exposures following deposition of contamination on the ground and surfaces, including resuspension and food transfer pathways. The public was assumed to take no measures to avoid radiation doses.

- Air emissions from removal of large MDAs were modeled as individual release sites. These MDAs included MDA A, B, T, U, AB, C, and G. Schedules for removal of these MDAs were conservatively assumed to comply with the remedy completion schedules in the Consent Order. Complete removal of waste and contamination was assumed.

- Remediation needs and schedules for other LANL PRSs are uncertain. Airborne releases were modeled by assuming that contamination is removed from an assumed area of property at LANL annually. The mechanical stresses imposed on the contaminated property were assumed to disperse contamination into the air.

It was assumed that during removal, a fraction of the radioactive inventory within the MDAs would be released into the air. The total source term for release was given as:

$$\text{Source Term (picocuries per year)} = \text{Total MDA Inventory (curies)} \times \text{Fraction Released}$$

The inventories for the MDAs were developed using several information sources. For some MDAs, although historical information indicated that particular isotopes may have been disposed of, disposed quantities were lacking. In these cases, the inventories were estimated by scaling to known inventories in MDA G. In addition, a documented safety analysis was issued in 2004 for nuclear environmental sites (LANL 2004l). The analysis performed for this documented safety analysis reconsidered earlier information, and better accounted for the initial presence of plutonium-241 and the ingrowth of its progeny, americium-241. Where different inventories from different references could be assumed for some MDAs, doses (MEI and population within 50 miles) were calculated for each inventory, and the more conservative inventory (the one resulting in the larger dose) was used. In addition, because many MDAs have several radionuclides in their inventories, a screening process eliminated those radionuclides that contributed minimally (less than 1 percent) to the total dose. This screening resulted in those radionuclides having the largest health impacts being modeled. The postscreening inventories for each of the MDAs (and the combined PRS area) are listed in **Table I–93**.

The fraction of the inventory that would be released was generally assumed to be represented by PM_{10}. A conservative release fraction of 10^{-4} was assumed. Volatile radionuclides such as C-14, radon isotopes, and iodine were conservatively assumed to be all released (release fraction = 1). The release fraction for tritium was assumed to be 0.01 for MDA G and unity for other MDAs.

It is believed that very little of the tritium disposed of in the MDAs was disposed of in a gaseous form (as in vials of tritium gas). Rather, most tritium was disposed of as an absorbed liquid (generally tritiated water) or otherwise solid objects such as pumps. The great bulk of the tritium disposed of at LANL was disposed of within shafts within Area G at TA-54. Early disposals of large quantities of tritium were within asphalt-lined drums that were emplaced, rather than dropped, within the shafts (Rogers 1977). The largest quantities of tritium were double-packaged (one asphalt-lined and sealed drum within another). Shafts containing large quantities of tritium were asphalt-lined (Rogers 1977). Starting in the 1990s, disposal was within stainless steel containers.

Although many of the drums containing the tritium may have corroded to the point that there are leak paths from the drum interior to the environment, it is expected that the drums would still be sufficiently intact that widespread gross wall failures would be uncommon. Hence, the drums would largely retain their overall integrity during removal. In addition, it is expected that removal of waste from those shafts containing large quantities of tritium would be controlled in a manner sufficient to safeguard worker and public safety and the environment.

A release fraction of unity was assumed for tritium disposed of in other MDAs because of uncertainties about the form of the waste and the packaging used (if any).

All MDAs were modeled assuming that removal occurred with and without enclosures. For those MDAs assumed to be exhumed without enclosures, an area source was modeled. For such MDAs, it was assumed that, at any given time in the exhumation of an MDA, an area no larger than 100 square meters would be disturbed. The area source was modeled with zero velocity and zero height to the air emissions.

Table I–93 Screened Inventories of Radionuclides Within Large Material Disposal Areas and the Combined Potential Release Site Area [a]

Radionuclide (curies)	*MDA A (TA-21)*	*MDA B (TA-21)*	*MDA T (TA-21)*	*MDA U (TA-21)*	*MDA AB (TA-49)*	*MDA C (TA-50)*	*MDA G (TA-54)*	*Combined PRS*
Americium-241	6.14	6.55	3,740		6,570	140	2,140	0.130
Cobalt-60	–	–	–	–	–	8.42	480	
Cesium-137	–	–	–	–	–	–	726	4.7×10^{-4}
Plutonium-238	0.266	9	31.3	0.414	2,990	6.7×10^{-9}	3,590	0.14
Plutonium [b]	55.5	7.65	161	6.59	2,830	–	2,370	0.335
Plutonium-241	78.9	–	37,400	–	3,370	82.9	–	–
Strontium-90	–	–	–	–	–	12	1,040	0.013
Tritium	–	252	–	4.34	0.917	16,800	472,000	0.047
Uranium [c]	3.95	0.22	6.9	–	0.258	29.5	68	0.442

MDA = material disposal area, TA = technical area, PRS = potential release site.
[a] The screening process eliminated those radionuclides contributing less than one percent of the total dose.
[b] Plutonium may include plutonium-239 and plutonium-240.
[c] Uranium may include uranium-233, uranium-234, uranium-235, uranium-236, or uranium-238.
Inventory sources:
MDA A – LANL 2004l for General's Tanks. For Eastern and Central Pits, available information (for example LANL 1991) identifies disposed radionuclides but not quantities. Hence, for these pits, the radionuclide inventories were scaled from known inventories in MDA G (LANL 1997).
MDA B – For plutonium-239, assumed 6.22 curies from LANL 1999b, DOE 1999g, and LANL 2004l, and added an estimated 1.45 curies of plutonium-240. For plutonium-240 and other radionuclides, because available information (Rogers 1977; LANL 1991, 1999b, 2004d) did not provide quantities, inventories were scaled from known inventories in MDA G (LANL 1997). A 2007 document estimates a plutonium-239 inventory ranging from 1.5 to about 15 curies, with an estimated 7.08 curies at the 50th percentile and 10.6 curies at the 90th percentile. The inventory in interstitial soil and backfill is estimated to be 4.53 curies at the 50th percentile and 5.87 curies at the 90th percentile. The remaining inventory is distributed among gloves, personal protective equipment, glassware, lab debris, and liquid containers (LANL 2007g), and would be expected to be less subject to airborne dispersal during normal removal operations than the inventory in the interstitial soil and backfill.
MDA T – LANL 2004l.
MDA U – The original inventory was estimated from available information (LANL 1991, 2004k). Some radionuclides were scaled from known inventories in MDA G (LANL 1997). Two-thirds of the original inventory was assumed removed in 1985. The Removal Option for MDA U is unlikely, because NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).
MDA AB – Most radionuclides estimated from *RFI Work Plan for Operable Unit 1044* (LANL 1992b). Americium-241 was decayed from the cited inventory of plutonium-241. Inventories of plutonium-238 and plutonium-242 were scaled from known inventories in MDA G (LANL 1997).
MDA C – Radionuclide inventories were developed from data from LANL 1992c, LANL 2003k, Rogers 1977, and DOE 1999g.
MDA G – LANL 1997.
Combined PRS – Scaled from known inventories of contaminated soil disposed of into MDA G (LANL 1997).

Release of radionuclides from enclosures was modeled as a point source assuming a representative enclosure for all MDAs.[81] (Enclosures would be relocated as needed.) The assumed enclosure has dimensions of 150 by 300 feet (46 by 91 meters), with a minimum height of 20 feet (6.1 meters) at the structure eaves. Assuming an elliptically domed roof having flat sides and a maximum height under the dome of about 40 feet (12 meters), the interior volume of the structure would be 1.25×10^6 cubic feet (35,400 cubic meters).

[81] *Additional engineering work would be needed to arrive at optimum numbers, sizes, configurations, and relocation schedules for the removal enclosures.*

The ventilation system for the enclosure would be designed to provide sufficient air exchange to ensure that airborne concentrations would not exceed derived air concentration limits over a given period of time, based on a conservative estimate of entrainment of contaminants from the digface. It was assumed that the ventilation system would exhaust through a roughing filter and at least one HEPA filter before discharge through a 20-foot-high (6.1-meter-high), 36-inch-diameter (0.91-meter-diameter) stack. A 99.95 percent removal efficiency was assumed.[82] The flow rate out the stack was assumed to be 20,000 cubic feet per minute, corresponding to an average air exchange rate within the enclosure of once per hour. This flow rate was converted to 14.4 meters per second by dividing by the cross-sectional area of the stack.

When determining the distance and direction from each MDA to the MEI, the land parcels that are designated as "To Be Conveyed" were considered. For additional CAP88-PC input, the same meteorological, population, and agriculture values and data were used here as in Appendix C of this SWEIS. (The location [latitude and longitude] that was used for each MDA is available in the administrative record.)

In addition to the MDAs addressed above, it was assumed that each year from FY 2007 through FY 2016, several small PRSs would be remediated at different locations within LANL. There may be several options for remediation, including removing, treating, or stabilizing contamination at a site. It was assumed that some of these remediation activities would annually cause release of radionuclides to the air from mechanical disturbance of soil, sediment, or other property. To estimate this release, a single PRS combined area was assumed to represent the annual remediation of several PRSs. The radioactive inventory subject to disturbance was estimated by extrapolating the radionuclide inventory in "contaminated soil," as reported disposed of in Area G from 1971 through September 25, 1988 (LANL 1997). The average radionuclide concentrations from this inventory, which was contained within 47,000 cubic yards (36,000 cubic meters) of disposed contaminated soil, was extrapolated to an assumed annual radiologically contaminated volume of 5,200 cubic yards (4,000 cubic meters).[83] Because of the large number of PRSs within TA-35 (see Section I.2.7.7), the location of the combined PRS area was assumed to be within TA-35.

The results of the analysis are presented in **Table I–94** for complete removal of waste from the large MDAs. The annual dose was calculated by dividing the total dose from MDA removal by the number of years needed to exhume the entire MDA. Smaller doses are expected from partial removal of waste from the MDAs. The annual MEI dose associated with the combined PRS area would be 7.5×10^{-3} millirem, and the annual population dose would be 1.8×10^{-2} person-rem.

---

[82] A single HEPA filter has a nominal rating of 99.97 percent efficiency for particulate removal, as designed and tested for 0.3-micrometer (1.2×10^{-6}) aerodynamic-equivalent diameter. This is equivalent to a leak rate of 3×10^{-4}. In practice, however, a lower level of efficiency is often assumed. Assuming an efficiency of 99.8 percent for one HEPA filter, and an efficiency of 99.7 percent for a second HEPA filter, the particulate release rate for two filters would be 6×10^{-6}. For purposes of this analysis, a more conservative release rate of 5×10^{-4} (99.95 percent efficiency) was used.

[83] Pit inventories from 1971 through September 1988 are provided in Table 3-8 of Appendix 2e of the 1997 Area G performance assessment and composite analysis (LANL 1997). Contaminated soil inventories were obtained from this table, and disposed volumes were obtained from Table 3-7 of this reference. The estimate of 5,200 cubic yards (4,000 cubic meters) was estimated assuming annual waste generation rates from remediating several PRSs. The inventory used for the analysis conservatively reflect the possibility that all waste removed from PRSs in any single year may be radioactively contaminated.

Table I–94 Annual Dose Estimates from Complete Removal of Large Material Disposal Areas

MDA	*Removal Period (years)*	*Individual MDA MEI Dose (millirem per year)* [a]	*Dose to LANL MEI* [b, c] *(millirem per year)*	*Population Dose (person-rem per year)* [c]
MDA A	1.8	0.0013 to 7.1	0.000097	0.00066
MDA B [d]	2.4	0.062 to 50	0.0081	0.024
MDA T	2.0	0.064 to 310	0.0043	0.036
MDA U [e]	0.8	0.0025 to 1.9	0.047	0.31
MDA AB	2.1	0.030 to 85	0.0017	0.056
MDA C	1.8	0.45 to 1.2	0.34	5.5
MDA G	6.8	0.18 to 97	0.012	0.25
Total	Not applicable	Not applicable	0.42	6.2

MDA = material disposal area, MEI = maximally exposed individual.

[a] A different MEI was assumed for removal of each MDA. The smaller dose for each MDA is for removal assuming use of an enclosure; the larger dose is for removal assuming no use of an enclosure.

[b] Total dose of the LANL MEI was conservatively estimated by assuming that all listed MDAs would be removed during an overlapping period of time, which would probably not actually occur.

[c] Doses are based on using enclosures except at MDAs C and U.

[d] Due to the high potential dose to the MEI, an enclosure would be used at MDA B. Consequently, even if the plutonium inventory were higher (see Table I–93), the offsite doses would be low.

[e] The Removal Option for MDA U is unlikely, because NMED has issued a Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).

Note: Numbers have been rounded.

The MEI location for each MDA was calculated separately. Those MEI locations for the four MDAs at TA-21 are very close. The other MDAs are relatively distant from one another. In this table, the “Individual MDA MEI Dose” is to the MEI associated with each MDA removal. The smaller dose would be received if the MDA is removed under an enclosure. If the MDA is exhumed without an enclosure, the MEI would receive the larger dose.

Because the MEI locations for the TA-21 MDAs are so close, the total dose to that MEI (MDAs A, B, T, and U) was assessed assuming that all removals occurred at the same time under enclosures (0.13 millirem per year). If removal of MDA U occurred, which is unlikely (see footnote c to Table I–94), and without use of an enclosure, the dose to the TA-21 MEI would increase to 2 millirem (1.9 millirem for MDA U plus the lower doses for MDAs A, B and T) in a year assuming the release assumptions and the inventory presented in Table I–93. If MDA A was also exhumed without the use of an enclosure, the dose to the TA-21 MEI could potentially exceed the 10-millirem public dose limit (7.1 millirem for MDA A plus 1.9 millirem for MDA U plus 1.5 millirem dose to TA-21 from operations at LANSCE). Notwithstanding this assessment, LANL would be operated, and remediations conducted, to ensure compliance with the 10-millirem public dose limit.

In addition to addressing doses to each MEI associated with large-MDA removal, the impacts of MDA removal on the LANL site-wide MEI were analyzed. Each MDA could add to the LANL site-wide MEI dose. In Table I–94, the doses to the LANL site-wide MEI were calculated separately. Doses from removal of MDA U and MDA C were calculated without use of enclosures because their contribution to the LANL site-wide MEI dose would be small. (Total doses to the LANL MEI from all sources are summarized in Chapter 5 of the SWEIS.)

When calculating the dose to the population within 50 miles (80 kilometers) of each MDA, it was assumed that MDA U and MDA C would be exhumed using no enclosures. All other large MDAs would be removed under enclosures. As much as an additional 6.2 person-rem per year would be attributed to the LANL population dose if all large MDAs were exhumed at the same time.

Nonradiological Emissions from Remediating MDAs and Other PRSs. The Removal Option would require the use of heavy equipment, resulting in emission of pollutants to the air, including criteria and hazardous pollutants. At some MDAs, these activities would be of longer duration than typical LANL construction activities and could involve extensive movement of materials. The overall emissions from heavy equipment under the Removal Option would be more than 20 times those under the Capping Option. As noted in Section I.5.4.3.1, emissions of some pollutants could be above 1-hour and 8-hour ambient standards. These emissions could be reduced by management controls such as scheduling so that public impacts would be minimized.

Borrow Pit. Operation of the borrow pit under the Removal Option could result in emissions of pollutants and particulate matter that would be comparable to those estimated for the Capping Option. Particulate emissions would be controlled using standard dust control techniques such as water sprays. Emissions could be controlled by management controls such as scheduling.

I.5.7 Cultural Resources

A variety of cultural resources are present within or near LANL boundaries, including archaeological resources, historic buildings and structures, and traditional cultural properties.

I.5.7.1 No Action Option

Under the No Action Option, there would be small risks to cultural resources at any of the TAs within which MDAs and PRSs are located, as the LANL environmental restoration project continues. These small risks would be managed using existing procedures.

I.5.7.2 Capping Option

Site Investigations. Installation of monitoring wells or other site investigation equipment under the Consent Order would be coordinated with LANL personnel responsible for preservation of cultural resources, with the objective of avoiding impacts on cultural resources. Usually there is sufficient flexibility in the selection of sites for investigation equipment so that impacts on cultural resources can be avoided.

Remediation of MDAs and Other PRSs. Under this option, the MDAs would be cleared of vegetation before being capped. Because no archaeological resources are within any of the MDAs, the Capping Option would not directly impact such sites. This would also be the case for actions involving grouting the General's Tanks in MDA A (see Section I.3.3.2.2.5) or actions performed to provide additional stabilization to any transuranic waste left in place in TA-54, if this option is implemented (see Section I.3.3.2.1.2.2).

Risks to cultural resources for other PRSs would depend on the PRS. In most cases, there would be few or no risks to cultural resources. At sites where there may be questions about risks, remediation operational plans and procedures would be coordinated with LANL personnel responsible for preservation of cultural resources. For example, one building eligible for listing in the National Register of Historic Places is within the R-44 firing site (SWMU 15-006(c)); however, this building would not be disturbed by remediation activities involving surface recovery of contamination.

Indirect impacts on cultural resources of remedial actions are possible because of increased erosion resulting from capping operations or PRS remediation and from workers or equipment occupying the work area. In those cases where archaeological resource sites and historic buildings and structures are located near work areas, LANL personnel responsible for preservation of cultural resources would be notified so that site boundaries could be marked and fenced, as needed (LANL 2006l). Fencing would prevent accidental intrusion and disturbance to the site. Best management practices would control erosion.

Borrow Pit. There are no archaeological resources in the immediate vicinity of the borrow pit in TA-61.

I.5.7.3 Removal Option

Site Investigations. Possible impacts on cultural resources of site investigations under the Consent Order would be the same as those under the Capping Option.

Remediation of MDAs and Other PRSs. Potential impacts under this option would be similar to those addressed for the Capping Option. Direct impacts on cultural resources would be unlikely. The potential for indirect impacts also would be similar to that under the Capping Option. As with that option, LANL personnel responsible for preservation of cultural resources would be notified so that any resource sites located near the affected areas would be protected. These conclusions would apply whether complete or partial removal occurred at the MDAs.

Borrow Pit. There are no archaeological resources in the immediate vicinity of the borrow pit in TA-61.

I.5.8 Socioeconomics and Infrastructure

I.5.8.1 No Action Option

Under the No Action Option, existing employment practices for LANL's environmental restoration project would continue, with contractor labor providing much of the support for site investigation and remediation. LANL's environmental restoration project currently employs 45 to 50 University of California and captive contractors,[84] along with 250 subcontractors who support various tasks at various levels (LANL 2006a). This may be compared with the total employment at LANL, which is currently about 13,500 employees (see Section I.4.8.1). Using the procedures outlined in Sections I.3.5 and I.3.6.4, total personnel hours were estimated through FY 2016 for removal of contaminated material from PRSs as part of the No Action Option. This estimate is 50,000 person-hours through FY 2016 (48,000 person-hours through FY 2011). Utility usage (electricity, natural gas, water) would not be significantly affected by

[84] *A DOE captive contractor is one that engages in little or no commercial business outside its work for DOE.*

continuing environmental restoration project operations. Roughly 75,000 gallons (280,000 liters) of liquid fuel (diesel and gasoline) would be required to operate heavy equipment for continuing site remediation through FY 2016.

I.5.8.2 Capping Option

Under the Capping Option, a higher density of remedial activities would occur through FY 2016 compared to the No Action Option. Including operations at the TA-61 borrow pit, carrying out the Capping Option is projected to require 1,400,000 to 2,200,000 person-hours through FY 2016 (680,000 to 1,100,000 person-hours through FY 2011). Assuming 2,000 hours per year per worker, the Capping Option would require the full-time efforts of an average of 70 to 110 workers per year.

Use of electricity or natural gas would likely be only marginally increased compared to the No Action Option. Roughly 3.9 to 6.7 million gallons (15 to 25 million liters) of liquid fuel (diesel and gasoline) may be needed through FY 2016 to operate heavy equipment under the Capping Option.

Compared to the No Action Option, additional water would be required, mainly for soil compaction at the MDAs and dust suppression at the MDAs and borrow pit. Implementing the Capping Option could require from 20 to 53 million gallons (76 to 200 million liters) of water from FY 2007 through FY 2016, with the largest annual quantity of water (roughly 5 to 14 million gallons [19 to 53 million liters]) needed during FY 2011.

I.5.8.3 Removal Option

Under the Removal Option, a very high density of remedial activities would conservatively occur through FY 2016 compared to the No Action Option. Under the Removal Option, complex and cost-intensive excavation processes would provide local economic benefits.

Including operations at the TA-61 borrow pit, and capping areas in TA-54 and TA-49, carrying out the Removal Option is projected to require up to 36 million person-hours through FY 2016 (16 million person-hours through FY 2011), assuming complete removal of waste from MDAs and covering the remaining disposal units in the existing Area G footprint with a thick cap. Assuming 2,000 hours per year per worker, the Removal Option would require the full-time efforts of an average of 1,800 workers per year.

Utility use may be affected. Significant additional volumes of waste would be generated, and it may be necessary to develop additional capacity to sort, characterize, treat, and package all the waste to be removed (see Section I.3.3.2.8 and Section I.5.9.3). Use of this additional capacity would increase utility infrastructure demands at LANL. Operation of heavy equipment for exhuming MDAs and performing other actions under the Removal Option is projected to require use of up to 70 million gallons (260 million liters) of liquid fuel (diesel and gasoline) through FY 2016. Water use through FY 2016 would be comparable to that under the Capping Option, or up to 58 million gallons (220 million liters).

I.5.9 Waste Management

I.5.9.1 No Action Option

The quantities of solid, chemical, and radioactive wastes to be generated would generally be consistent with, if not smaller than, previous projections of waste for continued operation of LANL. There should be no difficulty in accommodating the waste in existing on- and offsite low-level radioactive waste treatment and disposal facilities. Solid waste disposal capacity exists in nearby locations in New Mexico. Chemical waste treatment and disposal capacity exists at several locations within 600 miles of LANL. Low-level radioactive waste disposal capacity exists at LANL, and offsite capacity exists for the relatively small quantities of mixed low-level radioactive waste projected from LANL's environmental restoration project.

The expansion of low-level radioactive waste disposal operations into Zone 4 would accommodate the low-level radioactive wastes to be generated by LANL's environmental restoration project for the foreseeable future. Using the onsite disposal capacity in conjunction with possible use of offsite disposal capacity would allow flexibility to address short-term increases in waste generation from planned environmental restoration activities.

Only very small quantities of transuranic waste would be generated by LANL's environmental restoration project. Quantities of environmental restoration project wastes contaminated with high explosives are expected to be small compared to other sources at LANL.

Otherwise, LANL's environmental restoration project is not expected to generate liquid wastes (industrial, hazardous, radioactive) in volumes that would impact existing LANL treatment capacity. Because the No Action Option is not expected to significantly increase personnel needs at LANL, there would be no impact on LANL's capacity to treat sanitary wastes.

I.5.9.2 Capping Option

Although the Capping Option may cause generation of somewhat larger quantities of solid, liquid, and sanitary wastes compared with the No Action Option, impacts on LANL's waste management infrastructure should be small. Solid waste disposal capacity exists in nearby locations in New Mexico. Chemical wastes would be transported offsite for treatment and disposal. Quantities of environmental restoration wastes contaminated with high explosives should be small compared to several other sources at LANL.

Low-level radioactive waste disposal capacity exists at LANL and offsite, and would not be significantly impacted by the expected waste volume under this option. Offsite capacity exists for the relatively small quantities of mixed low-level radioactive waste projected from LANL's environmental restoration project. Only small quantities of transuranic waste would be generated by LANL's environmental restoration project and would not significantly increase current transuranic waste generation rates. Impacts on WIPP would hence be small.

Otherwise, compared to the No Action Option, LANL's environmental restoration project would generate somewhat larger quantities of liquid wastes (industrial, hazardous, radioactive), but not in quantities that by themselves would tax existing LANL treatment capacity. Because the

Capping Option is not expected to significantly increase personnel requirements, compared to the No Action Option, LANL's capacity to treat sanitary wastes should not be impacted.

I.5.9.3 Removal Option

The Removal Option would result in large quantities of wastes being excavated, requiring sorting, characterization, classification, treatment, packaging, shipment, and disposal. The material would include physically or chemically hazardous materials, and some would present external exposure or inhalation hazards. This may require development of additional waste management capacity as discussed in Section I.3.3.2.8. Development and use of this capacity would require increased use of utilities such as gas, water, or electricity, increased use of natural resources, and larger personnel requirements. These impacts would occur for the time required to remove and process the waste from the MDAs. Any structures constructed and used for this purpose would have to be safely decommissioned, which could generate additional quantities of waste to be treated, packaged, shipped, and disposed of.

Compared with the Capping Option, the Removal Option would generate much larger quantities of low-level radioactive waste—about 1 million cubic yards of bulk, alpha-contaminated, and remote handled wastes. About 180,000 cubic yards of mixed low-level radioactive wastes would also be generated. Low-level radioactive wastes would be generated from the environmental restoration program at annual rates that would exceed current plans for annual waste acceptance at Zone 4 of TA-54. The Zone 4 disposal capacity could be used within a shorter period of time than planned, requiring sooner expansion into Zone 6. Use of offsite disposal capacity would alleviate these impacts.

The amount of transuranic waste that would be exhumed from the MDAs is significant. WIPP personnel would need to review this potential waste stream to determine if its acceptance would remove future flexibility for WIPP to manage other new waste streams.

The significantly increased volumes of solid and chemical wastes would be transported offsite for treatment or disposal. In addition, compared to existing levels, the greatly increased personnel requirements for waste removal would cause increased sanitary system loads.

I.5.10 Transportation

Risks to the public could result from transportation of waste or bulk materials. Risks from transporting waste could include those from radiation exposures under normal transport conditions or from possible accidents resulting in physical injury or radiation exposure from release of radioactive material.

I.5.10.1 No Action Option

There would be continuing use of transportation systems within and near LANL. The transportation implications of continuing the LANL environmental restoration project would generally be comparable with those projected under the Expanded Operations Alternative of the *1999 SWEIS* (DOE 1999a).

I.5.10.1.1 Onsite Impacts

The No Action Option should not significantly affect existing traffic patterns within LANL. There would be some impacts associated with transporting low-level radioactive waste to onsite disposal facilities. These impacts are addressed in Section I.5.10.1.2.

I.5.10.1.2 Offsite Impacts

Transportation impacts were determined for the No Action Option using the annual projected waste volumes set forth in Section I.3.6 and the analysis assumptions described in Section I.3.5. Shipment crew and population radiation doses and risks from incident-free transportation and radiological and nonradiological risks from possible transportation accidents are presented in **Table I–95**. The table presents total doses and risks from FY 2007 through FY 2016, total doses and risks from FY 2007 through FY 2011, and the doses and risks for the peak year (2008).

These impacts were determined assuming that all nonradioactive wastes would be sent to offsite facilities, all transuranic wastes would be sent to WIPP, and all low-level and mixed low-level radioactive wastes would be sent to an offsite commercial disposal facility such as the one in Utah. Impacts of incident-free transport are presented in terms of the collective dose in person-rem resulting in excess LCFs. Excess LCFs are the number of cancer fatalities that may be attributed to the proposed project that are estimated to occur in the exposed population over the lifetime of the individuals. If the number of LCFs is smaller than one, the subject population is not expected to incur any LCFs. Impacts of possible transportation accidents are presented in terms of population risks (LCFs) from exposure to releases of radioactivity and fatalities anticipated from traffic accidents. Accident fatalities were estimated from exposure to radiation (LCFs) and from nonradiological injuries caused by collisions.

Table I–95 No Action Option Transportation Impacts Summary

Time Period	*Crew Dose and Risk*		*Population Dose and Risk*		*Accidents*	
	Person-Rem	*LCF*	*Person-Rem*	*LCF*	*Radiological (LCF)*	*Nonradiological (traffic fatalities)*
FY 2007 through FY 2016	2.2	0.0013	0.61	0.00037	0.0000072	0.019
FY 2007 through FY 2011	1.8	0.0011	0.49	0.00030	0.0000067	0.018
Peak Year (FY 2008)	0.75	0.00045	0.20	0.00012	0.0000027	0.0074

LCF = latent cancer fatality, FY = fiscal year.
Note: Numbers have been rounded.

However, low-level and mixed low-level radioactive wastes may be optionally transported to a DOE facility such as the Nevada Test Site or disposed onsite (assuming that mixed low-level radioactive waste capacity would be developed at LANL). Comparative impacts considering these options are presented in **Table I–96** for FY 2007 through FY 2016. The risks of developing excess LCFs are highest for workers under the offsite disposal options. This is because the dose is proportional to the duration of transport, which in turn is proportional to travel distance. Disposal at the Nevada Test Site, which is farthest from LANL, would cause the highest dose and risk, although the dose and risk would be low under all disposal options. Because all LCFs shown in the table are smaller than unity, the analysis indicates that no excess fatal cancers would result, either from dose received from packaged waste on trucks or potentially received from accidental release. Likewise, no fatalities are expected from traffic accidents.

Table I–96 No Action Option Comparison of On- and Offsite Radioactive Waste Disposal Transportation Impacts (Fiscal Year 2007 through Fiscal Year 2016)

Low-Level and Mixed Low-Level Waste Destination [a]	*Total Distance Traveled (million kilometers)*	*Crew Dose and Risk*		*Population Dose and Risk*		*Accidents*	
		Person-Rem	*Risk (LCF)*	*Person-Rem*	*Risk (LCF)*	*Radiological (LCF)*	*Nonradiological Traffic (fatalities)*
LANL [b]	0.21	0.56	0.00034	0.18	0.00011	7.9×10^{-10}	0.0043
DOE [c]	1.97	2.5	0.00015	0.69	0.00041	9.6×10^{-6}	0.022
Commercial [d]	1.72	2.2	0.0013	0.61	0.00037	7.2×10^{-6}	0.019

LCF = latent cancer fatality.
[a] All nonradiological wastes would be shipped offsite and all transuranic wastes would be shipped to WIPP.
[b] Modeled by assuming an average one-way distance of nine kilometers from the point of generation to the disposal site such as that in Technical Area 54.
[c] Modeled by assuming shipment to the Nevada Test Site.
[d] Modeled by assuming shipment to the EnergySolutions site in Utah.
Note: To convert kilometers to miles, multiply by 0.62137. Numbers have been rounded.

I.5.10.2 Capping Option

I.5.10.2.1 Onsite Impacts

Site Investigations. Although the site investigation program under the Consent Order may slightly increase vehicular traffic in and near LANL, this additional traffic should not significantly impact current traffic patterns. For example, installation of boreholes or monitoring wells would require the mobilization of equipment to the investigation site, followed by demobilization once installation is completed. Additional traffic would be associated with delivery of supplies and transport of personnel. Thereafter, periodic investigation site visits may be needed to collect samples. Sampling monitoring wells may involve the collection and temporary storage of purged groundwater and decontamination water before approved disposal. Collected water may need to be trucked to treatment facilities.

Remediation of MDAs and Other PRSs. The Capping Option would cause additional traffic in and near LANL. Additional workers would be needed to cap the MDAs, which would mean additional personal vehicles in the LANL vicinity. Additional radioactive and nonradioactive wastes could be sent to LANL treatment and disposal facilities. (Impacts associated with transporting low-level and mixed low-level radioactive waste to onsite disposal facilities are addressed in Section I.5.10.2.2.) Onsite risks from transporting this material could be mitigated or reduced through measures such as traffic control (site security), road closures, or transportation infrastructure improvements.

In addition, the Capping Option would require numerous shipments of tuff, rocks, and similar bulk materials from sources either on the LANL site or within the surrounding community. There could be some additional shipments of materials needed to grout the General's Tanks in MDA A. In addition, depending on remediation decisions, wastewater may be generated from groundwater treatment programs or from decontamination of equipment. There could be an increase in traffic to transport the wastewater to onsite treatment facilities. This larger number of shipments compared with the No Action Option presents an increased short-term risk to the public and LANL personnel from possible accidents. Risks from transporting this material to onsite personnel could be reduced by measures such as temporary road closures. There would also be small increases in traffic volumes to move equipment, modular structures, or other materials needed to support stabilization and capping operations.

As addressed in Section I.5.4.2.2, compared to the No Action Option, the Capping Option may increase traffic on East Jemez Road if solid waste from LANL's environmental restoration project is processed through the solid waste transfer station on East Jemez Road and tuff and similar material are procured from the TA-61 borrow pit. It is expected, however, that solid waste from LANL's environmental restoration project would be sent directly to a landfill without passing through the transfer station.

Another consideration is traffic into and out of DP Mesa for remediation of the TA-21 MDAs. Capping MDAs A, B, T, and U is projected to require slightly over 4 years. The total number of waste, soil, and similar bulk material shipments is shown in **Table I–97** for FY 2007 through FY 2016, as well as FY 2007 through FY 2011. Shipments are two way—for example, trucks delivering tuff and then leaving. Shipments would use DP Road, which intersects with Trinity Road at its western end.

Table I–97 Capping Option Shipments of Waste and Bulk Materials into and out of Technical Area 21 [a]

Waste and Material Shipments [b]	*Fiscal Year*				*Total Shipments*
	2009	*2010*	*2011*	*2012*	
Waste shipments [b]	1	260	300	1	560
Soil and Other Materials [b]					
Minimum cap	1,200	8,400	5,300	39	15,000
Maximum cap	3,200	23,000	15,000	110	41,000
Total Shipments					
Minimum cap	1,200	8,700	5,600	40	16,000
Maximum cap	3,200	23,000	15,000	110	41,000
Total Shipments per Day [c]					
Minimum cap	4.7	35	22	0.2	Not applicable
Maximum cap	13	93	59	0.4	Not applicable

[a] Assuming two-way shipments—that is, trucks entering and leaving Technical Area 21 via DP Road.
[b] Conservatively includes shipments for capping MDAs B and U. Current plans are to remove waste from MDA B and capping MDA U may be unlikely considering NMED's 2006 Corrective Action Complete with Controls certification for SWMUs comprising MDA U (NMED 2006b).
[c] Assuming 250 working days per year.
Note: Numbers have been rounded.

Traffic congestion could be reduced by redesigning the intersection of DP Road and Trinity Road.

Borrow Pit. See above discussion.

I.5.10.2.2 Offsite Impacts

Site Investigations. The site investigations program under the Consent Order should have few, if any, offsite impacts.

Remediation of MDSs and Other PRSs. Compared with the No Action Option, there would be additional shipments of radioactive and nonradioactive wastes to offsite treatment and disposal facilities. These shipments would occur over public roads and could therefore present risks to the public. These risks would be managed by packaging and shipping wastes in compliance with U.S. Department of Transportation requirements for shipment of radioactive materials.

Transportation impacts were estimated for the Capping Option using annual projected waste volumes estimated in Section I.3.6 and the assumptions and analysis described in Section I.3.5. Shipping crew and population radiation doses and risks from incident-free transportation and radiological and nonradiological risks from possible transportation accidents are presented in **Table I–98**. The table presents total doses and risks from FY 2007 through FY 2016, total doses and risks from FY 2007 through FY 2011, and doses and risks for the peak year (2008).

Table I–98 Capping Option Transportation Impacts Summary

Time Period	*Crew Dose and Risk*		*Population Dose and Risk*		*Accidents*	
	Person-Rem	*LCF*	*Person-Rem*	*LCF*	*Radiological (LCF)*	*Nonradiological (traffic fatalities)*
FY 2007 through FY 2016	3.9	0.0023	1.0	0.00062	0.000015	0.076
FY 2007 through FY 2011	2.8	0.0017	0.75	0.00045	0.000011	0.048
Peak year (FY 2008)	0.87	0.00052	0.23	0.00014	0.0000033	0.012

LCF = latent cancer fatality, FY = fiscal year.
Note: Numbers have been rounded.

The impacts for Table I–98 were determined assuming that solid and chemical wastes would be shipped to offsite facilities, transuranic wastes would be shipped to WIPP, and low-level and mixed low-level radioactive wastes would be sent to an offsite commercial facility such as the one in Utah. However, low-level and mixed low-level radioactive wastes may be optionally transported to a DOE facility such as the Nevada Test Site or disposed onsite (hypothetically assuming that mixed low-level radioactive waste capacity would be developed at LANL). Comparative impacts considering these options are presented in **Table I–99** for FY 2007 through FY 2016. The risks of developing excess LCFs are again highest for workers under the offsite disposal options. Disposal at the Nevada Test Site, which is farthest from LANL, would cause the highest dose and risk, although the dose and risk would be low under all disposal options. Because all LCFs would be much smaller than unity, no excess fatal cancers would result from this activity, either from dose received from packaged waste on trucks or potentially received from accidental release. Likewise, no nonradiological fatalities are expected from traffic accidents.

Borrow Pit. Operation of the borrow pit in TA-61 would have no offsite impacts from material transport.

Table I–99 Capping Option Comparison of On- and Offsite Radioactive Waste Disposal Transportation Impacts (Fiscal Year 2007 through Fiscal Year 2016)

Low-Level and Mixed Low-Level Radioactive Waste Destination [a]	*Total Distance Traveled (million kilometers)*	*Crew Dose and Risk*		*Population Dose and Risk*		*Accidents*	
		Person-Rem	*Risk (LCF)*	*Person-Rem*	*Risk (LCF)*	*Radiological (LCF)*	*Nonradiological Traffic (fatalities)*
LANL [b]	2.67	0.76	0.00045	0.24	0.00014	1.1×10^{-9}	0.0044
DOE [c]	6.45	4.4	0.0026	1.2	0.00070	2.0×10^{-5}	0.082
Commercial [d]	5.92	3.9	0.0023	1.0	0.00062	1.5×10^{-5}	0.076

LCF = latent cancer fatality.
[a] All nonradiological wastes would be shipped offsite and all transuranic wastes would be shipped to WIPP.
[b] Modeled by assuming an average one-way distance of 9 kilometers from the point of generation to the disposal site such as that in Technical Area 54.
[c] Modeled by assuming shipment to the Nevada Test Site.
[d] Modeled by assuming shipment to the EnergySolutions site in Utah.
Note: Numbers have been rounded.

I.5.10.3 Removal Option

I.5.10.3.1 Onsite Impacts

Site Investigations. Impacts of site investigations under the Consent Order would be the same as those under the Capping Option.

Remediation of MDAs and Other PRSs. Compared to the Capping Option, this option would cause additional traffic in and near LANL. Additional workers would be needed to remove the wastes from the MDAs and to carry out sorting, characterization, treatment, and packaging activities. This indicates a larger number of personal vehicles in the LANL vicinity, which could cause traffic congestion in some areas, such as on Pajarito Road and other roads near TA-54 or near the intersection of DP and Trinity Roads. There would be additional radioactive and nonradioactive wastes sent to LANL treatment and disposal facilities (see Section I.5.10.3.2). Onsite risks from transporting this material could be mitigated or reduced through measures such as traffic control (site security), road closures, and transportation infrastructure improvements.

In addition, the Removal Option would require numerous shipments of crushed tuff for backfilling excavations. These shipments would be accompanied by shipments of topsoil or soil amendment to promote revegetation. There may also be shipments transporting wastewater generated from groundwater treatment programs or from decontaminating equipment. This larger number of material shipments compared with the No Action Option presents an increased short-term risk to the public and LANL personnel associated with possible accidents. Risks to onsite personnel could be reduced by appropriate road closures and other traffic control measures or transportation infrastructure improvements.

As addressed in Section I.5.4.3.2, compared to the No Action Option, the Removal Option may increase traffic on East Jemez Road if solid waste from LANL's environmental restoration project is processed through the solid waste transfer station on East Jemez Road and tuff and similar material are procured from the TA-61 borrow pit. It is expected, however, that industrial solid waste generated from LANL's environmental restoration project would be sent directly to a landfill without passing through the transfer station.

Regarding TA-21, complete removal of MDAs A, B, T, and U is projected to cause two-way shipments of waste, soil, and similar bulk materials, as summarized in **Table I–100**. Average daily shipments for the peak year (2010) would be in the range of those estimated for the Capping Option. As for the Capping Option, traffic congestion could be reduced by measures such as redesigning the intersection of DP Road with Trinity Road.

Table I–100 Removal Option of Wastes and Bulk Materials into and out of Technical Area 21 [a]

Waste and Material Shipments [b]	*Fiscal Year*					
	2008	*2009*	*2010*	*2011*	*2012*	*Total Shipments*
Waste shipments	4,000	7,300	5,500	1,700	10	19,000
Soil and Other Materials						
Crushed tuff	3,400	6,200	4,600	1,500	10	16,000
Additional material	230	440	3,209	100	1	1,100
Total shipments	7,600	14,000	10,000	3,300	21	35,000
Total shipments per day [c]	31	56	42	13	Less than 1	

[a] Assuming two-way shipments – that is, trucks entering and leaving Technical Area 21 via DP Road.
[b] Conservatively includes shipments for removing MDA U. Removing MDA U may be unlikely considering NMED's 2006 Corrective Action Complete with Controls certification for the SWMUs comprising MDA U (NMED 2006b).
[c] Assuming 250 working days per year.
Note: Because all numbers have been rounded, the sums may not equal indicated totals.

Borrow Pit. See above discussion.

I.5.10.3.2 Offsite Impacts

Site Investigations. The site investigations program under the Consent Order should have few, if any, offsite impacts.

Remediation of MDAs and Other PRSs. Compared with the No Action Option, there would be additional shipments of radioactive and nonradioactive wastes to offsite disposal facilities. These shipments would occur over public roads and could therefore present risks to the public. These risks would be managed by packaging and shipping wastes in compliance with U.S. Department of Transportation requirements for shipment of radioactive materials.

Transportation impacts were determined for the Removal Option using annual projected waste volumes estimated in Section I.3.6 and the assumptions and analysis described in Section I.3.5. Shipping crew and population radiation doses and risks from incident-free transportation and radiological and nonradiological risks from possible transportation accidents are presented in **Table I–101**. The table presents total doses and risks for FY 2007 through FY 2016, doses and risks from FY 2007 through FY 2011, and doses and risks for the peak year during this 10-year period. Smaller doses and risks would occur under the assumption of partial rather than complete removal of waste from MDAs.

Table I–101 Removal Option Transportation Impacts Summary

Time Period	*Crew Dose and Risk*		*Population Dose and Risk*		*Accidents*	
	Person-Rem	*LCF*	*Person-Rem*	*LCF*	*Radiological (LCF)*	*Nonradiological (fatalities)*
FY 2007 through FY 2016	630	0.38	190	0.12	0.0012	2.2
FY 2007 through FY 2011	390	0.23	120	0.071	0.00064	1.2
Peak year (FY 2010)	160	0.10	50	0.030	0.00025	0.46

LCF = latent cancer fatality, FY = fiscal year.
Note: Offsite shipments of low-level and mixed low-level radioactive wastes (low-activity, remote-handled, and alpha) would be split between disposal facilities. Numbers have been rounded.

The impacts for Table I–101 were determined assuming that solid and chemical wastes would be shipped to offsite facilities, transuranic wastes would be shipped to WIPP, and low-activity low-level and mixed low-level radioactive wastes would be sent to an offsite commercial facility such as the one in Utah. The remaining low-level radioactive wastes (remote-handled and alpha wastes and mixed remote-handled and mixed wastes) would be sent to a DOE facility such as the Nevada Test Site. However, options were considered of shipping all low-level radioactive and mixed low-level radioactive wastes to a DOE facility such as the Nevada Test Site, or disposing of all such waste on the LANL site. Note that the commercial facility in Utah cannot accept wastes having characteristics similar to those assumed in this appendix for remote-handled and alpha-contaminated low-level radioactive and mixed wastes. In addition, there is no current mixed low-level radioactive waste disposal capacity at LANL.

Comparative impacts considering these options are presented in **Table I–102** for FY 2007 through FY 2016. The risks of developing excess LCFs are highest for workers under the offsite disposition options. Disposal at the Nevada Test Site, which is farthest from LANL, would result in the highest dose and risk. Transportation of radioactive wastes would not result in any excess LCFs among the exposed truck crew or population. The largest risk to the population from radioactive waste transport could result from (nonradiological) traffic fatalities resulting from accidents. Considering that the transportation activities would occur over a 10-year period and that the average number of traffic fatalities in the United States is about 40,000 per year, the total traffic fatalities (about two to three) estimated under the Removal Option are small.

Borrow Pit. Operations of the borrow pit would have no offsite impacts from material transport.

Table I–102 Removal Option Comparison of On- and Offsite Radioactive Waste Disposal Transportation Impacts (Fiscal Year 2007 through Fiscal Year 2016)

Low-Level and Mixed Low-Level Radioactive Waste Destination [a]	*Total Distance Traveled (million kilometers)*	*Crew Dose and Risk*		*Population Dose and Risk*		*Accidents*	
		Person-Rem	*Risk (LCF)*	*Person-Rem*	*Risk (LCF)*	*Radiological (LCF)*	*Nonradiological Traffic (fatalities)*
LANL [b]	11.1	65	0.039	20	0.012	8.6×10^{-8}	0.16
DOE [c]	241	660	0.40	200	0.12	1.5×10^{-3}	2.4
Commercial [d]	220	630	0.38	190	0.12	1.3×10^{-3}	2.2

LCF = latent cancer fatality.
[a] All nonradiological wastes would be shipped offsite and all transuranic wastes would be shipped to WIPP.
[b] Modeled by assuming an average one-way distance of 9 kilometers from the point of generation to the disposal site such as that in Technical Area 54.
[c] Modeled by assuming shipment to the Nevada Test Site.
[d] Modeled by assuming shipment of bulk low-level and mixed low-level radioactive wastes to the EnergySolutions site in Utah, and the remaining low-level and mixed low-level radioactive wastes to the Nevada Test Site.
Note: Numbers have been rounded.

I.5.11 Environmental Justice

I.5.11.1 No Action Option

The primary route designated by the State of New Mexico to be used for radioactive and other hazardous material shipments to and from LANL is the approximately 40-mile (64-kilometer) corridor between LANL and I-25 at Santa Fe. This route passes through the Pueblos of San Ildefonso, Pojoaque, Nambe, and Tesuque and is adjacent to the northern segment of Bandelier National Monument. This primary transportation route bypasses the city of Santa Fe on New Mexico 599 to I-25. Minority populations dominate these communities. Total waste shipments under the No Action Option, assuming all environmental restoration project waste is shipped offsite, are estimated at 1,050 shipments, or 2,100 total truck trips. (Half of the total trips would consist of empty returning trucks.) The highest number of waste shipments is projected to be 400 shipments (800 total truck trips) in 2008, or approximately 3 truck trips per working day (assuming 250 working days per year).

Table 4–52 in Chapter 4 of this SWEIS shows average daily vehicle trips eastbound on NM 502 east of its intersection with NM 4. Eastbound trips averaged 10,100 per day, while westbound trips averaged 7,765 per day (totaling 17,865 vehicle trips). Waste shipments consisting of about 3 truck trips per working day under the No Action Option would represent 0.02 percent of the total traffic (17,865 vehicle trips) on NM 502.

I.5.11.2 Capping Option

Additional wastes would be generated at LANL under the Capping Option, and, to the extent that the wastes must be trucked offsite for treatment or disposal, additional impacts could potentially occur on minority communities through which these waste shipments would pass. Assuming that all waste is shipped offsite through these affected communities, there would be approximately 7,200 waste shipments, or 14,400 total truck trips via NM 502 through 2016. (Half of the total trips would consist of empty returning trucks.) The largest number of waste shipments is projected to be 970 shipments (1,940 total truck trips) in 2008, or approximately 8 truck trips per working day (assuming 250 working days per year). Waste shipments consisting of 8 truck trips per working day under the Capping Option would represent 0.04 percent of the total traffic (17,865 vehicle trips) on NM 502.

I.5.11.3 Removal Option

Additional wastes would be generated at LANL under the Removal Option, and to the extent that the wastes must be trucked offsite for treatment or disposal, additional impacts could potentially occur on minority communities through which these waste shipments would pass. Assuming that all waste is shipped offsite through these affected communities, there would be approximately 110,000 waste shipments, or 220,000 total truck trips via NM 502 through 2016, an average of 11,000 shipments (22,000 truck trips) per year. (Half of the total trips would consist of empty returning trucks.) The highest number of waste shipments is projected to be 22,000 shipments (44,000 total truck trips) in 2010, or approximately 180 truck trips per working day (assuming 250 working days per year). Fewer shipments would occur if partial, rather than full, removal of MDAs took place, or if onsite disposal is used for some waste. Waste shipments consisting of 180 truck trips per working day under the Removal Option would represent about 1 percent of the total traffic (17,865 vehicle trips) on NM 502.

I.5.12 Accidents

The primary focus of this section is the risk-dominant accidents under the Removal Option.

Before any of the corrective measure options described in this appendix take place, appropriate planning and safety reviews would occur. The extent of the planning, safety review, and related preparatory activities would be commensurate with the size of the task and the extent of the possible hazard. Preparatory activities would include assessments similar to those conducted for remediation of MDA H by Omicron, Inc. (Omicron 2001). In this study, slightly more than 150 potential accident scenarios were postulated for the proposed MDA H corrective measure options. Process hazard analyses were performed on postulated accidents that were not screened out based on the likelihood of their occurrence and their potential effect on human health. Unmitigated and mitigated public, worker, and transportation risks associated with excavating MDA H were assessed. Activities included site preparation; site excavation; sorting and segregation of waste; declassification, packing, and loading of waste; waste transportation; and site restoration. The spectrum of hazards considered included industrial hazards, fires, explosions, spills, and penetrating radiation (DOE 2004b).

The Omicron assessment concluded that accidents involving the exposure of the public to radioactive or hazardous materials left in place at MDA H were not credible (a chance of occurrence of less than 1 in 1 million). Excavation and removal corrective measure options (including associated transportation) posed the greatest risk to members of the public, albeit a small one. The risk to the public from all other activities was negligible. The risk to workers was dominated by standard industrial accidents, followed by possible explosion accidents (Omicron 2001).

Safety analyses consistent with the likely level of hazard and the scope of the corrective measure contemplated would be performed for each of the MDAs and PRSs considered in this SWEIS.

I.5.12.1 Risks to Public

There would be low risks to the public from accidents involving radioactive or hazardous materials left in place in the MDAs. For neither the No Action Option nor the Capping Option would waste and hazardous constituents within the MDAs be disturbed. Materials that could be present in sufficient concentrations to potentially react in a manner involving violent dispersal of contamination (for example, chunks of high explosive, pyrophoric uranium, uranium hydride) are buried. The buried materials would generally lack sufficient oxygen to support combustion or ignition. In addition, most of the MDAs are relatively distant from residential areas. The MDAs closest to a residential area are in TA-21. Of these MDAs, MDA B is about 0.2 miles distant, and the remaining MDAs in TA-21 are typically about 0.4 miles distant. (MDA B, however, is near businesses on DP Road in TA-21.)

The principal risk to the public from accidents under the Capping Option would be from transportation accidents involving shipments of bulk materials and waste. Much of the transportation of materials and waste would take place within LANL, as crushed tuff is trucked from onsite borrow areas. Some materials may be acquired from locations nearby, but outside of, LANL. In this case, there could be small levels of increased risks to the public from transportation accidents. These risks could be mitigated by measures such as those described in Section 1.5.10.2.1.

Risks to the public from accidents from shipments of waste to locations outside of LANL have been addressed in Section I.5.10.1.2 for the No Action Option and Section I.5.10.2.2 for the Capping Option.

In addition to the risks from waste and bulk material transportation, removing waste from the MDAs would disturb buried materials and possibly cause conditions that would increase the likelihood of an undesired chemical reaction or release of materials. Materials such as high explosive and pyrophoric uranium may be present. The assessment for excavation of MDA H determined that of the 33 hazards analyzed (most with two or more initiating events), only an offsite transportation accident posed a credible threat to the public. The most serious effects were death or serious injury from the physical force of the accident. Risks from accidents involving transporting waste under the Removal Option to locations away from LANL have been addressed in Section I.5.10.3.2.

Site-specific assessments would consider the potential for such risks and mitigative actions. But for purposes of this appendix, bounding accidents that might occur during complete removal of two MDAs were addressed. Accidents involving airborne dispersal of radioactive materials were considered for MDA G because it has the largest estimated radionuclide inventory at LANL. Accidents involving airborne dispersal of radiological materials and toxic chemicals were considered for MDA B because of its proximity to the LANL site boundary.

Accidents Involving Release of Radioactive Materials. Removal of waste and contamination from MDAs would probably occur under enclosures for which any contaminant that may be dispersed into the air during removal would be passed through HEPA filtration systems before release. An explosion was assumed to occur at MDA G that breaches the enclosure and bypasses the HEPA filters. It was assumed that accident mitigation would not be completed for 24-hours; thus, suspension of the waste for this time period was included with the initial explosive release.

Although several fires occurred while operating MDAs B and C, and in one reported event several cartons gave off minor explosions, there is no experience at LANL with explosions associated with MDA remediation or removal. The documented fires and minor explosions involved packages of fresh waste containing unauthorized or reactive materials before their burial. Materials postulated for removal from MDAs B and G will have been covered and mixed with soil for up to 60 years. Therefore, past occurrences of fires and minor explosions during MDA operation are not an indication of the frequencies of fires and explosions that could occur during removal. In addition, the documented fires and explosions during past operations all involved far smaller quantities of materials at risk that those assumed for the SWEIS (see below). Also as noted below, removal operations would be conducted so that the quantities of materials at risk being removed at any one time would be smaller than those quantities assumed for the accident analysis.

The potential for explosive blast accidents associated with operations at LANL facilities that process high explosives was assessed, and, again, as of the *1999 SWEIS*, no such experience was identified at LANL (DOE 1999a). (High explosive processing includes storage, synthesis, formulation, pressing, machining, assembly, quality assurance processes, shipping and receiving of high explosives, and disposal at facilities in several LANL TAs.) Based on site-specific experience at Pantex, an annual accident frequency range of 10^{-3} to 10^{-2} was assumed for the No Action Alternative for the *1999 SWEIS* (DOE 1999a). An annual accident frequency of 10^{-2} was assumed for possible explosive accidents under the MDA G Removal Option.

It is believed that MDA B does not contain a sufficient quantity of explosives that could result in a significant release (LANL 2006c). At the time MDA B was operating, explosives production and test areas used what is now called MDA R in TA-16 for disposal of explosive waste (LANL 2007g). The chosen accident scenario for this MDA is a fire that results in releases that breach the enclosure and the HEPA filters. The specific materials and quantities of chemicals and fire sources in the MDA are poorly known, and, therefore, so is the frequency of occurrence of the hypothesized scenario. The frequency used for the explosion scenario at MDA G was ascribed to the fire at MDA B to facilitate radiological risk calculations.

Radiological accident impacts were determined using the MELCOR Accident Consequence Code System, Revision 2, Version 1.13.1 (MACCS2), using parameter assumptions appropriate for the LANL region. The impacts estimated from the analysis are presented in terms of consequences and risks. All consequences were determined assuming that the accident does occur and, therefore, the frequency or probability that the accident occurs was not taken into account. The risks of the accident do reflect the frequency of occurrence and were calculated by multiplying the accident's frequency (1×10^{-2} per year) by its consequences. Dose consequences, in rem for an individual or person-rem for a group of individuals, were estimated for the MEI located at the site boundary (390 yards [355 meters] from MDA G and 49 yards [45 meters] from MDA B), the offsite population out to a distance of 50 miles (80 kilometers), and a noninvolved worker located about 110 yards (100 meters) from the accident. Consequences are also expressed in terms of the likelihood of an LCF for the MEI and noninvolved worker and in terms of the number of additional fatalities for the surrounding populations. A conversion factor of 0.0006 LCFs (or number of LCFs) per rem (or person-rem) was used to convert dose to health effects; this factor is doubled for dose to an individual in excess of 20 rem.

For MDA G, the source term was assumed to be given by one of the early disposal pits in which transuranic-contaminated waste was disposed of. This waste was disposed of before the 1970 decision to place transuranic-contaminated material into retrievable storage. The radionuclide inventory for pits 1 through 6 at MDA G has been estimated in the performance assessment and composite analysis for the Area G low-level radioactive waste disposal site (LANL 1997). Because there was no information about the distribution of radionuclides between pits, a material at risk corresponding to one-sixth of the inventory in pits 1 through 6 was assumed, reflecting the assumption that no more than a single pit would be involved in the accident.[85]

MDA B was one of the earliest disposal sites at LANL and operated when radioactive material, particularly plutonium, was scarce and expensive. The estimated plutonium inventory in MDA B (about 100 grams) is considered to be conservative (LANL 2006i). The distribution of radionuclide contamination throughout MDA B is unknown. As noted in Section I.3.3.2.7, MDA B may consist of several (up to six) small disposal pits plus two chemical trenches and two areas of contamination. The material at risk was conservatively assumed to consist of one-half of the total estimated MDA B inventory to reflect the possibility that the contamination in MDA B may be concentrated in only a few small pits.

For both of these MDAs, the radionuclides considered in the analysis were limited in accordance with a screening process to the principal dose-contributing radionuclides. **Table I–103** shows the list of radionuclides plus other analytical parameters used in the accident analysis.

The estimated consequences and annual risks from an explosion at MDA G or a fire at MDA B are shown in **Tables I–104** and **I–105**. These tables include doses and risks as calculated for a noninvolved worker assumed to be 109 yards (100 meters) from the accident.

MDA G consequences and risks bound those of MDA B because of the larger source term in MDA G (see Table I–103). For the MEI, the difference in doses and risks between these two MDAs is smaller than would be expected from the source term difference because of the much closer distance to the MEI for MDA B than for MDA G.

[85] *It may be argued that the radionuclide inventory may be concentrated in a few of the six pits. However, there is little information with which to estimate this possibility. In any event, if the MDA was removed, only a small portion of any pit would be exposed at any one time. Also note that the early pits at MDA G were large in size (far larger in size than those projected for MDA B). Hence, it is very unlikely that the entire contents of any single pit at MDA G would be involved in any accident involving an explosion or similar reactive event.*

Table I–103 Analytical Parameters for Assumed Accidents at Material Disposal Area G and Material Disposal Area B

MDA	*Accident Phase*	*Nuclide*	*MAR (Ci)*	*DR* [a, b]	*ARF* [b]	*RF* [b]	*ARR (/hr)* [b]	*LPF*	*ST-Ci*	*DEL T (min)*
MDA G	Explosion	Americium-241	352	0.02	0.005	0.3		1	0.014	1
		Gadolinium-148	0.466	1	0.005	0.3		1	0.000699	1
		Thorium-230	2.67	1	0.005	0.3		1	0.00401	1
		Actinium-227	0.0430	1	0.005	0.3		1	0.0000645	1
		Plutonium-238	591	0.88	0.005	0.3		1	0.780	1
		Plutonium-239	319	0.96	0.005	0.3		1	0.459	1
		Plutonium-240	74.7	1	0.005	0.3		1	0.112	1
		Plutonium-241	219	1	0.005	0.3		1	0.329	1
		Uranium-233	1.03	0 [c]	0.005	0.3		1	0	1
		Uranium-234	0.392	1	0.005	0.3		1	0.000588	1
		Uranium-238	1.72	1	0.005	0.3		1	0.00258	1
	Suspension	Americium-241	352	0.02		1	4.00×10^{-6}	1	0.000659	1,440
		Gadolinium-148	0.464	1		1	4.00×10^{-6}	1	0.0000445	1,440
		Thorium-230	2.66	1		1	4.00×10^{-6}	1	0.000255	1,440
		Actinium-227	0.0428	1		1	4.00×10^{-6}	1	4.11×10^{-6}	1,440
		Plutonium-238	588	0.88		1	4.00×10^{-6}	1	0.0497	1,440
		Plutonium-239	318	0.96		1	4.00×10^{-6}	1	0.0292	1,440
		Plutonium-240	74.3	1		1	4.00×10^{-6}	1	0.00714	1,440
		Plutonium-241	218	1		1	4.00×10^{-6}	1	0.0209	1,440
		Uranium-233	1.03	0 [c]		1	4.00×10^{-6}	1	0	1,440
		Uranium-234	0.390	1		1	4.00×10^{-6}	1	0.0000374	1,440
		Uranium-238	1.71	1		1	4.00×10^{-6}	1	0.000164	1,440
MDA B	Fire	Actinium-227	0.000159	1	0.0005	1		1	7.95×10^{-8}	1
		Americium-241	3.01	1	0.0005	1		1	0.00151	1
		Tritium	116	1	1	1		1	116	1
		Plutonium-238	4.15	1	0.0005	1		1	0.00208	1
		Plutonium-239	3.10 [d]	1	0.0005	1		1	0.00155	1
		Plutonium-240	0.671	1	0.0005	1		1	0.000336	1

MDA	*Accident Phase*	*Nuclide*	*MAR (Ci)*	*DR* [a, b]	*ARF* [b]	*RF* [b]	*ARR (/hr)* [b]	*LPF*	*ST-Ci*	*DEL T (min)*
		Plutonium-241	0.428	1	0.0005	1		1	0.000214	1
		Uranium-233	0.0211	1	0.0005	1		1	1.06×10^{-5}	1
		Uranium-234	0.00712	1	0.0005	1		1	3.56×10^{-6}	1
		Uranium-238	0.0687	1	0.0005	1		1	3.44×10^{-5}	1
	Suspension	Actinium-227	0.000159	1		1	4.00×10^{-6}	1	1.53×10^{-8}	1440
		Americium-241	3.01	1		1	4.00×10^{-6}	1	0.000289	1440
		Tritium	0	1		1	4.00×10^{-6}	1	0	1440
		Plutonium-238	4.15	1		1	4.00×10^{-6}	1	0.000398	1440
		Plutonium-239	3.10	1		1	4.00×10^{-6}	1	0.000297	1440
		Plutonium-240	0.671	1		1	4.00×10^{-6}	1	0.0000644	1440
		Plutonium-241	0.428	1		1	4.00×10^{-6}	1	0.0000411	1440
		Uranium-233	0.0211	1		1	4.00×10^{-6}	1	2.02×10^{-6}	1440
		Uranium-234	0.00712	1		1	4.00×10^{-6}	1	6.83×10^{-7}	1440
		Uranium-238	0.0687	1		1	4.00×10^{-6}	1	6.59×10^{-6}	1440

MDA = material disposal area, MAR = material at risk (units of curies); DR = damage ratio; ARF = airborne release fraction; RF = respirable fraction; ARR = airborne release rate; LPF = leakpath factor; ST-Ci = source term (units of curies); DEL T = time period of exposure (minutes).

[a] DR smaller than unity indicates presence of nondispersable (concrete and sludge) waste forms.

[b] Values for DR, ARF, ARR, and RF were assumed from information in the DOE handbook for airborne release fractions and rates (DOE 1994), and from comparison to other environmental statements addressing similar accidents involving plutonium-contaminated materials (DOE 1998a, 1999f).

[c] DR is zero for uranium-233 because all uranium-233 was disposed within nondispersable (concrete and sludge) waste forms.

[d] A 2007 document estimates a total plutonium-239 inventory in MDA B ranging from 1.5 to about 15 curies, with an estimated 7.08 curies at the 50th percentile and 10.6 curies at the 90th percentile. The inventory distributed among gloves, personal protective equipment, glassware, lab debris, and liquid containers is estimated to be 2.55 curies at the 50th percentile and 4.73 curies at the 90th percentile (LANL 2007g). For accident analysis purposes, the balance of the inventory distributed in interstitial soil and fill would be less likely to disperse in a fire than the inventory distributed in the other material. If all of the other material was involved in the fire, the plutonium-239 material at risk would be about 50 percent higher at the 90th percentile than that assumed for the analysis.

Table I–104 Material Disposal Area Explosion or Fire: Radiological Accident Consequences

Accident Location	*Maximally Exposed Individual*		*Offsite Population to 80 Kilometers*		*Noninvolved Worker (at 100 meters)*	
	Dose (rem)	*Latent Cancer Fatality* [a]	*Dose (person-rem)*	*Latent Cancer Fatality* [b, c]	*Dose (rem)*	*Latent Cancer Fatality* [a]
MDA G	55	0.066	770	0.46	410	0.49
MDA B [d]	7.1	0.0043	7.8	0.0047	1.6	0.00095

MDA = material disposal area.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.
[b] Increased number of LCFs for the population, assuming the accident occurs.
[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 343,000 from MDA G and 271,600 from MDA B.
[d] The calculated impact could be up to 50 percent higher (see Table I–103).

Table I–105 Material Disposal Area Explosion or Fire: Radiological Accident Risks

Accident Scenario	*Latent Cancer Fatality Risk per Year of Operation*		
	Maximally Exposed Individual [a]	*Offsite Population (to 50 Miles)* [b, c]	*Noninvolved Worker (at 100 meters)* [a]
MDA G	0.00066	0.0046	0.0049
MDA B [d]	4.3×10^{-5}	4.7×10^{-5}	9.5×10^{-6}

MDA = material disposal area.
[a] Increased risk of an LCF to an individual per year. Risks were determined by conservatively assuming an accident frequency of 1×10^{-2} per year.
[b] Increased number of LCFs for the population per year.
[c] Offsite population size out to a 50-mile (80-kilometer) radius is approximately 343,000 from MDA G and 271,600 from MDA B.
[d] The calculated impact could be up to 50 percent higher (see Table I–103).

The MEI for MDA B is a hypothetical maximally exposed individual assumed to be positioned 45 meters from the accident at MDA B. Because this individual is hypothetical and certain very conservative assumptions are attributed to him (see Appendix D), he is not included in the calculation of population dose.

These calculated doses and risks are conservative. For example, the assumed airborne release and respirable release fractions for MDA B are the same as those used in other analyses for fires involving newly generated combustible materials (for example, DOE 1998a, 1999f), an assumption that discounts the effects of decades of exposure of the buried waste to the environment. Furthermore, before removal would actually occur at any MDA, thorough safety reviews would take place with the intent of identifying hazard scenarios and the barriers associated with preventing or mitigating each postulated hazard scenario. If it is determined that a possible hazard would actually be credible and significant, then measures would be taken to address the hazard. For example, if an explosion or similar reactive event was deemed credible and significant, exhumation could take place in an inert atmosphere, as has been considered as an option for MDA H (DOE 2004b). For removal of MDA B, several technical and administrative controls will be imposed to ensure safety, including visual inspections, use of several or remote sensing tools to monitor for radiation or hazardous constituents, and controls that limit the plutonium equivalent that may be present in different areas associated with MDA B removal. These areas and their plutonium equivalent include the dig face and excavation enclosure

(2.4 grams [0.15 curies]); the Definitive Identification Facility and field laboratory (7.0 grams [0.43 curies]); onsite transportation (2.4 grams [0.15 curies]); waste container storage area number 1 (7.0 grams (0.43 curies); and waste container storage area number 2 (28.0 grams [1.7 curies]) (LANL 2006a). The plutonium equivalent limits for each of these areas are smaller than the material at risk for the accident analysis presented here for MDA B removal. For the dig face and excavation enclosure the limit is 5 percent of the assumed material at risk.

Accidents Involving Release of Toxic Chemicals. A toxic chemical accident analysis for the MDAs was performed using the ALOHA code[86] and a conservative accident scenario postulated to result in the maximum human health effects of the atmospheric release of toxic chemicals. MDA B was chosen for this analysis because of its proximity to members of the public. Chemical releases from possible accidents at other MDAs having chemical inventory uncertainties equivalent to MDA B (see below) are expected to result in smaller impacts because of their greater distances to members of the public.

LANL staff have postulated that over 200 different chemicals may have been placed in MDA B for disposal of substances prior to its closure. There are no definitive records of the types or quantities of chemicals that were disposed of in MDA B. Therefore, conservative assumptions were made about the presence and quantity of toxic chemicals in the MDAs. That is, a hazardous chemical accident analysis was developed based on selecting the more toxic chemicals that could be present at MDA B and a quantity commensurate with current knowledge of the historical uses of these chemicals. The release scenario, a fire that breaches the enclosure and bypasses the HEPA filter, is consistent with that used to analyze radiological releases. The thermal energy that would accompany such a fire and that would tend to loft the plume over potential nearby receptors was conservatively ignored. (An explosion would also loft chemicals over potential nearby receptors.)

Within the context of the aforementioned data limitations, the list of possible chemicals was evaluated in terms of their potential effects on human health. A number of chemicals, either alone or in combination with others, could cause a fire. A fire is expected to release larger quantities of chemicals to the atmosphere than most other realistic accident initiators.

A measure of a chemical's relative toxicity is the numerical value of its Emergency Response Planning Guideline (ERPG), which is an air concentration value associated with a specific human health response. A lower ERPG indicates a more toxic chemical (see Appendix D). The list of chemicals that may be present in MDA B was reviewed for those chemicals with the lowest ERPG values, in addition to their maximum possible quantity. This review identified gases (sulfur dioxide, hydrogen chloride, hydrogen bromide), liquids (hydrofluoric acid, hydrochloric acid), and a solid (beryllium powder) having restrictive ERPG concentrations. Each of these chemicals was assumed to be disposed of in quantities consistent with their historical use. Sulfur dioxide and beryllium were found to be the most restrictive of these and were considered further. The identification of sulfur dioxide as the most restrictive non-solid-phase chemical was in agreement with a LANL determination, based on a detailed assessment of over 200 chemicals, of the aboveground inventory limits for chemicals to be staged or stored in a DIF

[86] The ALOHA code is a public domain code developed by EPA and the National Oceanic and Atmospheric Administration and used to plan for and respond to chemical emergencies. The code is widely used throughout the DOE complex for safety analysis applications.

and surrounding storage and staging area (LANL 2006c). The DIF will be constructed and operated to support the investigation and remediation program for MDA B.

Given the dearth of information on specific chemicals present, their quantity, degradation over more than 50 years, or environmental transport from the MDA, this accident analysis serves to quantify an approximate distance within which significant human health impacts may occur for relatively conservative quantities and types of chemicals that may be present during MDA B restoration activities. The aforementioned information does not support the estimate of an accident frequency at MDA B.

Table I–106 shows the accident risks posed from these two chemicals during MDA B waste retrieval. As noted, the frequency of an accident involving releases of these chemicals is unknown because the probability of their presence in the MDA is unknown. The direction traveled by the chemical plume will determine what segment of the worker and offsite populations would be at risk of exposure, and this direction will depend upon meteorological conditions at the time of the accident. The ERPG-3 concentration limit is defined in terms of 1-hour exposure and corresponds to the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a). The exposure duration to releases from an explosion event would be for a much shorter period of time and, therefore, is expected to result in smaller health effects than that indicated by the ERPG value.

Table I–106 Material Disposal Area B Waste Retrieval Chemical Accident Consequences

Chemical	*Frequency (per year)*	*Quantity Released*	*ERPG-2* [a]		*ERPG-3* [b]	
			Value	*Impact*	*Value*	*Impact*
Sulfur dioxide	unknown	1 pound (454 grams)	3 ppm	Risk of workers or public within 90 yards (83 meters) of facility receiving exposures in excess of limit. Public access is at 49 yards (45 meters) and beyond this limit.	15 ppm	Risk of workers within 37 yards (34 meters) of facility receiving exposures in excess of limit. Public access is at 49 yards (45 meters).
Beryllium powder	unknown	0.0013 pounds (0.6 grams) [c]	0.025 mg/m^3	Risk of workers within 25 yards (23 meters) of facility receiving exposures in excess of limit. Public access is at 49 yards (45 meters).	0.1 mg/m^3	Risk of workers within 10 yards (9 meters) of facility receiving exposures in excess of limit. Public access is at 49 yards (45 meters).

ERPG = Emergency Response Planning Guideline, ppm = parts per million, mg/m^3 = milligrams per cubic meter.

[a] ERPG-2 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action (DOE 2004a).

[b] ERPG-3 is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects (DOE 2004a).

[c] Based on a respirable release fraction of 6×10^{-5} of the total powder at risk and under thermal stress (DOE 1994), and on consideration of respiration release fractions assumed in other environmental statements (DOE 1998a, 1999f).

I.5.12.2 Risks to Workers

Workers would carry out tasks under the No Action and Capping Options that would be little different than those that have taken place for years at LANL. Continued work under LANL's environmental restoration project would subject workers to risks such as exposure to radioactive and hazardous constituents and standard industrial accidents. Workers receive training to recognize and avoid hazards and would wear personal protective equipment as appropriate. Capping the MDAs could result in slightly increased levels of risks because of extensive use of heavy construction machinery.

The most significant risks to workers would come from complete excavation and removal of the MDAs. Accidents that could result in severe worker injuries could include vehicle accidents, explosions, equipment failures, lightning strikes, electrocution, and operator errors. Removal procedures would be developed for the MDAs based on the experience and technology developed at LANL, Idaho National Laboratory, Hanford, and other DOE sites. Hazards associated with removal of waste and materials from the MDAs could be avoided or mitigated using techniques such as personal protective equipment, water sprays to separate high explosive from a waste matrix, excavation under an inert atmosphere, remotely controlled or shielded excavators, remotely controlled or shielded manipulators for waste sorting, designated safe areas and explosion shields, and other techniques.

Section I.5.12.1 summarizes the radiological consequences and risks to members of the public and, for convenience, to noninvolved workers from two bounding radiological accidents involving removal of wastes from MDAs G and B. Section I.5.12.1 also addresses possible public and worker consequences from two hypothetical accidents at MDA B involving release of chemicals.

Risks to workers from industrial accidents were determined using the procedures outlined in Section I.3.6.4. Industrial accident risks are summarized in **Table I–107** for each of the three options assuming statistical information pertaining to DOE construction workers and the general construction industry. **Table I–108** presents similar risks only for operation of the TA-61 borrow pit. Risks are presented as summed for FY 2007 through FY 2016 and for FY 2007 through FY 2011. DOE statistics indicate a favorable safety record compared to the construction industry as a whole.

The activities resulting in the largest industrial accident risks are those associated with removal of the MDAs, particularly MDA G. Risks for removal of MDA G are listed in **Table I–109**, along with risks for removal of all MDAs (A, B, T, and U) in TA-21.

I.5.13 Cumulative Effects

Several resource areas would not be appreciably affected by any of the options in this project-specific analysis and, therefore, would not contribute significantly to cumulative effects because they would not have major long-term or irreversible effects. These resource areas include: cultural, visual, and biological resources; air quality; noise; human health; transportation; environmental justice; and socioeconomics. The options could frequently have a negative effect on each of the resource areas, but the effect would be temporary. Resource areas receiving additional consideration are land use, geology, water quality, waste management, and infrastructure.

Land Use. All options would have a net positive effect on land use. Continuing the environmental restoration project under the No Action Option would remove contamination from land and property throughout LANL or fix it in place. This action provides greater freedoms in determining future uses for the land and property. The Capping and Removal Options would have additional positive effects.

Table I–107 Industrial Accident Risks for Remediation Options

Option	*Construction Industry*			*DOE Construction*		
	Recordable Injuries	*Lost Workdays*	*Fatalities*	*Recordable Injuries*	*Lost Workdays*	*Fatalities*
Fiscal Year 2007 through Fiscal Year 2016 [a]						
No Action	1.9	20	0.0045	0.49	1.6	–
Capping [a]						
Thin cap	51	550	0.12	14	45	–
Thick cap	83	900	0.20	22	73	–
Removal [b]	1,300	14,000	3.2	350	1,200	–
Fiscal Year 2007 through Fiscal Year 2011 [a]						
No Action	1.8	19	0.0043	0.47	1.6	–
Capping [a]						
Thin cap	25	270	0.060	6.5	22	–
Thick cap	40	430	0.097	11	35	–
Removal [b]	560	6,000	1.4	150	500	–

[a] Includes borrow pit operations.
[b] Includes borrow pit operations, capping the remaining disposal units in the existing Area G footprint following MDA G removal, and capping areas in TA-49. Thick caps are assumed.
Note: Numbers have been rounded.

Table I–108 Industrial Accident Risks for Technical Area 61 Borrow Pit Operations

Option	*Construction Industry*			*DOE Construction*		
	Recordable Injuries	*Lost Workdays*	*Fatalities*	*Recordable Injuries*	*Lost Workdays*	*Fatalities*
Fiscal Year 2007 through Fiscal Year 2016						
Capping						
Thin cap	12	130	2.9×10^{-2}	3.2	11	–
Thick cap	31	340	7.7×10^{-2}	8.4	28	–
Removal [a]	31	330	7.5×10^{-2}	8.2	27	–
Fiscal Year 2007 through Fiscal Year 2011						
Capping						
Thin cap	5.8	63	1.4×10^{-2}	1.5	5.1	–
Thick cap	15	160	3.6×10^{-2}	3.9	13	–
Removal [a]	15	160	3.7×10^{-2}	4.0	13	–

[a] Includes borrow pit operations, capping the remaining disposal units in the existing Area G footprint following MDA G removal, and capping areas in TA-49. Thick caps are assumed.
Note: Numbers have been rounded.

Table I–109 Industrial Accident Risks for Removal of Material Disposal Area G and Combined Material Disposal Areas A, B, T, and U

Option	Construction Industry			DOE Construction		
	Recordable Injuries	Lost Workdays	Fatalities	Recordable Injuries	Lost Workdays	Fatalities
Fiscal Year 2007 through Fiscal Year 2016						
MDA G	1,200	13,000	2.9	310	1,000	–
MDAs A, B, T, and U	58	630	0.14	16	52	–
Fiscal Year 2007 through Fiscal Year 2011						
MDAs G	450	4,900	1.1	120	400	–
MDA A, B, T, and U	58	630	0.14	16	52	–

MDA = material disposal area.
[a] Includes capping the remaining portion of Area G following MDA removal. A thick cap is assumed.
Note: Numbers have been rounded.

Geology and Soils. All options would have a net positive effect. All options would result in additional contamination being removed from property and soils or stabilized in place. Management of the MDAs under the Capping and Removal Options would be conducted in a manner that addresses mass-wasting concerns such as erosion or cliff retreat.

Water Quality. All options would have a net positive effect. All options would result in additional contamination being removed from property and soils or stabilized in place. These actions would reduce the potential for the contamination to enter surface water pathways and for continued movement of existing contamination in surface water channels. Both the Capping and Removal Options would reduce possible risks to groundwater.

Waste Management Infrastructure. The No Action and Capping Options would not generate wastes in volumes that would significantly tax the existing waste management infrastructure. The Removal Option, however, could impact the waste management infrastructure at LANL and elsewhere. This may require construction of additional and complex waste handling and disposal capacity. Development and use of such capacity would require increased use of utilities such as gas, water, or electricity, increased use of natural resources, and larger personnel requirements. Any structures constructed and used for this purpose would have to be safely decommissioned, which would generate additional quantities of waste to be treated, packaged, shipped, and disposed of. The transuranic waste that would be generated under the Removal Option represents roughly 9 percent of the total transuranic waste volume capacity at WIPP.

I.6 References

ACE (U.S. Army Corps of Engineers), 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico*, Albuquerque District, Albuquerque, New Mexico, October.

ACE (U.S. Army Corps of Engineers), 2006, *Report on Treatment, Storage & Disposal Facilities (TSDF) for Hazardous, Toxic, and Radioactive Waste (HTRW)* (accessed on February 27, 2007 from Regulatory Compliance Publications, Library, http://www.environmental.usace.army.mil).

AEAT (AEA Technology Engineering Services, Inc.), 2004, *Mobile Fluidic Tank Waste Retrieval Equipment for TA21 Generals Tanks, System Overview*, Draft, AEAT Document No. 2127-6, Mooresville, North Carolina.

Bennett, K., D. Keller, and R. Robinson, 2001, *Sandia Wetland Evaluation*, LA-UR-01-66, Los Alamos National Laboratory, Los Alamos, New Mexico.

Birdsell, K. H., T. A. Cherry, P. Lichtner, and B. J. Travis, 1999, *Numerical Model of Flow and Transport for Area 2, MDA AB at TA-49*, LA-UR-99-5501, Environmental Restoration Project, Los Alamos National Laboratory, Los Alamos, New Mexico, September.

Birdsell, K. H., A. V. Wolfsberg, D. Hollis, T. A. Cherry, and K. M. Bower, 2000, "Groundwater flow and radionuclide transport calculations for a performance assessment of a low-level waste site", *Journal of Contaminant Hydrology*, Vol. 46, pp. 99-129, June 27.

Birdsell, K. H., B. D. Newman, D. E. Broxton, and B. A. Robinson, 2005, "Conceptual Models of Vadose Zone Flow and Transport beneath the Pajarito Plateau, Los Alamos, New Mexico", *Vadose Zone Journal*, 4:620-636, August 16.

Breshears, D. D., J. W. Nyhan, and D. W. Davenport, 2005, "Ecohydrology Monitoring and Excavation of Semiarid Landfill Covers a Decade after Installation", *Vadose Zone Journal*, 4:798-810, August 16.

Burris (Burris Disposal Service), 2005, "Roll-Off Services" (accessed on December 23, 2005, www.burrisdisposal.com), Carbondale, Illinois.

CPEO (Center for Public Environmental Oversight), 2005, "Resonant Sonic Drilling" (accessed on December 12, 2005, http://www.cpeo.org), Mountain View, California.

DCA (Damon Clark Associates), 2005, *Code of Practice for Dry Stack Concrete Block Retaining Walls*, Draft (accessed from "Products" on December 23, 2005, www.damonclark.co.za).

DOE (U.S. Department of Energy), 1993, *DOE Standard, Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, DOE-STD-1021-93, Change Notice No. 1 on January 1996, reaffirmed with Errata April 2002, Washington, DC, July.

DOE (U.S. Department of Energy), 1994, *DOE Handbook, Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94, Washington, DC, December.

DOE (U.S. Department of Energy), 1997a, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad Area Office, Carlsbad, New Mexico, September.

DOE (U.S. Department of Energy), 1997b, *DOE Standard, Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, Change Notice No. 1, Washington, DC, September.

DOE (U.S. Department of Energy), 1998a, *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site*, DOE/EIS-0277F, Assistant Secretary for Environmental Management, Washington, DC, August.

DOE (U.S. Department of Energy), 1998b, *Innovative Technology Summary Report – Cryogenic Drilling, Subsurface Contaminants Focus Area*, DOE/EM-0382, Office of Environmental Management, October.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory, Los Alamos, New Mexico, Environmental Assessment*, DOE-EA-1269, Los Alamos Area Office, Los Alamos, New Mexico, June 23.

DOE (U.S. Department of Energy), 1999c, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 1999d, *Innovative Technology Summary Report – AEA FluidicPulse Jet Mixer, Tanks Focus Area*, DOE/EM-0447, Office of Environmental Management, Oak Ridge, Tennessee, August.

DOE (U.S. Department of Energy), 1999e, *Final Environmental Impact Statement for the Conveyance and Transfer of Certain Land Tracts Administered by the U.S. Department of Energy and Located at Los Alamos National Laboratory, Los Alamos and Santa Fe Counties, New Mexico*, DOE/EIS-0293, Los Alamos Area Office, Los Alamos, New Mexico, October.

DOE (U.S. Department of Energy), 1999f, *Surplus Plutonium Disposition Final Environmental Impact Statement*, DOE/EIS-0283, Office of Fissile Materials Disposition, Washington, DC, November.

DOE (U.S. Department of Energy), 1999g, *Buried Transuranic-Contaminated Waste and Related Materials Database*, December 15.

DOE (U.S. Department of Energy), 2000a, *Buried Transuranic-Contaminated Waste Information for U.S. Department of Energy Facilities*, Office of Environmental Management, Washington, DC, June.

DOE (U.S. Department of Energy), 2000b, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE-SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

DOE (U.S. Department of Energy), 2001, *Radioactive Waste Management*, DOE Order 435.1, Change 1, Washington, DC, August 28.

DOE (U.S. Department of Energy), 2002, *DOE Proposes Modification to Hazardous Waste Facility Permit: Remote-Handled Transuranic Waste Operations at WIPP*, Waste Isolation Pilot Plant Fact Sheet (http://www.wipp.energy.gov/rcradox/rfc/rhfactsheet.pdf), September 14.

DOE (U.S. Department of Energy), 2004a, *ERPGs and TEELs for Chemicals of Concern*, Rev. 20, DKC-04-003, April.

DOE (U.S. Department of Energy), 2004b, *Environmental Assessment for Proposed Corrective Measures at Material Disposal Area H within Technical Area 54 at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1464, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, June 14.

DOE (U.S. Department of Energy), 2004c, *Contact-Handled Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, Revision 2.0, DOE/WIPP-02-3122, Carlsbad Field Office, Effective Date: November 15.

DOE (U.S. Department of Energy), 2004d, "DOE and Contractor Facility Incident Rates," Office of Environment, Safety and Health, Washington, DC.

DOE (U.S. Department of Energy), 2005a, Personal communication (email) from J. E. Orban, U.S. Department of Energy, Albuquerque, New Mexico, to G. Roles, Science Applications International Corporation, Germantown, Maryland, Subject: Cap Volume Information, February 25.

DOE (U.S. Department of Energy), 2005b, *Final Environmental Assessment for Proposed Closure of the Airport Landfills Within Technical Area 73 at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1515, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, May 22.

DOI (U.S. Department of the Interior), 1986, *Visual Resource Contrast Rating*, Bureau of Land Management, BLM Handbook 8431-1, Washington, DC, January 17.

DOL (U.S. Department of Labor), 2003, *Incidence Rates of Nonfatal Occupational Injuries and Illnesses by Industry and Case Types, 2003*, Bureau of Labor Statistics, Washington, DC.

DRI (Desert Research Institute), 2002a, *Alternative Cover Assessment Program 2002 Annual Report*, Publication No. 41182, October.

DRI (Desert Research Institute), 2002b, *Alternative Cover Assessment Project Phase I Report*, Publication No. 41183, October.

Duratek (Duratek Services, Inc.), 2005, Duratek Transport Cask Inventory, (accessed on December 20, 2005, http://www.duratekinc.com).

Dwyer, S. F., 2001, "Finding a Better Cover," *Civil Engineering*, January.

EnergySolutions, 2006, *Bulk Waste Disposal and Treatment Facilities Waste Acceptance Criteria*, Revision 6, Salt Lake City, Utah, March.

EPA (U.S. Environmental Protection Agency), 1995, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources,* AP 42, Fifth Edition (http://www.epa.gov/ttn/chief/ap42), January.

EPA (U.S. Environmental Protection Agency), 2006, *Glossary of Terms on the MAIA Website*, Office of Research and Development, EPA Region III, Philadelphia, Pennsylvania (http://www.epa.gov/maia/html/glossary.html), March 3.

Finfrock, D., 2008, Time Solutions, Record of Conversation to Regina Wheeler, Los Alamos County Solid Waste Division Manager, Los Alamos County Landfill Closure Status, January 23.

FRTR (Federal Remediation Technologies Roundtable), 2005, *Remediation Technologies Screening Matrix and Reference Guide, Version 4.0* (accessed December 12, 2005, http://www.frtr.gov/matrix2/top_page.html).

Fugro (Fugro Geosciences, Inc.), 2005, Fugro Geosciences Direct Push Technology (DPT) Sampling (accessed December 9, 2005, http://www.geo.fugro.com/services/geosciences/direct_push.asp).

GWRTAC (Ground-Water Remediation Technologies Analysis Center), 2005, *Remediation Technologies* (accessed on December 23, 2005, www.gwrtac.org).

Hudak (Hudak, Paul F), 1996, *Hydrogeology Field Manual*, Department of Geography, University of North Texas (accessed June 3, 2005, http://www.geog.unt.edu/hudak/wellmanual.html).

ICON (ICON Environmental Services), 2005, Direct Push Technology (http://www.iconenv.com/directpush.html).

IES (Integrated Environmental Services), 2005, About Compressed Gases (accessed on January 17, 2006, www.iescylinders.com/compressedgas.html).

INEEL (Idaho National Engineering and Environmental Laboratory), 2000, *Hydrologic Behavior of Two Engineered Barriers Following Extreme Wetting*, INEEL/EXT-2000-00602, Applied Geosciences Department, Idaho Falls, Idaho, September.

INEEL (Idaho National Engineering and Environmental Laboratory), 2002a, *Preliminary Evaluation of Remedial Alternatives for the Subsurface Disposal Area*, INEEL/EXT-02-01258, Environmental Restoration Program, Idaho Falls, Idaho, December.

INEEL (Idaho National Engineering and Environmental Laboratory), 2002b, *Evaluation of Soil and Buried Transuranic Waste Retrieval Technologies for Operable Unit 7-13/14*, INEEL/EXT-01-00281, Environmental Restoration Project, Idaho Falls, Idaho, December.

INEEL (Idaho National Engineering and Environmental Laboratory), 2002c, *Evaluation of In Situ Grouting for Operable Unit 7-13/14*, INEEL/EXT-01-00278, Environmental Restoration Program, Idaho Falls, Idaho, December.

INEEL (Idaho National Environmental and Engineering Laboratory), 2002d, *Evaluation of Short-Term Risks for Operable Unit 7-13/14*, INEEL/EXT-02-00038, Revision 0, Environmental Restoration Program, Idaho Falls, Idaho, December.

Initiatives, 2001, "Going Natural with Passive Soil Vapor Extraction," *Initiatives Online*, Volume 8, Fall 2001 (accessed March 3, 2005, http://www.p2pays.org/ref/14/13958.htm).

ITRC (Interstate Technology and Regulatory Council), 2003a, *Technology Overview Using Case Studies of Alternative Landfill Technologies and Associated Regulatory Topics*, March.

ITRC (Interstate Technology and Regulatory Council), 2003b, *Technical and Regulatory Guidance for Design, Installation, and Monitoring of Alternative Final Landfill Covers*, December.

Jensen, C., M. Devarakonda, and J. Biedscheid, 2001, *Methodology for Determination of Radioassay Properties for RH-TRU Waste,* WM '01 Conference, Tucson, Arizona, February 25 to March 1, 2001.

KSL, 2004, LANL Roads/NM/502, 24 Hour Vehicular Traffic Counts, Directional AM and PM Peak Hour Traffic, September 12, 2004 – September 18, 2004 (Map), Los Alamos, New Mexico, November 18.

Kwicklis, E., M. Witkowski, K. Birdsell, B. Newman, and D. Walther, 2005, "Development of an Infiltration Map for the Los Alamos Area," New Mexico, *Vadose Zone Journal*, 4:694-707.

LANL (Los Alamos National Laboratory), 1981, *Alternative Transuranic Waste Management Strategies at Los Alamos National Laboratory*, LA-8982-MS, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 1984, *Distribution of Radionuclides and Water in Bandelier Tuff Beneath a Former Los Alamos Liquid Waste Disposal Site After 33 Years*, LA-10159-LLWM, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1986, *Corrective Measures Technology for Shallow Land Burial at Arid Sites: Field Studies of Biointrusion Barriers and Erosion Control*, LA-10573-MS, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 1989, *History and Geophysical Description of Hazardous Waste Disposal Area A, Technical Area 21*, LA-11591-MS, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 1991, *TA-21 Operable Unit RFI Work Plan for Environmental Restoration*, LA-UR-91-962, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992a, *RFI Work Plan for Operable Unit 1148*, LA-UR-92-855, Environmental Restoration Program, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992b, *RFI Work Plan for Operable Unit 1144*, LA-UR-92-900, Environmental Restoration Program, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992c, *RFI Work Plan for Operable Unit 1147*, LA-UR-92-969, Environmental Restoration Program, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992d, *RFI Work Plan for Operable Unit 1079*, LA-UR-92-850, Environmental Restoration Program, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992e, *RFI Work Plan for Operable Unit 1071,* LA-UR-92-810, Environmental Restoration Program, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992f, *RFI Work Plan for Operable Unit 1122*, LA-UR-92-925, Environmental Restoration Program, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1993a, *RFI Work Plan for Operable Unit 1130*, (TA-36, -68, -71), LA-UR-93-1152, Environmental Restoration Program, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1993b, *RFI Work Plan for Operable Unit 1132*, (TA-39), LA-UR-93-768, Environmental Restoration Program, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1993c, *RFI Work Plan for Operable Unit 1086*, LA-UR-92-3968, Environmental Restoration Program, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993d, *RFI Work Plan for Operable Unit 1157*, (TA-8, -9, -23, -69), LA-UR-93-1230, Environmental Restoration Program, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993e, *RFI Work Plan for Operable Unit 1114*, LA-UR-93-1000, Environmental Restoration Program, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993f, *RFI Work Plan for Operable Unit 1082*, (TA-11, -16, -28, -37), LA-UR-93-1196, Environmental Restoration Program, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993g, *RFI Work Plan for Operable Unit 1111*, LA-UR-93-2166, Environmental Restoration Program, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1993h, *Data Analysis of the 1984 and 1986 Soil Sampling Programs at Materials Disposal Area T in the Los Alamos National Laboratory*, LA-12650-MS, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 1997, *Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G*, LA-UR-97-85, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 1998a, *Stabilization Plan for Installing Best Management Practices at Potential Release Sites 49-001 (b, c, d, and g)*, LA-UR-98-1534, Environmental Restoration Project, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1998b, *Threatened and Endangered Species Habitat Management Plan Overview*, LALP-98-112, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 1999a, *Best Management Practices Report for Installation of Stabilization Measures at Potential Release Sites 49-001 (b, c, d, and g)*, LA-UR-98-4170, Environmental Restoration Project, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 1999b, *Material Disposal Areas Core Document*, LA-UR-99-4423, Environmental Restoration Project, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1999c, *Interim Measures Report for Potential Release Sites 49-001(b), 49-001(c), 49-001(d), 49-001(g)*, LA-UR-99-2169, Environmental Restoration Project, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1999d, *Work Plan for Sandia Canyon and Cañada del Buey*, LA-UR-99-3610, Environmental Restoration Project, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 1999e, *Environmental Technology Cost-Savings Analysis Project Summary Viewgraphs*, LA-UR-99-2367, Energy and Environmental Analysis, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2000a, *Major Accomplishments of the Environmental Restoration Project in Fiscal Year (FY) 2000*, LA-UR-00-5646, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2000b, *Installation Work Plan for Environmental Restoration Project*, Revision 8, LA-UR-00-1336, Environmental Restoration Project, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2000c, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2001a, *Information Sheet: Material Disposal Area P*, LA-UR-01-6778, ER2001-1002, Environmental Restoration Project, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2001b, *Information Sheet: Airport Landfill*, LA-UR-01-6778, ER2001-1002, Environmental Restoration Project, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2001c, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2001d, Bass, J., "MDA-P: Not the First but the Biggest," Los Alamos News Letter, Vol. 2, No. 17, p. 5, August 23.

LANL (Los Alamos National Laboratory), 2001e, *Supplemental Sampling and Analysis Plan for Potential Release Sites 73-001(a) and 73-001(d)*, LA-UR-01-3987, Environmental Restoration Project, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2001f, *Cerro Grande Fire One Year After: An Update on ER Activities to Reduce the Potential Movement of Contamination at Potential Release Sites*, LA-UR-01-4122, Environmental Restoration Project, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2002a, *Information Sheet: Technical Area 21 Material Disposal Areas*, LALP-02-130, ER2002-0466, Environmental Restoration Project, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2002b, R. Shuman, S. French, and C. Pollard, *Performance Assessment Closure Plan for Area G*, LA-UR-02-7821, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2002c, *Information Sheet: 260 Outfall*, LALP-02-70, ER2002-0333.

LANL (Los Alamos National Laboratory), 2002d, *Transuranic Waste Inspectable Storage Project (TWISP) Retrieval from Pads 1, 2, and 4 at Technical Area 54*, FWO-Solid Waste Operations, February 4.

LANL (Los Alamos National Laboratory), 2002e, *Sampling and Analysis Plan for the Middle Mortandad/Ten Site Aggregate*, LA-UR-02-0244, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2002f, *Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21*, LA-UR-02-2218, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2002g, "New Mexico Environment Department (NMED) Draft Order," Memorandum from B.A. Ramsey, Risk Reduction and Environmental Stewardship Division, to Ralph Erickson, Office of Los Alamos Site Operations, Department of Energy, July 30.

LANL (Los Alamos National Laboratory), 2003a, *Site Screening Study for Los Alamos County Sanitary Landfill*, LA-UR-03-1349, Infrastructure, Facilities, and Construction, Los Alamos, New Mexico, February.

LANL (Los Alamos National Laboratory), 2003b, *Corrective Measures Study Report for Material Disposal Area H, Solid Waste Management Unit 54-004, at Technical Area 54,* LA-UR-03-3354, Risk Reduction and Environmental Stewardship Division, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2003c, *Waste Volume Forecast*, Rev. 0, LA-UR-03-4009, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003d, *Investigation Work Plan for Material Disposal Area L Solid Waste Management Unit 54-006 at Technical Area 54*, LA-UR-03-5998, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2003e, *Interim Measure Completion Report for the NTISV Hot Demonstration at SWMU 21-018(a)-99 (MDA V)*, LA-UR-03-6494, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003f, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003g, *Phase III RFI Report for Solid Waste Management Unit 16-021(c)-99*, LA-UR-03-5248, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003h, *Material Disposal Area P Site Closure Certification Report*, LA-UR-03-8046, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2003i, *Voluntary Corrective Measure (VCM) Completion Report for Solid Waste Management Unit 21-011(k) at Technical Area 21,* LA-UR-03-7293, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2003j, *The General's Tanks Characterization Activities Documented Safety Analysis*, LA-UR-03-6520, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2003k, *Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009 at Technical Area 50*, Rev. 1, LA-UR-03-8201, Los Alamos, New Mexico (Updated January 2004), November.

LANL (Los Alamos National Laboratory), 2003l, *Corrective Measures Study Report for Solid Waste Management Unit 16-021(c)-99,* LA-UR-03-7627, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2003m, *Historical Investigation Report for Area L,* ER2003-0766, December.

LANL (Los Alamos National Laboratory), 2004a, *Investigation Work Plan for Material Disposal Area T at Technical Area 21, Solid Waste Management Unit 21-016(a)-99*, LA-UR-04-0559, Los Alamos, New Mexico, February.

LANL (Los Alamos National Laboratory), 2004b, *Los Alamos County Sanitary Landfill Site Evaluation*, LA-UR-04-3166, Power Point Slides, National Nuclear Security Administration, May 5.

LANL (Los Alamos National Laboratory), 2004c, "Historical Investigation Report," Appendix B to *Investigation Work Plan for Material Disposal Area G, Solid Waste Management Unit 54-013(b)-99,* at Technical Area 54, Rev. 1, LA-UR-04-3742, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2004d, *Investigation Work Plan for Material Disposal Area B at Technical Area 21, Solid Waste Management Unit 21-015,* LA-UR-04-3713, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2004e, *Investigative Work Plan for Delta Prime Site Aggregate Area at Technical Area 21,* LA-UR-04-5009, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2004f, *Information Document in Support of the Five-Year Review and Supplemental Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004g, *Phase III RCRA Facility Investigation Report for Consolidated SWMU 16-021(c)-99 (Revised)*, ER2004-0521, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004h, *Environmental Surveillance at Los Alamos During 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004i, *Waste Volume Forecast*, Rev. 1, LA-UR-04-6682, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004j, *Proposed Remediation of MDA V Within TA-21*, NEPA Review, LAN-05-001, October 4.

LANL (Los Alamos National Laboratory), 2004k, *Historical Investigation Report for Material Disposal Area U, Solid Waste Management Unit 21-017(a)-99*, at Technical Area 21, LA-UR-04-7267, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2004l, *Documented Safety Analysis for Surveillance and Maintenance of Nuclear Environmental Sites at Los Alamos National Laboratory*, LA-UR-04-7505, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2005a, *Siting Study for Los Alamos County Solid Waste Transfer Station*, LA-UR-05-0338, Space and Site Management Office, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2005b, *Investigation Work Plan for Material Disposal Area A at Technical Area 21, Solid Waste Management Unit 21-014*, LA-UR-05-0094, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2005c, PRS Data Base for LANL, Unpublished, Word file dated January 24.

LANL (Los Alamos National Laboratory), 2005d, *Modification of a Special Use Permit to the Incorporated County of Los Alamos for the Construction and Operation of a Solid Waste Transfer Station at TA-61*, Accession No. 11228, LASO 05-003, February 8.

LANL (Los Alamos National Laboratory), 2005e, DOE to Sample Airport Ash Site, Lamonitor.com, the *Online News Source for Los Alamos*, available at http://www.lamonitor.com/articles/2005/04/15/headline_news/news02.txt, April 19.

LANL (Los Alamos National Laboratory), 2005f, *Work Plan for the Implementation of an In Situ Soil Vapor Extraction Pilot Study at Technical Area 54*, Material Disposal Area L, Los Alamos National Laboratory, LA-UR-05-0633, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2005g, *Pueblo Canyon Aggregate Area Investigation Work Plan*, LA-UR-05-2366, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2005h, *Radioactive Waste Operations at Area G*, LA-UR-05-3190, PowerPoint slides, Los Alamos, New Mexico, May 3.

LANL (Los Alamos National Laboratory), 2005i, Airport Landfill Plan Progresses, Lamonitor.com, the *Online News Source for Los Alamos*, June 6.

LANL (Los Alamos National Laboratory), 2005j, *Investigation Work Plan for Guaje/Barrancas/Rendija Canyons Aggregate Area at Technical Area 00*, LA-UR-05-3869, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2005k, *Status Report for Integrated Closure Activities at Technical Area 54*, LA-UR-05-6767, Los Alamos, New Mexico, July 7.

LANL (Los Alamos National Laboratory), 2005l, *Facility Integration Program*, LA-UR-05-5601, Los Alamos, New Mexico, July 26.

LANL (Los Alamos National Laboratory), 2005m, *Environmental Stewardship Division Remediation Project – NMED Consent Order Implementation and Update on Remediation Milestones*, LA-UR-05-5660, Los Alamos, New Mexico, July 26.

LANL (Los Alamos National Laboratory), 2005n, *Aggregate Areas List; Maps of TAs, SWMUs/AOCs*, LA-UR-05-6234, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005o, *SWEIS Yearbook—2004, Comparison of 2004 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-05-6627, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005p, *Documented Safety Analysis for Investigation, Remediation, and Restoration of Material Disposal Area B Nuclear Environmental Site,* ER2005-0346, 30 Percent Draft Submittal, September.

LANL (Los Alamos National Laboratory), 2005q, *Investigation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at Technical Area 54*, LA-UR-05-6398, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005r, *Investigation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54*, LA-UR-05-5777, Los Alamos, New Mexico, September 2005.

LANL (Los Alamos National Laboratory), 2006a, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006b, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006c, *Chemical Inventory Limits for Investigation, Remediation, and Restoration of Material Disposal Area B Nuclear Environmental Site*, LA-UR-06-0371, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2006d, "Pilot test of volatile organic removal from former lab disposal site is a success", *LANL Newsletter,* Vol. 7, No. 16, July 31.

LANL (Los Alamos National Laboratory), 2006e, *Response to Notice of Disapproval for the "Investigation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at Technical Area 54," Los Alamos National Laboratory, EPA ID#NM0890010515, HWB-LANL-05-019, Dated July 26, 2006, and the Supplement to the Notice of Disapproval for Material Disposal Area G, Dated August 4, 2006*, EP2006-0752, Los Alamos Site Office, Los Alamos, New Mexico, August 31.

LANL (Los Alamos National Laboratory), 2006f, *Documented Safety Analysis for the Removal, Characterization, and Restoration at Material Disposal Area B Nuclear Environmental Site*, LA-UR-06-3993, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006g, *Investigation Report for Material Disposal Area U, Consolidated Unit 21-017(a)-99, at Technical Area 21*, *Revision 1*, LA-UR-06-6137, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006h, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006i, *Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at Technical Area 21, Revision 1*, LA-UR-06-6918, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2006j, *Second Response to New Mexico Environment Department's Notice of Disapproval and Supplement to Notice of Disapproval for the "Investigation Report for Material Disposal Area (MDA) G, Consolidated Unit 54-013(b)-99, at Technical Area 54," Los Alamos National Laboratory, Dated September 13, 2006*, EP2006-0890, Los Alamos Site Office, Los Alamos, New Mexico, November 7.

LANL (Los Alamos National Laboratory), 2006k, *Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009 at Technical Area 50*, LA-UR-06-8096, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2006l, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory, New Mexico*, LA-UR-04-8964, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2006m, *Summary Report: 2006 In Situ Soil Vapor Extraction Pilot Study of Material Disposal Area L, Technical Area 54, Los Alamos National Laboratory*, LA-UR-06-7900, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2007a, *Addendum to the Investigation Report for Material Disposal Area G, Consolidated Unit 54-103(b)99, at Technical Area 54*, LA-UR-07-2582, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2007b, *Corrective Measures Evaluation Plan for Material Disposal Area G at Technical Area 54, Revision 1*, LA-UR-07-4591, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2007c, *Work Plan for the Implementation of an In Situ Soil-Vapor Extraction Pilot Study at Technical Area 54, Material Disposal Area G, Los Alamos National Laboratory*, LA-UR-07-7134, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2007d, *Addendum to the Investigation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54*, LA-UR-07-3214, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2007e, *Interim Subsurface Vapor-Monitoring Plan for Material Disposal Area L at Technical Area 54, Revision 1*, LA-UR-07-7040, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2007f, *Subsurface Vapor-Monitoring Plan for Material Disposal Area T at Technical Area 21*, LA-UR-07-7037, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2007g, *Material Disposal Area B: Process Waste Review, 1945 to 1938*, LA-UR-07-2379, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2008a, *Corrective Measures Evaluation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54*, LA-UR-08-0050, Los Alamos, New Mexico.

Levitt, D. G., M. J. Hartmann, K. C. Kisiel, C. W. Criswell, P. D. Farley, and C. Christensen, 2005, "Comparison of the Water Balance of an Asphalt Cover and an Evapotranspiration Cover at Technical Area 49 of the Los Alamos National Laboratory", *Vadose Zone Journal*, 4:789-797.

LLNL (Lawrence Livermore National Laboratory), 2002, *A Survey of Commercially Available and Proven Remote Control Machines for Excavation and Recovery of Buried Ordnance*, UCRL-ID147836, March 1.

Marsh, Laura K., 2001, *A Floodplains and Wetlands Assessment for the Potential Effects of the Wildfire Hazard Reduction Project*, LA-UR-01-3643, National Nuclear Security Administration, Los Alamos, New Mexico, July 13.

NCDENR (North Carolina Department of Environment and Natural Resources), 2005, Directional Sonic Drilling (accessed December 12, 2005, www.p2pays.org,).

Newman, B. D., 1996, *Vadose Zone Water Movement at Area G, Los Alamos National Laboratory, TA-54: Interpretations Based on Chloride and Stable Isotope Profiles*, LA-UR-96-4682, Los Alamos National Laboratory, Los Alamos, New Mexico, December 9.

NFESC (Naval Facilities Engineering Services Center), 2005, Vertical Cutoff Wall, from Technologies button at Vertical Cutoff Wall Technology Web page (accessed December 9, 2005, http://enviro.nfesc.navy.mil/scripts/WebObjects.exe/erbweb.woa/2/wa/default?wosid=kg5PgvsoqkwMY8esEKS7Cg#slide_show_end.

NFS RPS (Nuclear Fuel Services Radiation Protection Systems), 2005, *Perma-Con® Turnkey Containment Systems* (accessed on December 9, 2005, www.nfsrps.com/docs/pcon.pdf).

NMED (New Mexico Environment Department), 2000, *Solid Waste in New Mexico*, 2000 Annual Report, December 1.

NMED (New Mexico Environment Department), 2004, Fact Sheet, *Proposed Order on Consent Under Section 74-4-10 of the New Mexico Hazardous Waste Act and Section 74-9-36(D) of the New Mexico Solid Waste Act Issued to the United States Department of Energy, and the Regents of University of California for the Los Alamos National Laboratory, Los Alamos, New Mexico*, EPA ID Number: NM0890010515, Santa Fe, New Mexico, September.

NMED (New Mexico Environment Department), 2005, Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act §74-4-10 and the New Mexico Solid Waste Act §74-9-36(D), March 1.

NMED (New Mexico Environment Department), 2006a, *Notice of Disapproval for the "Investigation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at Technical Area 54," Los Alamos National Laboratory,* EPA ID#NM0890010515, HWB-LANL-05-019, Hazardous Waste Bureau, Santa Fe, New Mexico, July 26.

NMED (New Mexico Environment Department), 2006b, *Approval for the Investigation Report for Material Disposal Area U, Consolidated Unit 21-017(a)-99, at Technical Area 21, Los Alamos National Laboratory (LANL)*, EPA ID #NM0890010515, HWB-LANL-06-006, Hazardous Waste Bureau, Santa Fe, New Mexico, September 28.

NMED (New Mexico Environment Department), 2007a, *Selection of a Remedy for Corrective Action at Material Disposal Area H, SWMU 54-004 at Technical Area 54, Los Alamos National Laboratory, Los Alamos, New Mexico, EPA ID No. NM08990010515*, Hazardous Waste Bureau, Santa Fe, New Mexico, November 5.

NMED (New Mexico Environment Department), 2007b, *Approval with Modifications for the Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, a Technical Area 212, Revision 1, Los Alamos National Laboratory, EPA ID #NM0890010515, HWB-LANL-06-007*, Hazardous Waste Bureau, Santa Fe, New Mexico, January 31.

NNSA (National Nuclear Security Administration), 2003, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350, Los Alamos, New Mexico, November.

NRC (U.S. Nuclear Regulatory Commission), 1981, *Draft Environmental Impact Statement on 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste*," NUREG-0782, Vol. 3, Office of Nuclear Material Safety and Safeguards, Washington, DC, September.

Nyhan, J. W., 2005, "A Seven-Year Water Balance Study of An Evapotranspiration Landfill Cover Varying in Slope for Semiarid Regions," *Vadose Zone Journal*, 4:466-480, June 13.

Omicron (Omicron Safety and Risk Technologies, Inc.), 2001, *Transportation and Worker Risk Assessment for Material Disposal Area (MDA) H, TA-54 at Los Alamos National Laboratory for the Excavation Alternative*, 01-OMICRON-014, Albuquerque, New Mexico, September 30.

ORNL (Oak Ridge National Laboratory), 1998, *Demonstration of Fluidic Pulse Jet Mixing for a Horizontal Waste Storage Tank*, ORNL/TM-13578, Oak Ridge, Tennessee, January.

Pfeil, J. J., A. J. Leavitt, M. E. Wilks, S. Azevedo, L. Hemenway, K. Glesener, and J. M. Barker, 2001, *Mines, Mills and Quarries in New Mexico, 2001*, New Mexico Bureau of Mine Inspection, Socorro, New Mexico.

PNNL (Pacific, Northwest National Laboratory), 1997, *Analysis of the Long-Term Impacts of TRU Waste Remaining at Generation/Storage Sites for No Action Alternative 2*, PNNL-11251, Richland, Washington, September.

Pope, P., N. Becker, E. Van Eeckhout, C. Rofer, N. David, and J. Irvine, 2000, *Environmental Site Characterization Utilizing Aerial Photographs and Satellite Imagery: Three Sites at Los Alamos National Laboratory*, New Mexico, LA-UR-00-3781, Chattanooga, Tennessee, September 28.

Reade (Reade Advanced Materials), 2005, *Weight per Cubic Foot and Specific Gravity* (accessed December 30, 2005, www.reade.com).

Roesler, A. C., C. H. Benson, and W. H. Albright, 2002, *Field Hydrology and Model Predictions for Final Covers in the Alternative Assessment Program-2002*, Geo Engineering Report Number 02-08, University of Wisconsin-Madison, Wisconsin, September 20.

Rogers, M. A., 1977, *History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)*, LA-6848-MS, Vol. I., Los Alamos Scientific Laboratory of the University of California, Los Alamos, New Mexico, June.

SNL (Sandia National Laboratories), 2003, *Chemical Waste Landfill Excavation Voluntary Corrective Measure Final Report*, Environmental Restoration Project, Albuquerque, New Mexico, April.

SNL (Sandia National Laboratories), 2004, *Mixed Waste Landfill Corrective Measures Study Final Report, Sandia National Laboratories, Albuquerque, New Mexico*, SAND2004-0627, Albuquerque, New Mexico, March.

Stephens (Daniel B. Stephens & Associates, Inc.), 2005, *Borrow Source Survey for Evapotranspiration Covers at Los Alamos National Laboratory*, Draft, Los Alamos, New Mexico, January 18.

TH (TH Drilling Services, Ltd.), 2005, (accessed June 13, 2005, www.thdrilling.com/services.htm).

USGS (U.S. Geological Survey), 2003, *The Mineral Industry of New Mexico*, U.S. Geological Survey Minerals Yearbook–2003.

Waugh, W. J., G. M. Smith, D. Bergman-Tabbert, and D. R. Metzler, 2001, "Evolution of Cover Systems for the Uranium Mill Tailings Remedial Action Project, USA," *Mine Water and the Environment*, V. 20, pp190-197.

WCS (Waste Control Specialists, LLC), 2002, Meeting the Nation's needs for cost effective waste management services (accessed December 14, 2005, www.wcstexas.com).

Weiner, R. F., D. M. Osborn, G. S. Mills, D. Hinojosa, T. J. Heames, and D. J. Orcutt, 2006, *RadCat 2.2 User Guide*, SAND2006-1965, Sandia National Laboratories, Albuquerque, New Mexico, April.

WERC (A Consortium for Environmental Education and Technology Development), 2002, *New Mexico Greenhouse Gas Action Plan, Enhancing Our Future through Mitigation*, August.

WIPP (Waste Isolation Pilot Plant), 2004, *EPA Approves Remote-Handled Waste Procedures for WIPP*, U.S. Department of Energy News Release, Carlsbad Field Office, Carlsbad, New Mexico, March 30.

WIPP (Waste Isolation Pilot Plan), 2005, *Transuranic Waste Transportation Containers* (accessed December 9, 2005, www.wipp.energy.gov/fctshts/TRUwastecontainers.pdf).

Wolf, J., 2002, *Innovative Soft-Sided Waste Packaging System Implementation at a Small Department of Energy Environmental Restoration/Waste Management (ER/WM) Site,* WM'02 Conference, Tucson, Arizona, February 24-28.

WSDOE (Washington State Department of Ecology), 2005, "Northwest Interstate Compact on Low-Level Radioactive Waste Management," (accessed on December 14, 2005, www.ecy.wa.gov/ecyhome.html).

WSRC (Westinghouse Savannah River Company), 1997, *Miscellaneous Chemical Basin Treatability Study: An Analysis of Passive Soil Vapor Extraction Wells (PSVE)*, WSRC-TR-97-00405, Rev. 1, Savannah River Site, Aiken, South Carolina, December.

WSRC (Westinghouse Savannah River Company), 2000, *Metallurgical Laboratory (MetLab) Treatability Study: An Analysis of Passive Soil Vapor Extraction Wells (PSVE), June 2000 Update (U)*, WSRC-TR-2000-00182, Savannah River Site, Aiken, South Carolina, June.

APPENDIX J
IMPACTS ANALYSES OF PROJECTS ASSOCIATED WITH NEW INFRASTRUCTURE OR LEVELS OF OPERATION

APPENDIX J
IMPACTS ANALYSES OF PROJECTS ASSOCIATED WITH NEW INFRASTRUCTURE OR LEVELS OF OPERATION

Appendix J presents the project-specific analyses for three proposed projects that would result in either new infrastructure or increased levels of operation at Los Alamos National Laboratory (LANL) within the timeframe under consideration in the *Final Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS). These three proposed projects are:

- Security-Driven Transportation Modifications;
- Nicholas C. Metropolis Center for Modeling and Simulation (Metropolis Center) Increase in Levels of Operation; and
- Increase in the Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project.

These projects are part of the Expanded Operations Alternative, and their implementation could entail changes in the use of resources (such as water and electric power) or new accident types (such as the introduction or movement of new materials at risk [MAR]) not fully addressed in existing National Environmental Policy Act (NEPA) analyses. The proposed timeframes associated with construction and operation of these facilities are depicted in **Figure J–1.**

Facility or Project Name	Fiscal Year					
New Infrastructure or Levels of Operations	2007	2008	2009	2010	2011	2012 & beyond
Security-Driven Transportation Modifications	Construction			Operation		
Nicholas C. Metropolis Center Increased Levels of Operations			Gradual Increase			
Increase in the Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project			Ongoing Activity			

Figure J–1 Proposed Timeframes for Construction and Operation of Projects to Add New Infrastructure or Increase Levels of Operation

The projects included in this appendix are categorized into two broad groups: (1) those that would add new elements to LANL's present infrastructure; and (2) those that would increase the present operating levels at existing LANL facilities. A brief introduction to each project is presented below, with detailed analysis of the environmental consequences associated with each project presented in the following sections.

New Infrastructure. The *Security-Driven Transportation Modifications* Project is part of LANL's ongoing physical protection efforts around critical assets that directly support nuclear weapons, homeland security, and other nuclear-related national security missions. Since the September 11, 2001, terrorist attacks, security-related issues have risen in prominence and have been a driving consideration in LANL planning. As part of this ongoing security improvement effort, the National Nuclear Security Administration (NNSA) determined that there is a continuing need for upgrade physical protection in the area of the Pajarito Corridor West. This would involve restricting vehicle access, according to the security level, to LANL's core nuclear science and materials area between Technical Area (TA) 48 and TA-63. Staff and visitors would access this area through an internal shuttle system linked to parking areas in TA-48 and TA-63.

Increased Levels of Operation. The *Metropolis Center* is an existing facility that houses one of the world's largest and most advanced computers. It is part of an integrated tri-lab (LANL, Lawrence Livermore National Laboratory, and Sandia National Laboratories) effort to run supercomputers that allows researchers to integrate past weapons test data, materials studies, and current simulation experiments, thereby serving as an alternative to underground testing. While the computing capacity of the Metropolis Center is currently between 30 and 50 teraflops (30 to 50 trillion floating point operations per second), the long-term goal was to develop a computer system capable of performing up to at least 100 teraflops. With this goal in mind, the infrastructure was originally designed so that this projected computing capacity could be added without expanding the building. Since the 1998 *Environmental Assessment for the Proposed Strategic Computing Complex (SCC EA)* (DOE/EA-1250), NNSA has made the programmatic decision that in order to ensure the safety, reliability, and performance of the nation's nuclear weapons stockpile, the Metropolis Center's operations need to be upgraded to 100 teraflops, with the possibility that a future operating level of approximately 1,000 teraflops (1 petaflops) might be requested.

The *Increase in the Type and Quantity of Sealed Sources Managed at LANL by the Off-Site Source Recovery Project* is an ongoing effort that involves the recovery and storage of excess and unwanted radiological sources licensed by the U.S. Nuclear Regulatory Commission (NRC) to public or private organizations. As requested by the NRC, from 1979 to 1999, the U.S. Department of Energy (DOE) retrieved, on a case-by-case basis, approximately 1,100 sealed sources and sent them to LANL. The increased costs and inefficiencies associated with this case-by-case approach prompted DOE to formulate a management strategy that was addressed in the *Environmental Assessment for the Radioactive Source Recovery Program* (DOE 1995). In 2000, NNSA prepared the *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Certain Unwanted Radioactive Sealed Sources at Los Alamos National Laboratory*, DOE/EIS-0238-SA-01 (DOE 2000). Sealed sources would be packaged in multifunctional shielded containers (at the origination point or consolidated at a licensed commercial facility under contract to DOE) and shipped directly to LANL for storage as waste items.

In response to the events of September 11, 2001, NRC conducted a risk-based evaluation of potential terrorist threats and concluded that unwanted radiological sealed sources constituted a potential vulnerability. In order to meet this security need, NNSA's recovery mission was expanded, thereby necessitating the management of additional numbers and types of sealed sources. While NNSA intends to use commercial organizations and their facilities where appropriate, LANL site facilities would be utilized when commercial storage was not appropriate to fulfill the national security mission of the Off-Site Source Recovery Project.

J.1 Security-Driven Transportation Modifications Impacts Assessment

This section provides an assessment of the potential environmental impacts associated with proposed security-driven transportation modifications in the Pajarito Corridor West and nearby areas at LANL. Section J.1.1 provides background information including the purpose and need for the proposed security-driven transportation modifications. Section J.1.2 provides a summary of the Proposed Project and presents the option being considered, plus auxiliary actions to extend roadways across canyons to connect with mesas to the north. Section J.1.3 describes the affected environment in the Pajarito Corridor West and the mesas to the north, and impacts associated with the options and auxiliary actions.

J.1.1 Introduction, Purpose, and Need for Agency Action

Security-related issues have risen in prominence in the United States following the terrorist attacks of September 11, 2001. Similarly, security is figuring prominently in planning at LANL, affecting current and future concepts for controlling traffic on the site. Transportation planning at LANL is being conducted in response to updated NNSA security requirements and guidance.

Background

The current proposal is to implement security-driven transportation modifications that would further enhance security by restricting, according to the security level, privately-owned vehicles along portions of the Pajarito Corridor West between TA-48 and TA-63. Under this planned approach, vehicle traffic in the Pajarito Corridor West could be limited, according to the security level, to only government vehicles and physically inspected service vehicles. Access for staff and visitors to this controlled area would be provided by an internal shuttle system linked to large parking areas at TA-48 and TA-63. In addition to controlling potential vehicle-borne threats, this approach provides an opportunity for LANL to use transit systems to reduce onsite vehicle use, related resource consumption, and impacts on air quality. **Figure J–2** provides an overview of the proposed Pajarito Corridor West security-driven transportation plan.

This transportation plan reflects proposed modifications that would be implemented over the near term – that is, primarily over the next 5 years. Further development of the West Pajarito Corridor is expected, and a comprehensive development concept has been issued covering the next 20 to 30 years for the West Pajarito Corridor Planning Area (LANL 2006a). Further NEPA analyses would be needed for proposals developed from this long-term conceptual plan that are not addressed in this SWEIS.

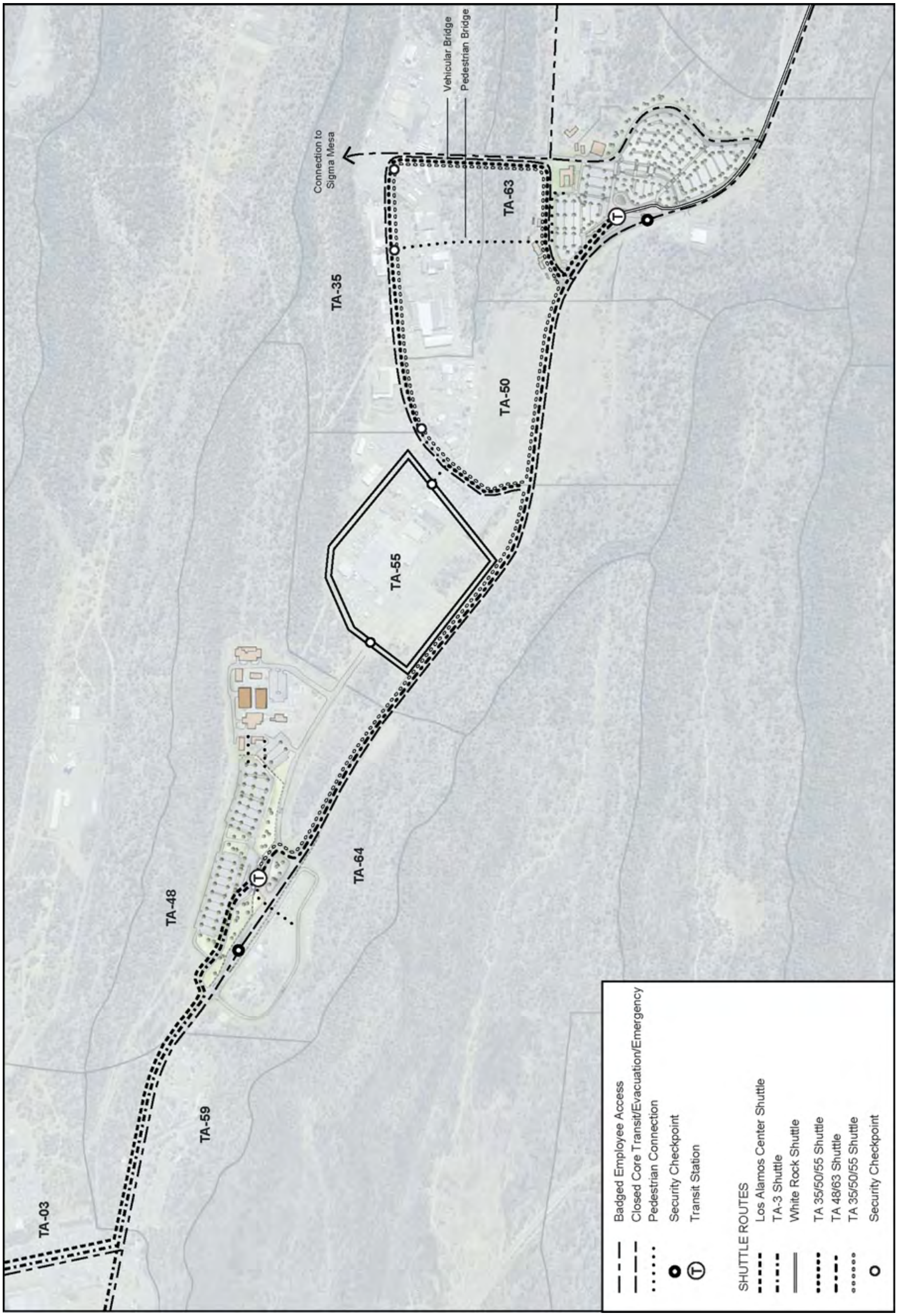


Figure J–2 Proposed Pajarito Corridor West Security-Driven Transportation Plan

Several NEPA documents are related to the Proposed Project. The *Environmental Assessment for Proposed Access Control and Traffic Improvements at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1429 (DOE 2002) evaluated the impacts of constructing and implementing traffic control measures that would, according to the security level, restrict vehicle traffic in the vicinity of the core area of LANL, including the main administrative and technical area at TA-3.

The *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350 (DOE 2003), analyzed alternatives for upgrading or replacing the Chemistry and Metallurgy Research Building. The Record of Decision (ROD) issued in the *Federal Register* (FR) on February 12, 2004, (69 FR 6967) selected the Preferred Alternative, which is the construction of a new Chemical and Metallurgy Research Replacement facility at TA-55. Implementation of the ROD would result in the construction of a new nuclear Hazard Category 2 facility along the Pajarito Corridor West.

The Plutonium Facility Complex Refurbishment Impacts Assessment (see Appendix G of this SWEIS) evaluates the environmental consequences of a multi-year project to modernize and upgrade facilities and infrastructure at the TA-55 complex. The project would be implemented through a series of subprojects. The subprojects are all infrastructure- or facility-related as opposed to adding programmatic capabilities. They range from relatively simple emergency lighting replacement to more complex fire and criticality alarm systems upgrades and exhaust stack replacement.

The TA-Radiography Facility Impacts Assessment (see Appendix G of this SWEIS) evaluates the impacts of locating a radiography facility in TA-55 to serve pit production and surveillance programs needs. This project would result in a minor increase in the number of personnel in TA-55.

The Radiological Sciences Institute Impacts Assessment (see Appendix G of this SWEIS) evaluates the environmental consequences of consolidating radiochemistry and other related activities into a complex in TA-48. Currently the functions to be consolidated are distributed among a number of facilities in multiple TAs including the Sigma Complex and the radiological Machine Shops in TA-3, the Pajarito Site in TA-18, the Radiochemistry Laboratory in TA-48, and other facilities in TA-35, TA-46, and TA-59. This consolidation would result in demolition of old, and construction of new, facilities in TA-48 and an increase in the number of personnel in TA-48.

Other related activities in the vicinity of the Proposed Project are the Nuclear Materials Safeguards and Security Upgrades Project Phases I and II involving activities that were determined to be categorically excluded from NEPA evaluation. Phase I involves installing the data and communications backbone for the security system to the central and secondary alarm stations. Phase II will upgrade the security system at TA-55.

Purpose and Need

LANL's primary mission is to support national security. To carry out that and other assigned missions, LANL staff operates a number of nuclear and radiological facilities in the TAs along the upper end of Pajarito Road, or the Pajarito Corridor West, including the facilities in TA-35, TA-48, TA-50, and TA-55. Current planning includes moving nuclear and radiological capabilities from other locations at LANL into this area. This includes constructing a new facility in TA-55 to which most of the operations of the Chemistry and Metallurgy Research Building would be moved and a Proposed Project evaluated in this SWEIS to consolidate radiochemistry work in TA-48 (see Appendix G, Section G.3).

In recognition of increased and changing threats, NNSA determined that there is a continuing need to upgrade physical protection around critical assets that house quantities of nuclear and radiological materials and directly support LANL's core missions. Facilities and operations in this area are among the most sensitive to LANL nuclear weapons, homeland security, and other nuclear-related missions. LANL management has determined that an effective means of enhancing security would be to control threats that could be transported by vehicles into the area of the Pajarito Corridor West.

J.1.2 Options Descriptions

The two options identified for the Pajarito Corridor West Security-Driven Transportation Modifications Project are the No Action and the Proposed Project to construct and operate the Security-Driven Transportation Modifications. If the Proposed Project were implemented, two auxiliary actions could be implemented. Auxiliary Action A involves the construction of a two-lane bridge crossing between TA-35 and Sigma Mesa (in TA-60), with a new road proceeding west through TA-60 toward TA-3. Auxiliary Action B involves a two-lane bridge crossing between TA-60 and TA-61, with a new road proceeding northward to East Jemez Road.

J.1.2.1 No Action Option

Under this option, no action would be taken to change the current physical control of personally-owned vehicles entering the TAs along the Pajarito Corridor West. Transportation-related upgrades aimed at addressing the increased and changing needs for physical protection around facilities in TA-35, TA-48, TA-50, and TA-55 would not be undertaken. Vehicle traffic would continue to be screened at the existing access control stations located on Pajarito Road near Diamond Drive and near Route 4. Staff and visitors with DOE-issued security badges would continue to traverse Pajarito Road and be allowed to drive vehicles in the proximity of the facilities in TA-35, TA-48, TA-50, and TA-55.

J.1.2.2 Proposed Project: Construct Security-Driven Transportation Modifications in the Pajarito Corridor West

Under the Proposed Project, a comprehensive planned approach would be implemented to upgrade and enhance security in the Pajarito Corridor West area (LANL 2006d). In the near-term, this would include restricting, according to the security level, private through traffic along Pajarito Road at and between TA-48 and TA-63. Surface parking lots would be constructed at these two termini. Provision would be made at these two parking lots for incoming commuter buses. Within this secure project area, a shuttle bus system would be deployed; this would necessitate the modification of some existing roads as well as the construction of some new roads. Retaining walls and security barriers would be constructed, as needed, to provide physical separation of the security-controlled portion of the Pajarito Corridor West from the parking areas and other roadways. A pedestrian and bicycle pathway system also would be provided in this secure area. Shelters and related amenities (benches, bicycle racks, lighting, landscaping, etc.) would be provided at various locations within the project area. Finally, both a pedestrian crossing and a vehicular crossing would be constructed between TA-63 and TA-35.

West Pajarito Transit-Based Concept. The West Pajarito transit-based concept would create two large park-and-ride locations, one at TA-48 and the other at TA-63, with a shuttle transit system running between, transporting people to all the facility areas in TA-35, TA-48, TA-50, and TA-55.

During peak transit hours in the morning and afternoon, the shuttles would operate on intervals of 2 to 5 minutes. During nonpeak hours of operation, the shuttle intervals would be 15 to 30 minutes. Proposed routes for the shuttle system are as follows:

- A route originating from the TA-48 parking area circulating to TA-55, TA-50, and TA-35;
- A route originating from the TA-63 parking area circulating to TA-55, TA-50, and TA-35; and
- A loop between TA-48 and TA-63.

The shuttles would meet Americans with Disabilities Act requirements and allow for bicycle transport as well.

At each of the proposed TA-48 and TA-63 parking areas, transfer locations to local and regional buses would be provided to encourage and make practical the use of public transportation as a method of arriving to the site for employees and visitors. Because the proposed TA-48 and TA-63 parking locations are within a 5-to-10 minute walk of the secure zone, wide well-designed pedestrian walkways and connections would be provided as part of the basic infrastructure improvements of this plan. This would allow and encourage walking as an alternate during much of the year when weather permits. An all-weather pedestrian connection would be included connecting the parking area at TA-63 to the west end of TA-35 to further encourage walking as an alternate transportation mode.

Improvements West of TA-55. The Security-Driven Transportation Modifications Project improvements proposed in the areas west of TA-55 are described below. **Figure J–3** shows the conceptual plan for the proposed modifications around TA-48.

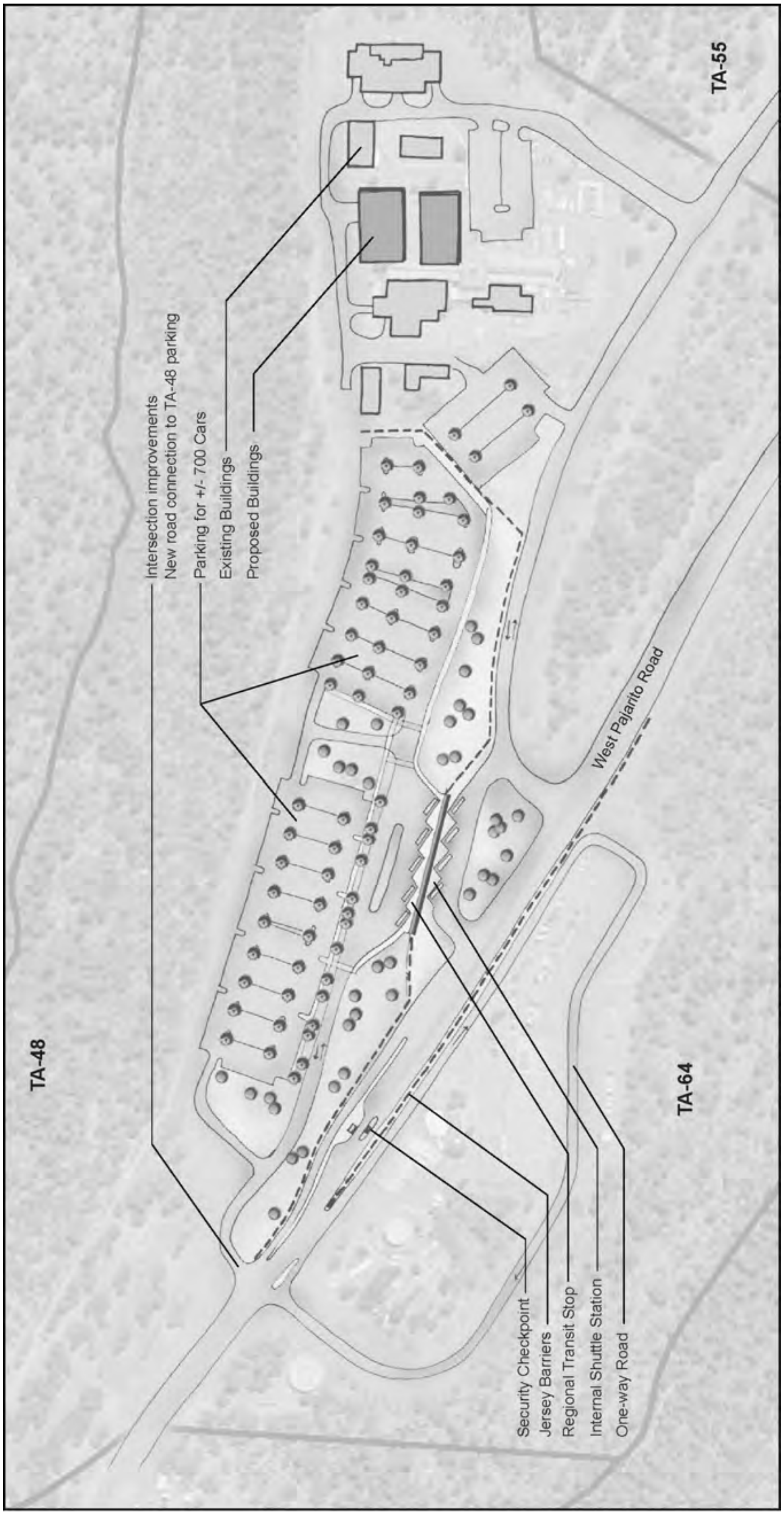


Figure J–3 Proposed Technical Area 48 Security-Driven Transportation Modifications

- A new intersection would be built west of the current guard gate creating the entrance to the TA-48 parking lot and TA-64. The total area to be covered by this new intersection would be approximately one-half acre (0.2 hectares). A standard signalized intersection or a roundabout would be used to control traffic. Vehicle types traveling through this intersection generally would be cars, light- and medium-duty trucks, vans, tank trucks, dump trucks, and sometimes forklifts and cranes. The existing guard gate would remain unchanged.

- A new paved one-way route through TA-64 would be established. The route would go east from the new intersection, running parallel and adjacent to Pajarito Road, then enter TA-64 at its current entrance. The route would circle through the TA-64 parking lot and head west back to the new intersection on a new paved road constructed on an existing dirt road. Much of the land for the new route is currently used as roadway. New sections of this road would be approximately 20 feet (6 meters) wide; retaining walls and side safety barriers would be installed as needed to separate this route from Pajarito Road.

- A new paved two-way road going north from the new intersection would be constructed to provide access to the expanded parking lots in TA-48. This road would be approximately 26 feet (7.9 meters) wide and 400 feet (122 meters) long. Retaining walls and side safety barriers would be built, as needed. The retaining walls could be substantial at the initial turn.

- New surface parking would be constructed at TA-48 to provide parking for approximately 700 cars. Grading and construction of the parking area would disturb approximately 11 acres (4.5 hectares) of land, some of which is currently undisturbed.

- A transit stop would be built at the edge of the TA-48 parking lot where commuters would catch the shuttles to the TAs in the secure area or transfer between buses and shuttles. Amenities would include shade and wind shelters, landscaping, benches, bicycle racks, lighting, phones, and emergency access. Approximately one-half acre (0.2 hectares) of land would be used for the transit stop, shuttle transfer, and associated amenities.

- New short connecting roads would be constructed between the transit stop and the existing road in the TA-48 area.

- An improved walkway would be built to connect the parking lot to the TA-48 complex. This walkway would be at least 10 feet (3 meters) wide and would incorporate rest sites along its length. The 10-foot width would accommodate bicycle use.

Improvements East of TA-55. The Security-Driven Transportation Modifications Project improvements proposed in the areas east of TA-55 are described below. **Figure J–4** shows the conceptual plan for the proposed transportation modifications around TA-35 and TA-63.

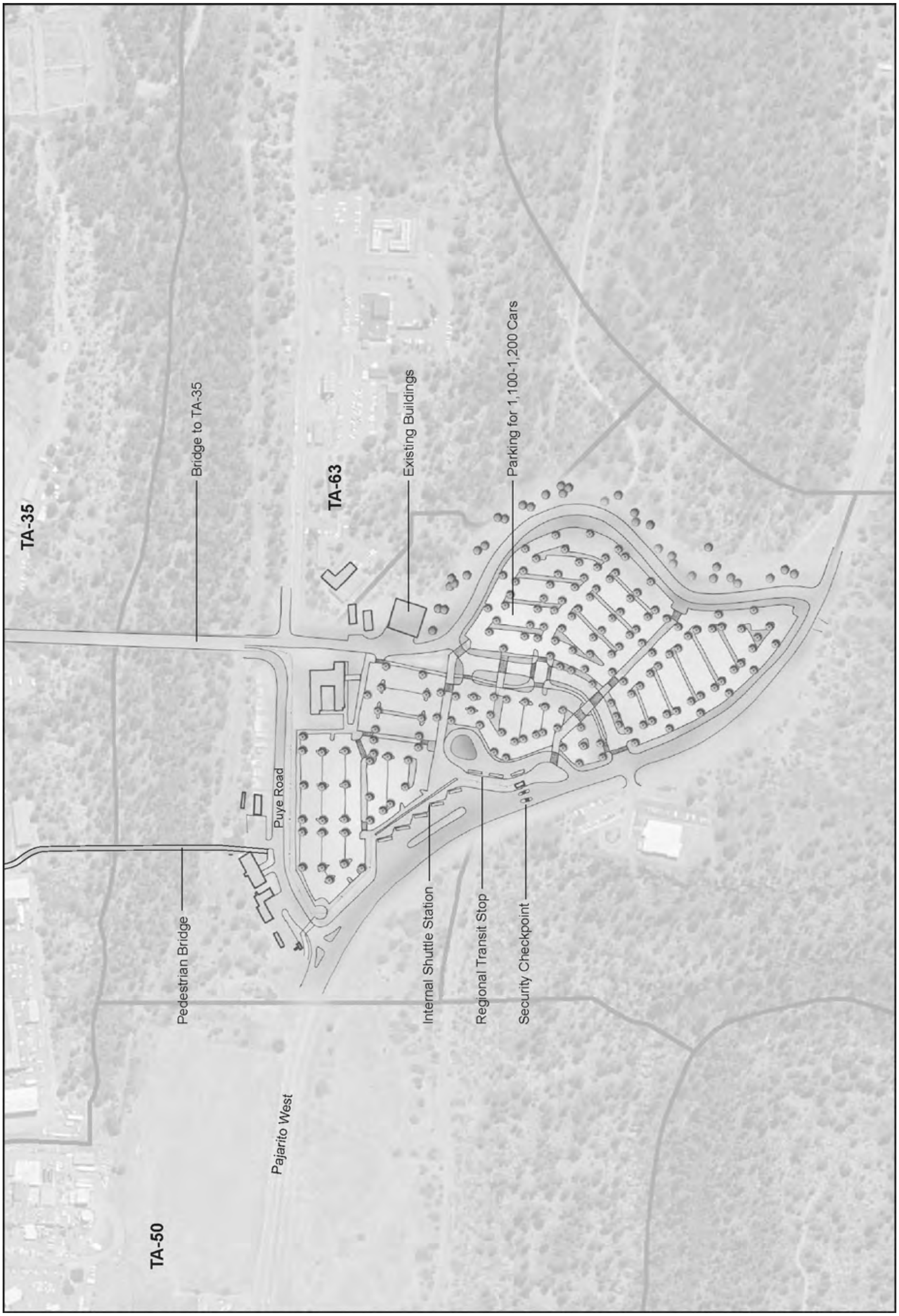


Figure J–4 Proposed Technical Area 35 and Technical Area 63 Security-Driven Transportation Modifications

- A new intersection east of TA-63 would be constructed to provide access to the proposed parking lot and other areas outside the secure area. The new intersection would cover approximately one-half acre (0.2 hectares), a portion of which is undisturbed land. Vehicle types traveling through this intersection generally would be cars, light- and medium-duty trucks, vans, tank trucks, dump trucks, and sometimes forklifts and cranes.

- A new paved two-lane road heading north from the new intersection on Pajarito Road would be constructed. The road would skirt the east edge of TA-63 going northward, and would be 26 feet (7.9 meters) wide and 1,250 feet (380 meters) long.

- A new vehicle crossing would be constructed between TA-63 and TA-35 over a branch of Mortandad Canyon (known locally as Ten Site Canyon). This crossing would align with the new road leading north from TA-63. The new vehicle crossing would be four lanes wide (48 feet [7.3 meters]), approximately 600 to 800 feet (180 to 240 meters) long, and would be about 100 feet (30 meters) above the canyon bottom. The bridge would have dividers down the center; the two west lanes would be for secured traffic traveling among TA-35, TA-48, TA-50 and TA-55; and two east lanes would be for limited secured traffic which would include personally-owned vehicles. **Figure J–5** shows the upper end of Ten Site Canyon that would be spanned by the vehicle bridge and a neighboring pedestrian bridge (described below). A variety of design alternatives would be investigated, including a land bridge and a span bridge.

Figure J–5 Photograph of Canyon to be Bridged between Technical Area 35 and Technical Area 63

- A redesigned road would be built from the end of the vehicle crossing to the north edge of TA-35. The total length of this redesigned road would be approximately 800 feet (240 meters). Routing of this road would likely require the removal of transportables, transportainers, and permanent structures.

- New surface parking additions, or modification of existing parking, would be constructed to accommodate approximately 1,100 to 1,200 cars at TA-63. The parking would be built in two phases, with approximately 450 parking spaces built in the first phase (LANL 2006d). A 126-foot (38-meter) by 78-foot (24-meter) retention pond would be built immediately south of the parking lot to serve as a catchment for parking lot runoff. Grading and construction would result in ground disturbance of about 19 acres (7.7 hectares). The northern portion of the existing site contains 200 existing parking spaces and two office trailers, while the southern portion is not developed. Two overhead power lines which traverse the site would not be relocated. The existing main water pipe that passes through the site would not be affected by the proposal (DMJM H&H 2005).

- A new transit stop similar to the one described above for TA-48 would be constructed.

- A new access control station would be built on Pajarito Road east of the new intersection for TA-63.

- Puye Road would be rerouted. From the Pajarito Road side, Puye Road would be routed to run parallel to, but not intersect, the new road around TA-63, as the two cross the new bridge.

- A permanent barrier system separating Puye Road from the new road along the east side of TA-63 and the TA-63 parking areas would be installed.

- A new pedestrian bridge connecting the TA-63 parking lot to the west portion of TA-35 would be constructed. This new pedestrian crossing would consist of an 8-foot- (2.4-meter-) wide lane, that would be approximately 200 feet (61 meters) long, and could be as much as 100 feet (30 meters) above the canyon bottom. A variety of design alternatives would need to be investigated, including a land bridge and a span bridge.

- New walkways would be constructed to connect the TA-63 parking lot to TA-55 and the new pedestrian bridge. These improved pedestrian walkways would be a minimum of 10-feet (3-meters) wide and would incorporate rest locations and provide for bicycle use.

- The existing TA-55 footprint would be expanded into the middle of the adjacent section of Pecos Drive, with a corresponding relocation of the TA-50 fence eastward to accommodate a new section of bicycle and walking paths.

- New shuttle stops would be built at TA-35, TA-48, TA-50, and TA-55. The size of these stops would be scaled to the expected populations at each area, and some TAs could require multiple stops. The largest shuttle stop would be at TA-55 and would be as large as, or larger, than the current onsite shuttle shelter. Each shuttle stop would have shelters, benches, bicycle racks, lighting, landscaping, and other amenities.

- Various walkway improvements would be made as needed within TA-35, TA-48, TA-50, and TA-55 to create safe walking systems from the transit stops to the individual facilities.

Auxiliary Actions. Auxiliary Action A would involve continuing from TA-35 across Mortandad Canyon to a roadway that would traverse the spine of TA-60 westward to TA-3. A two-lane bridge would be constructed across Mortandad Canyon from TA-35 to TA-60 (see **Figure J–6**). The bridge would be 600 to 800 feet (180 to 240 meters) long; each lane would be 12 feet (3.6 meters) wide. At this early stage in the planning for this project, the specific location of the crossing has not been determined, so for purposes of analysis, a 1,000-foot- (300-meter-) wide zone across Mortandad Canyon in which the bridge would be built has been identified (see Figure J–6). **Figure J–7** is a view from TA-35 across Mortandad Canyon to Sigma Mesa in the approximate location that the canyon would be crossed. The bridge would be 24 feet (7.3 meters) wide and approximately 100 feet (30 meters) above the canyon bottom. The design of the bridge is yet to be determined. Regardless of the design, construction would be necessary along the mesa edges and possibly in canyons. A new paved two-lane road (about 3,750 feet [1,140 meters] long would be constructed through TA-60 to connect the road crossing the bridge to a road extended east from TA-3. This new paved road would be constructed along the general alignment of an existing unpaved road. It would meet with an existing paved road located in the western portion of TA-60.

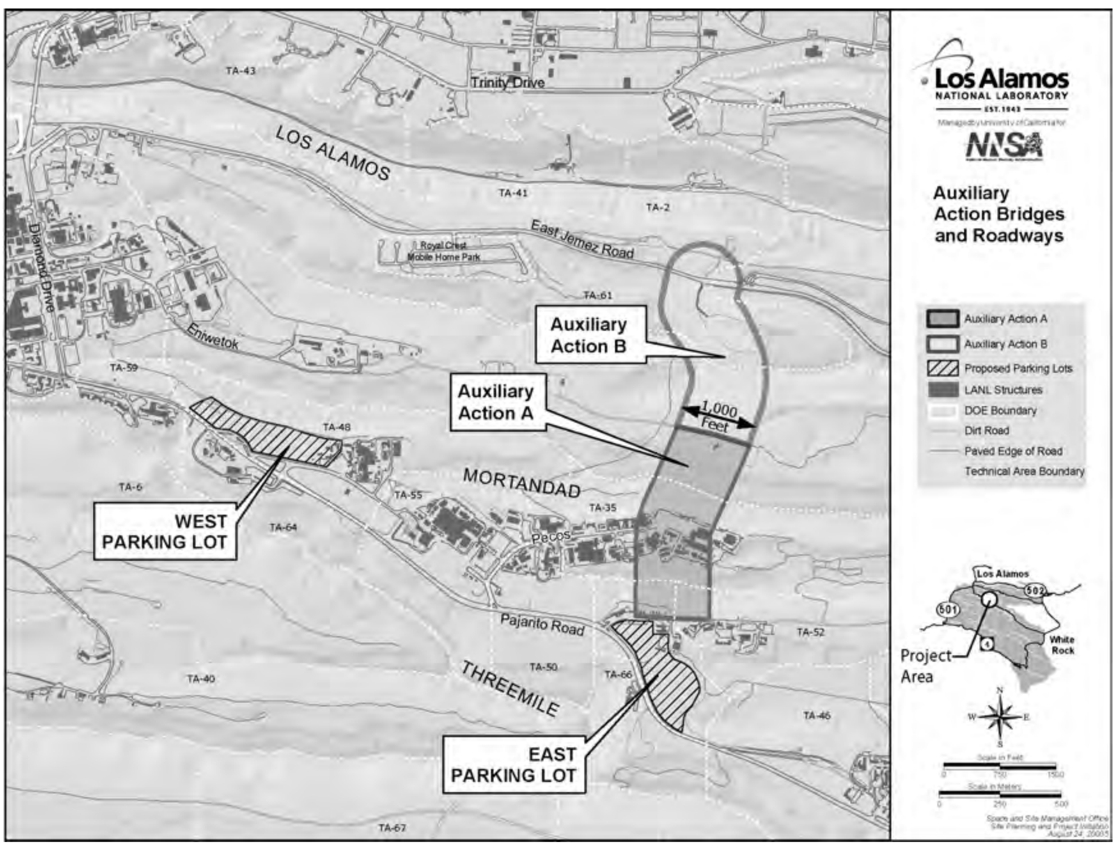


Figure J–6 General Locations of the Auxiliary Action Bridges and Roadways to Technical Area 60 and Technical Area 61

Figure J–7 Photograph Looking North Across Mortandad Canyon in the Area of the Bridge for Proposed Auxiliary Action A

Auxiliary Action B would involve continuing from TA-60 across Sandia Canyon to TA-61, where a new road would connect with East Jemez Road. Auxiliary Action B would provide the most benefit if it were implemented as an augmentation of Auxiliary Action A. A two-lane bridge would be constructed within a 1,000-foot- (300-meter-) wide zone across Sandia Canyon from TA-60 to TA-61 (see Figure J–6). As stated above for Auxiliary Action A, in this early stage of the project, the specific location of the crossing has not been determined, so for purposes of analysis a 1,000-foot- (300-meter-) wide zone across Sandia Canyon, in which the bridge would be built, has been identified (see Figure J–6). The bridge would be 600 to 800 feet (180 to 240 meters) long; each lane would be 12 feet (3.6 meters) wide, with an elevation of approximately 100 feet (30 meters) above the canyon bottom. The design of the bridge is yet to be determined; regardless of the design, however, construction would be necessary along the mesa edges and possibly in canyons. A new two-lane paved road 24 feet (7.3 meters) wide and approximately 750 to 1,000 feet (230 to 300 meters) long would be constructed northward from this bridge's northern terminus and proceed generally northward to meet East Jemez Road.

J.1.3 Affected Environment and Environmental Consequences

The analysis of environmental consequences relies heavily on the affected environment descriptions in Chapter 4 of this SWEIS. Where information specific to the security-driven transportation modifications is available and adds to the understanding of the affected environment, it is included here.

The proposed security-driven transportation modifications are located in the north-central portion of LANL along Pajarito Road between (and including) TA-48 and TA-63. This area includes the facilities in TA-35, TA-48, TA-50, and TA-55. It is anticipated that resource areas potentially affected by the Proposed Project include land resources, geology and soils, water resources, air quality and noise, ecological resources, cultural resources, infrastructure, and waste management.[1] An initial assessment of the potential impacts of the proposed project determined that there would be no or only negligible impacts to the following resource areas and that no further analysis was necessary.

- *Human Health* – There would be no change in practices or procedures associated with radiation exposure or the chemical environment.

- *Socioeconomics and Infrastructure* – It is not anticipated that socioeconomic impacts would occur as a consequence of the Proposed Project. Only infrastructure impacts are included in the impacts discussion.

- *Environmental Justice* – No disproportionately high and adverse environmental impacts on minority or low-income populations would be anticipated to occur.

J.1.3.1 No Action Option

There would be no change in the existing transportation network and no change to practices or procedures under the No Action Option. Therefore, it is anticipated that there would be no new impacts on land resources, visual resources, geology and soils, water resources, air resources, ecological resources, cultural resources, socioeconomics, infrastructure, transportation, or waste management. However, implementing the No Action Option would neither improve transportation flow within the Pajarito Corridor nor provide the needed security upgrades.

J.1.3.2 Proposed Project: Construct Security-Driven Transportation Modifications in the Pajarito Corridor West

Land Resources

Land Use

The Proposed Project would take place on lands in the Pajarito Corridor West. Auxiliary Action A would involve lands in TA-35 and TA-60, and Auxiliary Action B would involve lands in TA-60 and TA-61. The location of these TAs is shown in Chapter 4, Figure 4–3, of this SWEIS.

Pajarito Corridor West – The Pajarito Corridor West is located between Mortandad Canyon on the north and Twomile and Pajarito Canyons on the south, and is immediately southeast of TA-3. It includes TA-35, TA-48, TA-50, TA-52, TA-55, TA-63, TA-64, and TA-66, and totals 831 acres (336 hectares). Activities carried out within the Corridor include nuclear safeguards and chemical processes research and development, theoretical and computational programs

[1] Plans and facility designs for the Security-Driven Transportation Modifications are conceptual and may be subject to change. To conservatively bound impacts to resource areas such as land use, geology and soils, infrastructure, or waste management, the analysis in this appendix is based on the assumption that the proposed new parking areas in TA-48 and TA-63 and other improvements would cover about one-third more land than the nominal 30 acres included in the project description.

related to nuclear reactor performance, research and applications in chemical and metallurgical processes relating to plutonium, and industrial partnership activities. Among the goals for the Pajarito Corridor West are a number related to transportation flow along the mesa and development of a pedestrian campus environment. Existing land use within the Pajarito Corridor West varies by TA, with all TAs including at least some areas designated as Reserve. **Table J–1** identifies the present and planned future land use within each TA that makes up the Corridor, as well as development designations as set forth in the *Comprehensive Site Plan 2001* (LANL 2001). Current land use categories are depicted in Chapter 4, Figure 4–4.

Table J–1 Land Use Designations and Development Areas for Technical Areas that Comprise the Pajarito Corridor West

Technical Area	*Current Land Use*	*Planned Future Land Use*	*Comprehensive Site Plan Development Designation(s)*
35	Experimental Science, Nuclear Materials Research and Development, Physical/Technical Support, Reserve	Experimental Science, Nuclear Materials Research and Development, Reserve	Secondary Development, Potential Infill
48	Experimental Science, Reserve	Nuclear Materials Research and Development, Reserve	Primary Development, Potential Infill, Parking
50	Waste Management, Reserve	Waste Management, Reserve	Secondary Development, Potential Infill, No Development (Hazard)
52	Experimental Science, Reserve	Experimental Science, Reserve	Secondary Development, Potential Infill
55	Nuclear Materials Research and Development, Reserve	Nuclear Materials Research and Development, Reserve	Primary Development, Potential Infill, Parking
63	Physical/Technical Support, Reserve	Waste Management, Reserve	Secondary Development, Potential Infill
64	Physical/Technical Support, Reserve	Physical/Technical Support, Reserve	Potential Infill
66	Experimental Science, Reserve	Experimental Science, Reserve	Secondary Development, Potential Infill

Sources: LANL 2001, 2003.

Technical Area 48 – Except for an existing powerline, the western portion of TA-48, where a surface parking lot for 700 cars is proposed, is vacant. Much of this area has been disturbed as a result of previous activities.

Technical Area 63 – The southern and southeastern areas of TA-63, where a surface parking lot for 1,100 to 1,200 cars is proposed, is vacant. Much of the site has been disturbed as a result of previous activities; the northwestern and central portions of the proposed parking lot have existing surface parking areas, and two powerlines traverse the area.

Technical Area 60 – TA-60, Sigma Mesa, is located immediately east of TA-3 and is 445 acres (180 hectares) in size. The area contains physical support and infrastructure facilities, including the Target Fabrication Facility and Rack Assembly and the Alignment Complex (DOE 1999). Presently, most of the central section of the TA is classified as Physical/Technical Support, with a small area designated as Nuclear Materials Research and Development. Land use is not expected to change in the future (LANL 2003). According to the *Comprehensive Site Plan 2001*, TA-60 is within the Sigma Mesa Development Area (LANL 2001). While developed portions of the TA are classified as Potential Infill, most of the mesa is designated as Primary and Secondary Development. A small corridor of Potential Infill also exists in the eastern part of the TA and connects with a similarly designated area in TA-35. In general, the Plan indicates that considerable development growth is planned for TA-60 and other portions of the Sigma Mesa Area.

Technical Area 61 – TA-61 is located to the northeast of TA-3 and is 297 acres (120 hectares) in size. TA-61 is used for physical support and contains infrastructure facilities, including the Los Alamos County Landfill, which occupies 48 acres (19.4 hectares), and the onsite borrow pit (LANL 2004c). The generalized land use categories within which TA-61 is located are depicted in Chapter 4, Figure 4–4, of the SWEIS, and include Physical/Technical Support and Reserve. According to the *Comprehensive Site Plan 2001*, TA-61 falls within the Sigma Mesa Development Area, an area which could undergo considerable development growth in the future (LANL 2001).

Under the Proposed Project, a number of actions would be implemented within the Pajarito Corridor West. In terms of land area, the largest projects are two parking lots; one in TA-48 and one in TA-63. These would require the disturbance of approximately 11 acres (4.5 hectares) and 19 acres (7.7 hectares), respectively. Some of the land for the proposed parking area in TA-48 has been disturbed from previous activities, and is crossed by an electrical power line. TA-63 has existing parking areas, two temporary structures, and two power lines. Additional actions that would disturb vacant land include a new two-lane road along the east edge of TA-63, new auto and pedestrian crossings connecting TA-63 and TA-35, and a road through the northern edge of TA-35. Other actions associated with this option would involve relatively small areas of land, most of which are disturbed or vacant.

As noted above, the Pajarito Corridor West is highly developed, although vacant land is present. Land use plans for the Corridor have designated some of these vacant areas for future development, including the areas designated for parking. Specifically, the parking area within TA-48 has been designated for Primary Development and that in TA-63 for Secondary Development. Also, the new two-lane road along the eastern edge of TA-63 would pass through areas designated for Secondary Development and Potential Infill. The roadway connecting TA-63 and TA-35 would pass through a corridor designated as Potential Infill, as would the new road along the northern edge of TA-35. However, the new pedestrian walkway connecting the two TAs would not be within an area designated for development in the *Comprehensive Site Plan 2001* (LANL 2001). Many of the other actions under this option would take place largely within developed portions of the Pajarito Corridor West.

While this option would affect future land use by developing currently undeveloped portions of the Pajarito Corridor West, all construction, except the pedestrian walkway between TA-63 and TA-35, would take place within areas designated either for development or for infill. Thus, this option generally would be compatible with land use plans for the Pajarito Corridor West as set forth in the *Comprehensive Site Plan 2001* (LANL 2001).

Visual Environment

Pajarito Corridor West – The TAs that make up the Pajarito Corridor West, along with TA-3, extend along the upper 2.7 miles (4.3 kilometers) of Pajarito Road. Development has taken place within large parts of these TAs. Thus, this area presents the appearance of a mosaic of industrial buildings and structures interspersed with forests along the mesa. Views of the area from a distance are as described in Chapter 4, Section 4.1.2, of this SWEIS. When viewed from along Pajarito Road, the Pajarito Corridor West has an industrial appearance. Mortandad, Twomile and Pajarito Canyons located to the north and south of the mesa, respectively, are wooded and present a natural appearance when viewed from both a distance and nearby.

Technical Area 48 – Most development within TA-48 has occurred in the eastern portion of the TA. Some wooded areas occur in the northern edge of the TA. The proposed surface parking area would be located in the western portion of TA-48; this area is vacant except for a powerline that traverses the northern portion. The area where the proposed parking lot would be sited is readily visible from Pajarito Road.

Technical Area 63 – Most development within TA-63 has occurred in the northern portion of this TA along both sides of Puye Road. The proposed surface parking area would be located in the southern two-thirds of TA-63; this area is vacant except for two powerlines that traverse the site. The area where the proposed parking lot would be sited is readily visible from Pajarito Road.

Technical Area 60 – Most development within TA-60 has occurred within the western portion of the TA. Although some wooded areas occur on the mesa, much of it has been disturbed by a power line and road that runs its length. Additionally, a portion of the mesa is used for the storage of dirt, concrete, and miscellaneous materials. From higher elevations to the west, the mesa appears to be minimally developed; however, due to the power line and road, its appearance contrasts with the adjacent forested canyons. Because of security limitations, near views of the mesa are limited to LANL personnel. Those portions of the TA that include Mortandad Canyon and Sandia Canyon are forested and present a natural appearance.

Technical Area 61 – Most of the mesa within the western portion of TA-61 has been developed, with the Los Alamos County Landfill being the largest facility. The landfill is adjacent to East Jemez Road. Although developed portions of the landfill are not visible from the road, a large berm of stockpiled soil can be seen. The onsite borrow pit is two miles east of the county landfill. The borrow pit is not visible from East Jemez Road due to its location relative to the road, trees bordering the road, and a small hill on the north side of the pit. Although much of TA-61 presents a forested appearance from higher elevations to the west, the landfill and the borrow pit are visible as areas devoid of vegetation. Dust generated from current activities may at times also be visible to the public. Although East Jemez Road passes through the eastern portion of the TA, this part of the TA includes areas of undeveloped woodland both on the mesa and in Pueblo Canyon. This part of TA-61 presents a more natural appearance to those traveling along the road.

The Pajarito Corridor West is a highly developed area that is readily visible from both near and distant locations. While many actions associated with implementing the Security-Driven

Transportation Modifications Project would have little or no visual impact, the construction of the two parking lots, the new roads across TA-63 and TA-35, and the vehicle and pedestrian bridges over the Ten Site branch of Mortandad Canyon would noticeably add to the built-up appearance of the area.

Construction of the two parking lots would disturb approximately 30 acres (12.1 hectares) of land, some previously disturbed and some open and forested. The section of road crossing the eastern portion of TA-35 would disturb open and forested land. However, much of the rest of the roadway would be built within developed portions of the Pajarito Corridor West and would have minimal visual impact. The removal of open and forested land would add to the overall developed appearance of the Pajarito Corridor West as viewed from both nearby and higher elevations to the west. The construction of both the vehicle and pedestrian bridges across a branch of Mortandad Canyon would also have pronounced visual impacts since they would span a forested canyon that has an otherwise natural appearance. These bridges would be readily visible from the canyon where little development is presently apparent; they would also be visible from more distant areas. Careful planning related to site selection and bridge design could help to mitigate these impacts. Most remaining projects associated with the Security-Driven Transportation Modifications Project would be constructed within currently developed portions of the Corridor and, thus, would have little impact on the visual environment.

Geology and Soils

There would be a potential for seismic risk to the facilities constructed under the Security-Driven Transportation Modifications (including the proposed bridges). This risk would be related to seismicity on the nearest fault, the Rendija Canyon Fault (see Chapter 4, Section 4.2.2, of this SWEIS). The bridges under the Proposed Project would be approximately 0.8 miles (1.3 kilometers) east of the Rendija Canyon Fault. The potential for surface rupture at the bridge locations would be low, due in part to the distance from the fault zone, the absence of near-surface faults observed in TA-55 (located between the fault zone and the proposed bridges), and the low recurrence interval of motion on the fault. To minimize the risk of accident, the proposed facilities would be designed and constructed to current DOE seismic standards and applicable building codes.

Soil resources in the area of the Proposed Project include both those disturbed by previous LANL activities and undisturbed soils. The undisturbed soils maintain the present vegetative cover. The arid soils in this area are largely sandy loam material eroded from upslope basalt and tuff units and from underlying geologic units. The soils are generally poorly developed with relatively little horizon differentiation and organic matter accumulation. These factors, combined with the dry moisture regime of the area result in only a limited number of plant species being able to subsist on the soil medium, which in turn supports a very limited number of wildlife species.

Radionuclides are present at near or above background levels in sediments onsite and offsite; however, the overall pattern of radioactivity in sediments has not greatly changed since the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (LANL 2004b). Although it is not expected that the Proposed Project would result in the release of contaminants, the potential exists for some contaminated sediments to be disturbed. Prior to ground disturbance, potentially contaminated areas would be surveyed to determine the extent and nature of any contamination and, as necessary, contaminated areas would be remediated.

Construction of the Security-Driven Transportation Modifications would conservatively disturb approximately 240,000 cubic yards (183,000 cubic meters) of soil and rock. Aside from earth moving, deep trenching and excavation, work would generally be limited to that necessary to realign or install new piping, utility lines, and other conveyances that could be affected by this project. Most of the work would be done in areas where these resources already have been disturbed by existing or past activities including the proposed surface parking lots at TA-48 and TA-63. Minor exceptions would be areas along the southern and southeastern edges of the proposed TA-63 parking lot and along the northern edge of the proposed TA-48 parking lot. The undisturbed (native) soil resources would be irretrievably lost as a result of the construction. To mitigate this loss, valuable surface soil in this area may be scraped off of the building sites and stockpiled prior to beginning construction activities. The saved soil stockpiles (and any excavated rock) could then be used at other locations at LANL for site restoration following remediation. If soil or rock stockpiles are to be stored for longer than a few weeks, the stockpiles may be seeded or managed as appropriate to prevent erosion and loss of the resource. In addition, care would be taken to employ all necessary erosion control best management practices during and following construction to limit impact on soil resources adjacent to the construction and building sites.

A number of potential release sites are in the project area. Grading and embankment excavation work, as well as establishing construction laydown pads, would directly impact sediments, soils, and tuff on the mesa and possibly near and in Mortandad Canyon. While no provisions for wet or flooded soils would likely be required, the potential exists for some contaminated sediments to be disturbed within the canyon areas. Prior to commencing any ground disturbance, potentially affected contaminated areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures. Proposed parking lots, roadways, walkways, shuttle bus structures, and security facilities would be designed, constructed, and operated in compliance with applicable DOE Orders, requirements, and governing standards that have been established to protect public and worker health and the environment.

Geologic resource consumption would be small under this option and would not be expected to deplete local sources or stockpiles of required materials. Conservatively, about 50,000 cubic yards (38,000 cubic meters) of gravel, 25,000 cubic yards (19,000 cubic meters) of asphalt, and 9,000 cubic yards (6,900 cubic meters) of concrete would be needed during construction. Aggregate resources are readily available from onsite borrow areas and are otherwise abundant in Los Alamos County. Concrete and asphalt would be procured from an offsite supplier.

Facility operations would not result in additional impacts on geologic and soil resources at LANL.

Water Resources

Mortandad Canyon receives natural runoff, as well as effluent from several National Pollutant Discharge Elimination System (NPDES) outfalls. The Radioactive Liquid Waste Treatment Facility at TA-50 discharges treated liquids via NPDES Outfall 051 into Mortandad Canyon (EPA 2001). The volume of treated effluent discharged from the TA-50 Radioactive Liquid Waste Treatment Facility has steadily decreased since the *1999 SWEIS*, and LANL is considering options for evaporating rather than discharging this effluent (see Appendix G, Section G.4). Annual flows are shown in Chapter 4, Table 4–9, of this SWEIS.

TA-55 is flanked by Mortandad Canyon to the north and Twomile Canyon to the south (USGS 1984). The site is largely comprised of a heavily developed facility complex with surface drainage primarily occurring as sheet flow runoff from the impervious surfaces within the complex. No developed portions of the complex are located within a delineated floodplain. One TA-55 facility discharges cooling tower blowdown via NPDES Outfall 03A181 directly into Mortandad Canyon (EPA 2000, 2001).

TA-48 and TA-63 do not currently have any NPDES outfalls into Mortandad Canyon or its ancillary canyons. TA-48 and TA-63 are both located on mesa tops and are not within the 100-year or 500-year floodplain boundaries. Storm water flow from the buildings and parking lots in these TAs drain into the Mortandad Canyon system, with some runoff from TA-63 possibly entering Cañada del Buey or Pajarito Canyon.

Ephemeral streams flow in both Mortandad and its ancillary canyon north of TA-63, and in Sandia Canyon. Potential contamination of those streams is minimized by the LANL NPDES Industrial Storm Water Permit Program and the LANL NPDES Storm Water Construction Program.

While nearly every major watershed shows some level of impact from LANL operations, the overall quality of most surface water is described as good. Most samples are within normal ranges or at concentrations far below regulatory standards or risk-based advisory levels (LANL 2004c). Releases from the Radioactive Liquid Waste Treatment Facility have introduced some radionuclide and chemical contamination into surface waters of Mortandad Canyon. This surface water is not used as a drinking source and flows do not normally extend offsite. Beginning in 1999, LANL made significant upgrades to the Radioactive Liquid Waste Treatment Facility treatment system. As a result, for the 6 years ending in 2005, the Radioactive Liquid Waste Treatment Facility has met all DOE radiological standards, all NPDES requirements, and for all but 2 weeks has voluntarily met New Mexico groundwater standards for fluoride, nitrate, and total dissolved solids. In 2005, polychlorinated biphenyls above water quality standards were detected in storm runoff samples from Mortandad Canyon (LANL 2006e).

Effluent discharges have affected perched alluvial groundwater in Mortandad Canyon. Most notably, radionuclide constituents in effluents discharged to Mortandad Canyon from the Radioactive Liquid Waste Treatment Facility at TA-50 have created a localized area of alluvial groundwater with plutonium-238, plutonium-239, plutonium-240, americium-241, tritium, strontium-90, and gross beta measured above the 4-millirem DOE Derived Concentration Guides for drinking water or U.S. Environmental Protection Agency (EPA) drinking water criteria

(LANL 2004c). Nitrate also contained in the effluent has caused alluvial groundwater concentrations to exceed the New Mexico groundwater standard and EPA Maximum Contaminant Level of 10 milligrams per liter.

Perchlorate was detected in Mortandad Canyon in 2002 through 2005, before the EPA issued any water quality standard for this contaminant. In 2005, perchlorate concentrations in four Mortandad Canyon wells exceeded EPA's Drinking Water Equivalent Level of 24.5 micrograms per liter, which was established in January 2006. In 2005, 1,4-dioxane was detected in two perched intermediate aquifer wells in Mortandad Canyon. There is no Federal or State standard for 1,4-dioxane and LANL and the New Mexico Environment Department are currently working to determine the extent and impact of this contaminant. In 2005, a regional aquifer monitoring well in Mortandad Canyon indicated hexavalent chromium levels four times the EPA Maximum Contaminant Level. This is currently being investigated by LANL and New Mexico Environment Department staff and is likely due to past cooling tower discharges in Sandia Canyon (LANL 2006e).

Minimal impacts to surface water are expected during the construction of the Proposed Project. Adverse impacts from constructing the additional parking lots, intersections, and roads required for the Proposed Project would be minimized by the implementation of best management practices described in construction storm water pollution prevention plans. These plans meet the requirements of the NPDES Construction General Permit. Construction of the pedestrian and vehicular crossing between TA-63 and TA-35 would require a bridge over Ten Site Canyon, an ancillary branch of Mortandad Canyon. This bridge construction would require a general or individual 404 Permit from the U.S. Army Corps of Engineers and a New Mexico Environment Department 401 Water Quality Certification for linear transportation projects, because the effluent flows and ephemeral streams in the Mortandad Canyon system are considered "waters of the United States." Construction impacts to these canyon surface water flows and the canyon-bottom floodplains would be mitigated by the provisions provided in the permit and the construction storm water pollution prevention plan.

Minimal impacts to surface water would occur during the operation of the Proposed Project. The presence of large parking lots at TA-48 and TA-63 and additional paved roads would increase the amount of storm water runoff from those sites. Potential storm water contamination from parking lot runoff would be minimized by proper maintenance practices at the facility, including spill response and cleanup. Spill prevention and response procedures would also reduce any potential contamination that could occur as a result of spills on the bridge across TA-48 and TA-63. The Integrated Storm Water Monitoring Program that monitors runoff on a watershed basis would evaluate the effectiveness of these controls.

No adverse affects on groundwater are expected from the implementation of this project. Water used during construction is included in the utility requirements for the project. Groundwater quality would not be affected unless the surface water quality controls fail and contaminated surface water infiltrates through the soil to the groundwater.

Air Quality and Noise

Construction of parking lots, pedestrian walkways, roads, and bridges associated with this option would result in temporary increases in nonradiological air quality impacts from construction equipment, trucks, and worker vehicles. There would also be particulate emissions from disturbance of soil caused by the wind and equipment.

Operation of these facilities would result in emissions of criteria and toxic air pollutants from vehicles, including employee vehicles and shuttle buses. Since the number of employee vehicles is not expected to change as a result of this option, the change in emissions could be small, except for the addition of emissions from shuttle buses.

Construction or operation of these facilities would not result in an increase in the emissions of radiological air pollutants.

Construction of parking lots, pedestrian walkways, roads, and bridges associated with this alternative would result in some temporary increase in noise levels near the new roads from construction equipment and activities. Some disturbance of wildlife near the area could occur as a result of operation of construction equipment. There would be no change in noise impacts to the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipment.

Operation of these facilities would result in some change in noise levels along the new roadways and bus routes under both options. Some disturbance of wildlife near the area could occur.

Ecological Resources

This section first addresses the ecological setting (that is, terrestrial resources, wetlands, aquatic resources, and protected and sensitive species) of the Pajarito Corridor West and several TAs within it. This is followed by a discussion of the potential impacts on those resources. Discussions of protected and sensitive species concentrate on those species for which Areas of Environmental Interest have been established, since they receive protection under the Endangered Species Act of 1973. Ecological resources of LANL as a whole are described in Chapter 4, Section 4.5, of the SWEIS and the vegetation zones are depicted in Figure 4–25.

Pajarito Corridor West – The Pajarito Corridor West includes TA-35, TA-48, TA-50, TA-52, TA-55, TA-63, TA-64, and TA-66 (LANL 2001). The entire Corridor falls within the Ponderosa Pine Forest vegetation zone. Thus, vegetation present within the area is dominated by ponderosa pine (*Pinus ponderosa* P. & C. Lawson), gambel oak (*Quercus gambelii* Nutt.), kinnikinik (*Archtostaphylos uva-ursi* L.), New Mexico locust (*Robinia neomexicana* Gray), pine dropseed (*Blepharoneuron tricholepis* Torr Nash), mountain muhly (*Muhlenbergia montana* Nutt A.S. Hitchc), and little bluestem (*Schizachyrium scoparium* Michx.) (DOE 1999). Much of the mesa-top areas of the Pajarito Corridor West are fenced, highly developed industrial areas that are devoid of natural habitat and the wildlife that it typically supports. However, the canyons are very good wildlife habitats.

Nearly the entire Pajarito Corridor West was burned at a Low/Unburned severity level during the Cerro Grande Fire. However, the northern portion of TA-48 (that is, a portion of Mortandad

Canyon) was burned at a Medium severity level. At a Low/Unburned severity level, seed stocks are largely unaffected. Also, the existing species may recover quickly. At a Medium severity level, seed stocks can be adversely affected and erosion can increase due to the removal of vegetation and ground cover. In such areas, recolonization by different species of plants may occur. Wildlife response to the fire could include direct loss of less mobile species and young and displacement of more mobile species. As areas succeed to a more mature state, there is a corresponding change in the diversity, composition, and numbers of wildlife present (LANL 2000b).

Several wetlands occur within the Pajarito Corridor West, including four in TA-48 and one in TA-55. Three of the four wetlands in TA-48 are located between TA-48 and TA-60 in Mortandad Canyon. These wetlands, which total about 1.1 acres (0.4 hectares), are characterized by coyote willow (*Salix exigua* Nutt.), Baltic rush (*Juncus balticus* Willd.), cattail (*Typha* spp.), and wooly sedge (*Carex lanuginose* Michx.). The fourth wetland is located between TA-48 and TA-55; cattail is the dominant plant. This wetland is smaller than 0.1 acre (0.04 hectares). The wetland within TA-55 is within a branch of Pajarito Canyon between TA-55 and TA-48; it covers 1.2 acres (0.48 hectares). This wetland is dominated by cattails (ACE 2005).

The Pajarito Corridor West falls within portions of the Sandia-Mortandad Canyon, Pajarito Canyon, and Threemile Canyon Mexican spotted owl (*Strix occidentalis lucida*) Areas of Environmental Interest (LANL 2000a). Specifically, parts of TA-48, TA-35, and TA-52 are within the core zone for the Sandia-Mortandad Canyon Areas of Environmental Interest, while portions of TA-55, TA-50, TA-63, and TA-66 are included in the core zone of the Pajarito Canyon Areas of Environmental Interest. No part of the Corridor is within the core zone of the Threemile Canyon Area of Environmental Interest. Since buffer zones extend beyond the core zone, they encompass additional land within the Pajarito Corridor West. In fact, with the exception of the western portions of TA-48 and TA-64, as well as a very small section of TA-55, nearly the entire Corridor falls within the buffer and core zones of the three Areas of Environmental Interest. No portion of the Pajarito Corridor West is within Areas of Environmental Interest for the bald eagle (*Haliaeetus leucocaphalus*) or southwestern willow flycatcher (*Empidonax trailii extimus*).

Technical Area 48 – Vegetation and wildlife present would include the same species as noted above for the Pajarito Corridor West. Much of the area proposed for surface parking has been disturbed because of previous activities, with vegetation principally comprising of grasses; the area along the northern edge contains mature conifers.

Technical Area 63 – Vegetation and wildlife present would include the same species as noted above for the Pajarito Corridor West. Much of the area proposed for surface parking has been disturbed because of previous activities; vegetation in undeveloped portions of this area principally comprises grasses and junipers.

Technical Area 60 – Vegetation and wildlife present would include the same species as noted above for the Pajarito Corridor West. Most of TA-60 was burned at a Low/Unburned severity level; however the south central portion of the site (that is, a portion of Mortandad Canyon) was burned at a Medium severity level. As noted above, at a Low/Unburned severity level, seed sources should remain viable; whereas, at a Medium level, this may not be the case, with the result that recolonization by different species of plants may occur (LANL 2000b).

The Sandia wetland is located between TA-60 and TA-61. Vegetation present within this wetland includes cattails and a number of species of grass. In 2000, the Sandia wetland encompassed 3.5 acres (1.4 hectares); however, this represented a 48 percent reduction in size from 1996. At present it is slightly less than 3 acres (1.2 hectares) in size (Bennett, Keller, and Robinson 2001; ACE 2005).

TA-60 falls within the Sandia-Mortandad Canyon and Los Alamos Canyon Mexican spotted owl Areas of Environmental Interest (LANL 2000a). Most of the eastern portion of the TA falls within either the core or buffer zone of the Sandia-Mortandad Canyon Areas of Environmental Interest, while only the very northern border of the TA is within the buffer zone of the Los Alamos Canyon Areas of Environmental Interest. No portion of TA-60 falls within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Technical Area 61 – Vegetation and wildlife present would include the same species as noted above for the Pajarito Corridor West. Two major features of the TA are the Los Alamos County Landfill and the borrow pit where all vegetation has been removed. Without cover, the landfill and borrow pit provide minimal habitat for wildlife. Most of TA-61 was unaffected by the Cerro Grande Fire. However the very eastern portion of the TA was burned at a Low/Unburned severity level. At this level, seed sources should remain viable (LANL 2000b). The Sandia wetland located between TA-61 and TA-60 was discussed above in relation to TA-60.

As is the case for TA-60, TA-61 falls within the Sandia-Mortandad Canyon and Los Alamos Canyon Mexican spotted owl Areas of Environmental Interest (LANL 2000a). The southeastern portion of the TA is within the core zone of the Sandia-Mortandad Canyon Areas of Environmental Interest, while the northern edge is within the core zone of the Los Alamos Canyon Areas of Environmental Interest. The rest of the TA is included within the buffer zones of these Areas of Environmental Interest. No portion of the TA-61 is within Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher.

Impacts of the project would be greatest on currently undeveloped land. Although the Pajarito Corridor West falls within the Ponderosa Pine vegetation zone, the area is highly developed, especially on the mesa. Most actions associated with implementing the Security-Driven Transportation Modifications Project would have little or no impact on ecological resources; however, the construction of the two parking lots, a portion of the new road across TA-63, and the vehicle and pedestrian bridges over the branch of Mortandad Canyon would affect undeveloped forest and open land. Other project elements would largely take place in currently developed portions of the Corridor.

Construction of the two parking lots would disturb a total of approximately 30 acres (12 hectares). The parking lot at TA-48 would total approximately 11 acres (4.5 hectares), of land consisting partly of open field and ponderosa pine forest. The parking lot at TA-63 would total approximately 19 acres (7.7 hectares) of land consisting partly of open field and junipers. Both habitats would be lost due to construction of the parking lots as well as a portion of the road around the eastern edge of TA-63. The pedestrian and vehicle bridges connecting TA-63 with

TA-35 would involve some loss of habitat due to construction of approaches and pier foundations. Clearing and grading for these projects would result in the loss of less mobile animals such as small mammals and reptiles. In general, more mobile species would be able to avoid the area during the construction period; however, depending upon the season, nests and young could be destroyed. Indirect impacts to wildlife could also result from equipment noise. During operation, noise and added human presence could cause some species to avoid nearby areas; however, considering the present level of human presence within the corridor it would be expected that many species have already adapted. Wetlands located within TA-48 would not be affected by the Proposed Project, since none are in the immediate area of the parking lots or bridges. Indirect impacts (such as sedimentation) to the wetland located between TA-48 and TA-60 from construction of the parking lot in TA-48 would be prevented by using best management practices. There are no aquatic resources on the mesa, therefore impacts to these resources would not occur.

As noted above, portions of the Pajarito Corridor West are within the Sandia-Mortandad Canyon, Pajarito Canyon, and Threemile Canyon Areas of Environmental Interest for the Mexican spotted owl. The parking lot and associated activities in TA-48 are not located in threatened or endangered species habitat. However, the parking lot in TA-63, the road across the eastern edge of TA-63, and the pedestrian and vehicle bridges fall within buffer habitat and a portion of the parking lot is within core habitat. A biological assessment prepared by NNSA determined that up to 18.8 acres (7.6 hectares) of buffer and 1 acre (0.4 hectares) of core Mexican spotted owl habitat consisting of disturbed grassland and ponderosa pine woodland would be lost. Additionally, the assessment noted that the project had the potential to disturb the Mexican spotted owl due to excess noise or light. Therefore, the biological assessment concluded that activities associated with the project may affect, and were likely to adversely affect, the Mexican spotted owl. Nevertheless, the biological assessment noted that reasonable and prudent alternatives should be implemented such as ensuring that all lighting complies with the New Mexico Night Sky Protection Act, employing appropriate erosion and runoff controls, avoiding unnecessary disturbance to vegetation, and revegetating all exposed soils as soon as feasible. Additionally, consultation with the U.S. Fish and Wildlife Service (USFWS) would be reinitiated if a land bridge instead of a span bridge were used over Ten Site Canyon (LANL 2006c). After reviewing the biological assessment, the USFWS concluded that the effects to the owl from construction activities associated with the Security-Driven Transportation Modifications Project would be insignificant and discountable, and would not result in adverse effects. This assessment was based on the fact that: 1) the parking lot in TA-48 would not be located in listed species habitat; 2) the parking lot at TA-63 consists of open field, junipers and ponderosa pine woodland.; and 3) reasonable and prudent alternatives would be implemented to reduce or avoid potential impacts (see Chapter 6, Section 6.5.2).

Areas disturbed by the Security-Driven Transportation Modifications Project do not fall within Areas of Environmental Interest for either the bald eagle or southwestern willow flycatcher. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation is associated with the project, the biological assessment concluded that provided appropriate reasonable and prudent alternatives were implemented to protect adjacent foraging habitat, the project may affect, but is not likely to adversely affect, the bald eagle. In addition to the reasonable and prudent alternatives noted above for the Mexican spotted owl, those for the bald eagle could include not disturbing winter roosting trees, monitoring the presence or absence of eagles during project activities, and keeping noise and disturbance to a minimum. Because the southwestern willow flycatcher Area of Environmental Interest is more than 2 miles (3.3 kilometers) from the project site, the biological assessment concluded that the proposed project would have no direct, indirect, or cumulative impacts on this species (LANL 2006c). The USFWS has concurred with the biological assessment as it relates to the bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Cultural Resources

Cultural resource surveys have been conducted within the TAs involved in the Security-Driven Transportation Modifications Project, including those within the Pajarito Corridor West (TA-35, TA-48, TA-50, TA-52, TA-55, TA-63, TA-64, and TA-66), TA-60, and TA-61. Due to the sensitive nature of cultural resource sites, only their general nature and National Register of Historic Places eligibility is discussed below; specific resource locations are not provided.

Pajarito Corridor West – A total of 22 archaeological resource sites have been identified within the Pajarito Corridor West. These sites include rock features, cavates, 1 to 3-room structures, lithic scatters, rock shelters, rock art, rock and wood enclosures, and article and artifact scatters. Of these sites, 1 has been excavated, 11 have been determined to be eligible for listing on the National Register of Historic Places, and 4 are of undetermined eligibility. One National Register of Historic Places-eligible building is located in the Pajarito Corridor West in TA-55.

Technical Area 48 – TA-48 contains 2 cultural resource sites. Neither of these sites is located at or in the vicinity of the proposed parking lot.

Technical Area 63 – TA-63 contains 2 cultural resource sites, one of which is an historic site situated near an area to be disturbed by the proposed parking lot.

Technical Area 55 – TA-55 contains 3 archaeological resource sites. One site is a prehistoric lithic scatter, while the other two sites are historic structures. Only one site is National Register of Historic Places-eligible. There are no buildings or structures located in TA-55 that are eligible for listing on the National Register of Historic Places.

Technical Area 60 – A total of 13 archaeological resource sites have been documented in TA-60. These resources include 1 to 3-room structures, rock features, lithic and ceramic scatters, and historic structures. Eight of these sites are eligible for the National Register of Historic Places, while 6 are of undetermined eligibility. Historic resources include homesteads and sites of an undetermined nature. There are no National Register of Historic Places-eligible buildings or structures located in TA-60.

Technical Area 61 – TA-61 contains 6 archaeological resource sites, 4 of which include a trail and stairs, cavates, and a historic structure. Four of the sites are National Register of Historic Places-eligible, while one is of undetermined status.

In terms of activities that would result in the disturbance of land, the largest projects associated with the Security-Driven Transportation Modifications Project are two parking lots, one in TA-48 and one in TA-63. These would require the disturbance of approximately 11 acres (4.5 hectares) and 19 acres (7.7 hectares), respectively. Additional actions that would disturb land include a new two-lane road along the east edge of TA-63, new auto and pedestrian crossings connecting TA-63 and TA-35, and a new road through the northern edge of TA-35. Other actions associated with this alternative would involve relatively small areas of land, most of which is disturbed or vacant (see Section J.1.3.2).

Implementation of these construction projects would not impact cultural resources within the Pajarito Corridor West. This is the case since no known cultural sites are located within any of the areas to be disturbed. A historic site is situated near an area to be disturbed within TA-63; however, direct impacts would be unlikely. In order to protect the site from indirect impacts, boundaries would be marked and the site fenced, as appropriate. Fencing would prevent accidental intrusion and disturbance of the site.

As noted in the above Visual Resources narrative, the proposed vehicle and pedestrian bridges would be highly visible from both nearby and distant locations. Thus, the potential exists for them to conflict with views of the affected branch of Mortandad Canyon from sites identified by Native American and Hispanic communities as traditional cultural properties. Although the specific locations have not been identified due to their sensitivity, 54 such locations are present on or near LANL (see Chapter 4, Section 4.7.3, of this SWEIS). Prior to construction of the proposed bridges, it would be necessary to consult with these groups so that potential impacts to traditional cultural properties could be taken into account early in the planning process.

Socioeconomics and Infrastructure

Within the proposed project area, 115-kilovolt and 13.2-kilovolt power lines now cross the proposed TA-63 parking area. In addition, there is a 13.2-kilovolt line along the northern portion of the proposed TA-48 parking area and a north-south 115-kilovolt line just west of the existing guard station.

Utility resource requirements to support proposed Security-Driven Transportation Modifications are expected to have a minor impact on site infrastructure. Approximately 3.4 million gallons (13 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work (mainly by heavy equipment), including construction of new structures. Liquid fuels would be procured from offsite sources and therefore would not be limited resources. In addition, it is anticipated that approximately 16.6 million gallons (63 million liters) of water would be needed for construction, mainly for dust suppression and soil compaction. The existing LANL water supply infrastructure would be capable of handling this demand.

Some existing utilities, including water and telecommunications, might be relocated or rerouted. While this would have no long-term effect, it would involve trenching and placement of new lines and the capping and abandonment of existing lines or removal of the lines. Most of the trenching that would impact traffic would occur along Pajarito Road to serve the access-control and shuttle bus transit stations.

Waste Management

Key facilities within TA-35, TA-48, TA-50, and TA-55 produce large quantities of radioactive or chemical wastes that currently must be transported outside the Pajarito Corridor West for disposal. Wastes generated by these facilities are either shipped directly offsite for treatment and disposal or are transferred to the waste management facilities at TA-54 for later shipment offsite or disposal onsite (low-level radioactive waste only). A proposed project could result in the establishment of a transuranic waste management facility within the Pajarito Corridor West (see Appendix H, Section H.3, of this SWEIS).

During construction for the Proposed Project, a relatively small amount of construction-related waste would be generated. Approximately 1,300 cubic yards (990 cubic meters) of construction debris would be generated as a consequence of this option.

Once implemented, this option would impose restrictions, according to the security level, on transportation to and from TA-35, TA-48, TA-50, and TA-55. Wastes generated within these TAs are either shipped directly offsite for treatment and disposal or are transferred to the waste management facilities at TA-54. Because the Pajarito Corridor West would still be available for use by government vehicles and physically inspected service vehicles, the proposed transportation modifications would not have a major impact on waste transport trucks. Some minor delays would occur as vehicles are inspected, and some additional administrative controls might be imposed. The impacts associated with management and transportation of chemical and radioactive wastes in these affected TAs would remain the same as under the No Action Option.

Transportation

Traffic counts were taken in 2004 at specific locations throughout LANL. **Table J–2** presents the traffic counts taken along Pajarito Road at TA-48 and TA-63, approximately at the west terminus of the Proposed Project where traffic controls and a new security access station would be located. **Table J–3** presents the traffic counts taken along Pajarito Road immediately east of TA-63, which would be the eastern end of the proposed Security-Driven Transportation Modifications Project.

Table J–2 2004 Traffic Counts Along Pajarito Road at Technical Area 48 and Technical Area 64

Location	*Average Vehicles per Weekday*	*Average Vehicles per Weekend Day*	*AM Westbound Peak Vehicles per Hour*	*Noon Westbound Peak Vehicles per Hour*	*PM Westbound Peak Vehicles per Hour*
Pajarito Road at TA-48 and TA-64	9,119	942	570	562	440

TA = technical area.
Source: KSL 2004.

Table J–3 2004 Traffic Counts Along Pajarito Road Immediately East of Technical Area 63

Location	*Average Vehicles per Weekday*	*Average Vehicles per Weekend Day*	*AM Eastbound Peak Vehicles per Hour*	*PM Eastbound Peak Vehicles per Hour*
Pajarito Road immediately east of TA-63	5,758	674	859	825

TA = technical area.
Source: KSL 2004.

Because new roads would be constructed around TA-48 and TA-63, the Proposed Project would have some long-term effects on the existing transportation network at LANL. Some portion of the traffic shown on Tables J–2 and J–3 is associated with staff that works in TAs along Pajarito Road. Other traffic is through traffic, for instance people traveling from White Rock to TA-3 or the Los Alamos townsite. Implementation of the proposed project in a manner that restricts private vehicles from this section of Pajarito Road would result in increased traffic on other local roads – most likely the truck route (NM 501) and NM 502. Additional traffic information would be needed to fully assess the impacts that the Security-Driven Transportation Modification would have on local traffic. Project design and sequencing would be used to minimize traffic and infrastructure impacts during construction of the proposed bypass roads, bridge, and related access controls, including delayed response times for emergency vehicles.

Traffic control plans would be implemented to minimize delays and congestion during construction. Nevertheless, those traveling to and from LANL would experience some inconvenience and delays during construction. In the long term, traffic patterns would change for commuter traffic between White Rock and TA-3.

The location and access to total available parking would change following construction, possibly resulting in somewhat more circuitous trips and longer walks to work places. Parking lot shuttles would operate within the proposed access-controlled area, and service would not be disrupted because new parking lot access roads would be constructed.

After completion of the Security-Driven Transportation Modifications, current levels of employment at LANL would remain relatively unchanged. Since employment requirements in support of LANL operations would not change, commuter traffic volumes would not change. However, temporary (during construction) and permanent (after construction) road and lane restrictions could affect traffic flow and volumes throughout the site and affect the roads entering LANL. In addition, as noted in the Project Description, traffic patterns at LANL would permanently change.

J.1.3.3 Auxiliary Action A: Construct a Bridge from Technical Area 35 to Sigma Mesa and a New Road toward Technical Area 3

Land Resources

The bridge would be constructed within a 1,000-foot- (300-meter-) wide corridor across Mortandad Canyon in the vicinity of TA-35 (see Figure J–6). Additionally, a new two-lane road would be built from the north end of the new bridge westward through TA-60 to connect TA-35 with TA-3. According to the *Comprehensive Site Plan 2001*, the corridor across the canyon is designated Potential Infill. The route of the proposed road, which would involve new construction and upgrading of an existing unpaved road, passes through areas designated for Primary and Secondary Development. The proposed route itself is designated for Road Improvement (LANL 2001). Thus, although actions taken under this auxiliary action represent a change in land use along the proposed route between TA-35 and TA-3, they are within the scope of the *Comprehensive Site Plan 2001*.

The two parts of this auxiliary action (that is, bridge and road construction) would have varying impacts on the visual environment at LANL. The roadway through TA-60 would involve some new right-of-way, but would in large part follow an existing unpaved road. Thus, construction of the road would have minimal visual impact. However, the proposed bridge over Mortandad Canyon would represent a highly visible change in the appearance of the local environment and would be in contrast to the forested setting of the canyon. Although careful planning related to site selection and bridge design would help mitigate visual impacts, the bridge would nevertheless alter the natural appearance of the canyon as viewed from both nearby locations and higher elevations to the west.

Geology and Soils

Under Auxiliary Action A, direct impacts on geology and soils would occur from the construction of the bridge and road along the top of Sigma Mesa. Approximately 21,600 cubic yards (16,500 cubic meters) of earth moving would be required under this auxiliary action. The bridge crossing would involve some disturbance of geology and soil resources for approaches and pier foundations on the mesas and possibly in Mortandad Canyon. In addition, the degree of induration and fracturing of the Bandelier Tuff would need to be investigated at the crossing site to determine the actions needed to provide sufficient foundations for the bridge piers. Placement of a construction laydown pad to facilitate construction of the proposed bridge spans would have the potential to impact contaminated sediments within the canyon. Construction of the paved road along the mesa in TA-60 would also result in disturbance of geology and soil resources. As with the Proposed Project, this auxiliary action has the potential of encountering potential release sites, either on mesa tops or in Mortandad Canyon. Prior to commencing any ground disturbance, potentially affected areas would be surveyed to determine the extent and nature of any contamination and required remediation in accordance with LANL procedures.

Because the proposed two-lane paved road along Sigma Mesa would generally follow the alignment of the existing two-lane unpaved road, it is anticipated that impacts on geology and soils would be negligible, as best management practices for soil erosion and sediment control would be employed. After construction, disturbed areas that have not been paved would be revegetated or otherwise stabilized and would not be subject to long-term soil erosion.

Geologic resource consumption would be very small under this auxiliary action and would not be expected to deplete local sources or stockpiles of required materials. Approximately 3,400 cubic yards (2,600 cubic meters) of gravel, 2,000 cubic yards (1,500 cubic meters) of asphalt, and 2,500 cubic yards (1,900 cubic meters) of concrete would be needed during construction. Aggregate resources are readily available from onsite borrow areas and otherwise abundant in the region. Concrete and asphalt would be provided by an offsite supplier.

Once constructed, use of the bridge and roadway would not have any ongoing impact on geologic and soil resources.

Water Resources

Minimal impacts to surface water would occur under Auxiliary Action A. Bridge construction would require a general or individual 404 Permit from the U.S. Army Corps of Engineers and a

New Mexico Environment Department 401 Water Quality Certification for linear transportation projects, as the effluent flows and ephemeral streams in the Mortandad Canyon system are considered "waters of the United States." Impacts to these canyon surface water flows and canyon bottom floodplain would be minimized by the provisions provided in the permit application, which would mitigate impacts to the discharge amounts and water quality of those streams. The additional road construction impacts would be minimized by implementation of the best management practices described in construction storm water pollution prevention plans. These plans meet the requirements of the NPDES Construction General Permit.

Impacts during operation and maintenance of the proposed bridge and road corridor would be minimized by proper maintenance of the bridge, including spill response and cleanup. The Integrated Storm Water Monitoring Program that monitors runoff on a watershed basis would evaluate the effectiveness of these controls.

No adverse affects on groundwater are anticipated from the implementation of this project. Water used during construction is included in the utility requirements for the project. Groundwater quality would not be affected unless the surface water quality controls fail and contaminated surface water infiltrates through the soil to the groundwater.

Air Quality and Noise

Construction of the bridge and roadways associated with this auxiliary action would result in temporary nonradiological air quality impacts from construction equipment, trucks, and worker vehicles. There would also be particulate emissions from wind and equipment disturbance of soil.

Operation under this auxiliary action would result in emissions of criteria and toxic air pollutants from vehicles, including employee vehicles and buses. Since the number of through vehicles is not expected to change as a result of this auxiliary action, the change in emissions is expected to be minimal.

Construction of bridge and roadway associated with this auxiliary action would result in some temporary increase in noise levels from construction equipment and activities. Some disturbance of wildlife near the area could occur as a result of operation of construction equipment. There would be no change in noise impacts to the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipment.

Operation of these facilities would result in some change in noise levels along the new bridge and roadway. Some disturbance of wildlife near the area could occur.

Ecological Resources

Construction of the road through TA-60 would have minimal impact on habitat along the right-of-way since it would follow an existing unpaved road for much of its distance. However, short-term impacts to wildlife would likely occur due to increased noise and human presence. This could result in animals avoiding the construction area; however, following construction most animals would likely return. Ensuring that all equipment was properly maintained and posting construction zone limits would help mitigate these impacts. No wetlands or aquatic resources would be directly affected by roadway construction, and best management practices would prevent erosion and subsequent sedimentation of any such resources in the canyon bottom.

The new road proposed under this option would pass through undeveloped portions of core and buffer habitat within the Sandia-Mortandad Mexican spotted owl Area of Environmental Interest. Additionally, the bridge to be built over Mortandad Canyon is within the Mexican spotted owl Area of Environmental Interest. A biological assessment prepared by NNSA determined that this option would disturb up to 25.3 acres (10.2 hectares) of undeveloped core habitat and 0.1 acres (0.4 hectares) of undeveloped buffer habitat. Further, construction of the road and bridge would cause temporary increases in light and noise; these impacts would be permanent once the bridge was operational. Although reasonable and prudent alternatives would be implemented (such as moving the bridges as far west as possible, avoiding the use of land bridges, avoiding new roads in the canyon, permanently closing hiking trails, and muting back-up indicators on all trucks and heavy equipment), the biological assessment concluded that this option may affect, and was likely to adversely affect, the Mexican spotted owl (LANL 2006c). The USFWS determined that it could not adequately analyze the affects of the proposed action because the exact location and design of the bridge had not been determined. Instead the agency requested that NNSA submit a request for consultation when plans relating to this option were finalized (see Chapter 6, Section 6.5.2).

Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher are not located near the proposed project site. However, recognizing that the bald eagle forages over all of LANL and that some habitat degradation would be associated with construction, the biological assessment concluded that with appropriate reasonable and prudent alternatives (see Section J.1.3.2), the project may affect, but would not likely to adversely affect, the bald eagle. Because the closest southwestern willow flycatcher Area of Environmental Interest is more than 2.3 miles (3.7 kilometers) from the nearest construction there would be no affect on this species (LANL 2006c). The USFWS has concurred with the biological assessment as it relates to bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Piers for the bridge across Mortandad Canyon would be placed to avoid direct impacts on any wetlands present within the canyon. Best management practices would prevent erosion and subsequent sedimentation of any such resources in the canyon bottom.

Cultural Resources

The corridor within which the bridge over Mortandad Canyon would be built does not contain any known cultural resources, thus, it is unlikely that construction of the bridge would have a direct impact on such resources. There are a number of prehistoric sites and one historic site located to the east and west of the proposed bridge corridor. Due to the relative proximity of these resources to the bridge corridor, it may be necessary to conduct further detailed analyses. Additionally, it may be necessary to fence these sites.

As noted in the above Visual Environment narrative, the proposed bridge would be highly visible from both nearby and distant locations. Thus, the potential exists for it to conflict with views of Mortandad Canyon from sites identified by Native American and Hispanic communities as traditional cultural properties. Although specific locations have not been identified due to their sensitivity, 54 such locations are present on or near LANL (see Chapter 4, Section 4.7.3, of this SWEIS). Prior to construction of the proposed bridge, it would be necessary to consult with these groups so that consideration to this potential impact could be taken into account early in the planning process.

Socioeconomics and Infrastructure

Utility resource requirements to support Auxiliary Action A are expected to have a negligible impact on site infrastructure. Approximately 370,000 gallons (1.4 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work, mainly by heavy equipment, including that for the construction of new structures. In addition, it is anticipated that about 2.1 million gallons (7.9 million liters) of water would be needed for construction. Finally, some existing utilities might be relocated or rerouted.

Waste Management

During construction under Auxiliary Action A, a relatively small amount of construction-related waste would be generated. Approximately 160 cubic yards (120 cubic meters) of waste materials would be generated as a consequence of this auxiliary action.

Once implemented, a change in the transport of waste that would otherwise use an open Pajarito Road would occur. It is anticipated that this potential transportation routing impact would be minor.

Transportation

Under Auxiliary Action A, it is anticipated that there would be some long-term effects on the existing transportation network at LANL, because a new bridge would be constructed between TA-35 and TA-60 and a new road on to TA-3. Effects on traffic and infrastructure would be minor. Project design and sequencing would be used to minimize traffic and infrastructure impacts during construction of the proposed bypass roads, bridge, and related access controls, including delayed response times for emergency vehicles.

Traffic control plans would be implemented to minimize delays and congestion during construction. Nevertheless, those traveling to and from LANL would experience some inconvenience and delays during construction. In the long term, traffic patterns would change for commuter traffic between White Rock and TA-3.

The current driving distance from the intersection of Route 4 and Pajarito Road to the intersection of Diamond Drive and East Jemez Road via Pajarito Road is approximately 7.6 miles (approximately 12.2 kilometers). Under Auxiliary Action A, the distance between these two end points would be approximately 8.3 miles (approximately 13.4 kilometers), a minor difference. The driving distance from the intersection of Pajarito Road and Route 4 to the intersection of East Jemez Road and Diamond Drive via Route 501 is approximately 10 miles (approximately 16 kilometers), while the driving distance from the intersection of Pajarito Road and Route 4 to the intersection of East Jemez Road and Diamond Drive via Route 502 is approximately 13 miles (approximately 21 kilometers). While this could result in an increase in vehicle miles traveled, it is anticipated that this would not be a major concern because of the introduction and use of shuttle buses for LANL staff.

After completion of this auxiliary action, current levels of employment at LANL would remain relatively unchanged. Since employment requirements in support of LANL operations would not change, commuter traffic volumes would also not change. However, temporary (during construction) and permanent (after construction) road and lane restrictions could affect traffic flow and volumes throughout the site and affect the roads entering LANL. In addition, as noted in the Project Description, traffic patterns at LANL would permanently change.

J.1.3.4 Auxiliary Action B: Construct a Bridge from Sigma Mesa to Technical Area 61 and a Road to Connect with East Jemez Road

Land Resources

Under Auxiliary Action B, a two-lane bridge would be constructed within a 1,000-foot- (300-meter-) wide corridor across Sandia Canyon (see Figure J–6). Although the terminus of the bridge and the new road to East Jemez Road would be within an area designated as Primary Development in the *Comprehensive Site Plan 2001*, there is no provision in the plan for a corridor for the bridge, as is the case for the bridge over Mortandad Canyon (LANL 2001). Thus, construction of the bridge would represent a departure from the current area development plan.

The two elements of this auxiliary action (that is, bridge and road construction) would have varying impacts on the visual environment at LANL. The roadway through TA-61 would involve a new right-of-way. Thus, construction of the road would alter the generally wooded appearance of the area. The bridge over Sandia Canyon would be constructed within a 1,000-foot- (300-meter-) wide corridor. Its presence would represent a highly visible change in the appearance of the local environment and would be in contrast to the forested setting of the canyon. As is the case for the proposed bridge over Mortandad Canyon, careful planning related to site selection and bridge design would help mitigate visual impacts; nevertheless, the bridge would alter the natural appearance of the canyon as viewed from both nearby locations and higher elevations to the west.

Geology and Soils

Under Auxiliary Action B, the bridge connecting TA-60 with TA-61 would involve some disturbance of geology and soil resources for approaches and pier foundations, and the construction of a paved road connecting the bridge's northern terminus with East Jemez Road would also result in some disturbance. In addition, the degree of induration and fracturing of the Bandelier Tuff would need to be investigated at any proposed canyon crossings where potential bridge foundations would be located.

Since the area between the northern terminus of the proposed bridge and East Jemez Road has been already disturbed by previous activities, it is anticipated that little or no impacts to geology or soil resources would occur. After construction, disturbed areas that have not been paved would be stabilized and revegetated and would not be subject to long-term soil erosion.

There are numerous potential release sites in the project area. In implementing the proposed auxiliary action, due care would be taken and appropriate procedures would be followed in order to ensure that contaminants are not released or that workers are not exposed to inappropriate contamination levels.

Major disturbance or consumption of geologic resources is not anticipated under Auxiliary Action B. Approximately 6,700 cubic yards (5,200 cubic meters) of earth would be disturbed as a consequence of implementing this auxiliary action; approximately 870 cubic yards (660 cubic meters) of gravel would be needed; approximately 690 cubic yards (530 cubic meters) of asphalt would be required; and 2,500 cubic yards (1,900 cubic meters) of concrete would be needed. Aggregate resources are readily available from onsite borrow areas and otherwise abundant in Los Alamos County. Concrete and asphalt would be supplied by an offsite supplier.

Following the completion of Auxiliary Action B, it is not anticipated that operations would result in additional impacts on geologic and soil resources at LANL.

Water Resources

Minimal impacts to surface water would likely occur during the construction of the Proposed Project under Auxiliary Action B, a road bridge crossing Sandia Canyon north of TA-60. Bridge construction would also require a general or individual 404 Permit from the U.S. Army Corps of Engineers and a New Mexico Environment Department 401 Water Quality Certification, which should specify project provisions that would minimize adverse impacts on the water quality and quantity of the Sandia Canyon ephemeral stream and canyon bottom floodplain. Adverse impacts from constructing the additional roads required for this auxiliary action would be minimized by implementation of the best management practices described in construction storm water pollution prevention plans. These plans meet the requirements of the NPDES Construction General Permit.

Impacts during operation and maintenance of the proposed bridge and road corridor would be minimized by proper maintenance of the bridge, including spill response and cleanup. The Integrated Storm Water Monitoring Program that monitors runoff on a watershed basis would evaluate the effectiveness of these controls.

Groundwater quality would not be affected unless the surface water quality controls fail and contaminated surface water infiltrates through the soil to the groundwater.

Air Quality and Noise

Operations under this auxiliary action would result in emissions of criteria and toxic air pollutants from vehicles, including employee vehicles and buses. Since the number of through vehicles is not expected to change as a result of this auxiliary action, the change in emissions is expected to be minimal.

Construction of the bridge and roadway associated with this auxiliary action would result in some temporary increase in traffic noise levels from construction equipment and activities. Some disturbance of wildlife near the area could occur as a result of the operation of construction equipment. There would be no change in noise impacts to the public outside of LANL as a result of construction activities, except for a small increase in traffic noise levels from construction employees' vehicles and materials shipment.

Operation of these facilities would result in some change in noise levels near the new bridge and roadway. Some disturbance of wildlife near the area could occur. Under this auxiliary action, some increased traffic noise near the Royal Crest Mobile Home Park could result from increased traffic along East Jemez Road.

Ecological Resources

This auxiliary action involves the construction of a new bridge across Sandia Canyon and a road connecting the bridge with East Jemez Road. Construction of the road would necessitate the clearing and grading of up to 1.3 acres (0.5 hectares) (assuming a 55-foot [16.8-meter] by 1,000-foot [300-meter] construction corridor) of ponderosa pine forest. Additionally, the bridge would result in the loss of ponderosa pine habitat for its approaches and piers. The destruction of ponderosa pine forest would represent a permanent loss of wildlife habitat. Short-term impacts to wildlife from road construction would occur as a result of increased noise and human presence and would likely result in animals avoiding the construction area. However, following construction, most animals would likely return. Ensuring that all equipment was properly maintained and posting construction zone limits would help mitigate these impacts. No wetlands or aquatic resources would be directly affected by roadway construction, and best management practices would prevent erosion and subsequent sedimentation of any such resources in the canyon bottom.

Road and bridge construction would take place within the buffer zone of the Sandia-Mortandad Canyon and Los Alamos Canyon Mexican spotted owl Areas of Environmental Interest. Additionally, they would impact the core zone of the Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest. Construction would directly impact 37.1 acres (15 hectares) of undeveloped core habitat and 28.7 acres (11.6 hectares) of undeveloped buffer habitat. Further, noise and light levels would be permanently increased in undeveloped core habitat. Due to these factors a biological assessment prepared by NNSA determined that even after implementing reasonable and prudent alternatives (see Section J.1.3.3), this option may affect, and would likely adversely affect, the Mexican spotted owl (LANL 2006c). As is the case for Option A, the USFWS could not adequately analyze the effects of the proposed action because the exact location and design of the bridge had not been determined. The agency requested that NNSA submit a request for consultation when plans relating to this option were finalized (see Chapter 6, Section 6.5.2).

Similar to Option A, the biological assessment determined that with appropriate reasonable and prudent alternatives (see Section J.1.3.2), the project may affect, but would not likely to adversely affect, the bald eagle. Further, because the closest southwestern willow flycatcher Area of Environmental Interest is more than 2.3 miles (3.7 kilometers) from the nearest construction there would be no effect on this species (LANL 2006c). The USFWS has concurred with the biological assessment as it relates to bald eagle and southeastern willow flycatcher (see Chapter 6, Section 6.5.2).

Cultural Resources

The proposed bridge would be highly visible from both nearby and distant locations. Thus, the potential exists for it to conflict with views of Sandia Canyon from sites identified by Native American and Hispanic communities as traditional cultural properties. As noted for the bridge over Mortandad Canyon, prior to construction, it would be necessary to consult with Native American and Hispanic groups so that potential impacts to traditional cultural properties could be taken into account early in the planning process.

Socioeconomics and Infrastructure

Infrastructure effects would primarily occur during construction of the proposed auxiliary action. Several existing utilities, including water and telecommunications, might be relocated or rerouted. While this would have no long-term effect, it would involve trenching and placement of new lines and the capping and abandonment of existing lines or removal of the lines.

Infrastructure effects would primarily occur during construction of the proposed auxiliary action. Approximately 217,000 gallons (821,000 liters) of fuel (diesel and gasoline) would be consumed for site work (including that for the construction of structures). In addition, it is anticipated that about 1.3 million gallons (4.9 million liters) of water would be needed for construction. Finally, some existing utilities might be relocated or rerouted.

Waste Management

During construction under Auxiliary Action B, a relatively small amount of construction-related waste would be generated. Approximately 110 cubic yards (84 cubic meters) of waste materials would be generated as a consequence of this action.

Once implemented, there would be a change in the transportation of waste that would otherwise use an open Pajarito Road. It is anticipated that this potential transportation routing impact would be minor.

Transportation

Traffic control plans would be implemented to minimize delays and congestion during construction. Nevertheless, those traveling to and from LANL would experience some inconvenience and delays during construction. In the long term, traffic patterns would change for commuter traffic between White Rock and TA-3, in that an additional option would be provided for traveling between these two points.

The current driving distance from the intersection of Route 4 and Pajarito Road to the intersection of Diamond Drive and East Jemez Road via Pajarito Road is approximately 7.6 miles (approximately 12.2 kilometers). Under Auxiliary Action B, the distance between these two end points would be approximately 8.5 miles (13.7 kilometers). The driving distance from the intersection of Pajarito Road and Route 4 to the intersection of East Jemez Road and Diamond Drive via Route 501 is approximately 10 miles (16 kilometers), while the driving distance from the intersection of Pajarito Road and Route 4 to the intersection of East Jemez Road and Diamond Drive via Route 502 is approximately 13 miles (21 kilometers). While this could result in an increase in vehicle miles traveled, it is anticipated that this would not be significant because of the introduction and use of shuttle buses for LANL staff.

Temporary (during construction) and permanent (after construction) road and lane restrictions could affect traffic flow and volumes throughout the site and affect the roads entering LANL. In addition, as noted in the project description, traffic patterns at LANL would permanently change.

J.2 Metropolis Center Increase in Levels of Operation Impacts Assessment

This section presents an assessment of potential impacts for expanding the computer operating capabilities within the existing Metropolis Center in TA-3 at LANL. NNSA plans to operate the Metropolis Center at a higher level than was analyzed in the *SCC EA*. Section J.2.1 presents the purpose and need for the expansion project and a description of the Metropolis Center. Section J.2.2 presents a description of the Proposed Project of expanding the computer operating capacity of the Metropolis Center, and the No Action Option of operating the Metropolis Center using its existing computing platform. Section J.2.3 provides an overview of the unique characteristics of TA-3 and LANL that could be affected by the expansion, as well as an assessment of impacts from the Proposed Project and the No Action Option. Chapter 4 of this SWEIS presents a description of the affected environment at LANL and TA-3. Any unique characteristics of TA-3 and LANL not covered in Chapter 4 that would be affected by the expansion of operations at the Metropolis Center are presented here.

J.2.1 Introduction, Purpose, and Need for Agency Action

The Metropolis Center (formerly called the Strategic Computing Complex, or SCC) is a 303,000-square-foot (28,179–square-meter) structure built at LANL in 2002 to house “Q,” one of the world’s largest and most advanced computers. The Metropolis Center is an integrated part of NNSA’s tri-lab (LANL, Lawrence Livermore National Laboratory, and Sandia National Laboratories) mission to maintain, monitor, and assure the performance of the nation’s nuclear weapons through the Advanced Simulation and Computing Program. LANL’s Advanced Simulation and Computing Program supercomputers, such as the “Q” machine, run three-dimensional codes that simulate the physics of a nuclear detonation. These supercomputers allow researchers to integrate past weapons test data, materials studies, and current experiments in simulations of unprecedented size (LANL 2004a, 2006d).

Background

In 1998, the *SCC EA* was completed for the construction and operation of the facility now referred to as the Metropolis Center. The *SCC EA* considered the potential impacts associated with constructing and operating this facility with an initial computing capacity of 30 to 50 teraflops (DOE 1998a). Based on that analysis, DOE announced in its Finding of No Significant Impact (FONSI) that constructing and operating the proposed facility at up to 50 teraflops would not result in significant environmental impacts as defined by NEPA (DOE 1998b).

As stated in the *SCC EA*, DOE’s long-term goal was to develop a computer system capable of performing 100 teraflops. By developing technologies to interconnect tens of thousands of advanced commodity processors, DOE planned to initially provide a collective computing power of at least 30 teraflops, with the 50- and 100-teraflops levels being short-term and long-term goals, respectively. As all of the computer hardware and software would be newly created, DOE's long-term goal of greater computational capability would, by necessity, need to be achieved through a series of technologically path-breaking hardware "platforms" at each of the three nuclear weapons laboratories, developed and employed in a phased-evolution approach (DOE 1998a). As such, the Metropolis Center facility infrastructure was designed to be scalable so that as the projected computing requirements of the Metropolis Center increased, mechanical and electrical equipment could be added in increments without expanding the building. The most recent of these planned incremental platforms is the "Roadrunner", which would provide almost four times the computational power as the Q machine but require only half the floor space (LANL 2006d).

At the time the *SCC EA* was issued in 1998, DOE had not yet made the programmatic decision to pursue levels of operation beyond those then associated with 50 teraflops. However, with the Metropolis Center presently operating near that 50-teraflops level, NNSA is now proposing expanding the existing platform to attain the increased operating capabilities necessary to meet the long-term goals for the Metropolis Center.

Purpose and Need

NNSA's Stockpile Stewardship and Management Program provides an integrated technical program for maintaining the continued safety and reliability of the nuclear weapons stockpile. As an alternative to underground testing, and due to the aging of nuclear weapons beyond original expectations, NNSA must maintain a means to verify the transportation, safe storage, and reliability of nuclear weapons. Without underground nuclear weapons testing, computer simulations that can perform highly complex three-dimensional large-scale calculations have become the only means of integrating the complex processes that occur in the life span of a nuclear weapon. In order to best fulfill its prime stewardship mission to ensure the safety, reliability, and performance of the nation's nuclear weapons stockpile, NNSA needs to increase its existing computer system capability. At LANL's Metropolis Center, a capability of at least 100 teraflops is essential for effectively running these high-fidelity, full system weapon simulations. It is estimated that in the future, an operating level of approximately 1,000 teraflops (1 petaflops) might be requested.

J.2.2 Options Descriptions

J.2.2.1 No Action Option: Continue Metropolis Center Operations Using the Existing Computing Platform

Under the No Action Option, the existing computing center would continue to be operated at up to approximately the 50-teraflops level analyzed in the *SCC EA*. Computing capacity would not be expanded beyond that level, and NNSA would not attain the long-term goal of at least 100 teraflops functional capability that was identified in the *SCC EA* (DOE 1998a).

J.2.2.2 Proposed Project: Modify and Operate the Metropolis Center at an Expanded Computing Platform

Under the Proposed Project, NNSA would expand the computing capabilities of the Metropolis Center at TA-3 to support, at a minimum, a 100-teraflops capability, and approximately 1,000 teraflops (1 petaflops) eventually expected. This action would consist of the addition of mechanical and electrical equipment, including chillers, cooling towers, and air-conditioning units. Because the scope of the *SCC EA* analysis already considered the potential impacts of constructing a building to house equipment for upwards of a 50-teraflops computing capability at LANL, these new proposed enhancements would be added without a need to expand the external dimensions of the building or disturb additional land. These modifications would not result in any changes to the present number of employees operating the center or increase operating hazards (LANL 2006d).

J.2.3 Affected Environment and Environmental Consequences

The Metropolis Center is located in TA-3, which is situated in the west-central portion of LANL and is separated from the Los Alamos townsite by Los Alamos Canyon. It is the main entry point to LANL, and most of the administrative and public access activities are located within its approximately 357 acres (144 hectares). TA-3 is heavily developed and contains numerous buildings located on the top of a mesa between the upper reaches of Sandia and Mortandad Canyons.

The *SCC EA* and FONSI identified potential environmental concerns associated with projected water and electrical requirements. Because the proposed expansion of computing capacity at the existing Metropolis Center (up to a 15-megawatt platform) is expected to only affect water and electrical requirements, this analysis focuses on the affected environment and subsequent potential impacts to these infrastructure resources. The proposed expansion in operations would not physically disturb the building site or environs, result in additional emissions or waste, nor result in changes to the Metropolis Center or regional workforce. Therefore, the following resource areas would not be affected by the Proposed Project and are not part of this impact assessment: land resources, geology and soils, air quality and noise, ecological resources, human health, cultural resources, socioeconomics, transportation, waste management, and environmental justice.

J.2.3.1 No Action Option

Under the No Action Option, NNSA would operate the Metropolis Center only up to the 50-teraflops level analyzed in the *SCC EA*. **Table J–4** summarizes the operational requirements associated with the existing and proposed operating platforms compared with those originally forecast in the *SCC EA*, and current available utility infrastructure capacity.

As shown in Table J–4, the *SCC EA* conservatively estimated water usage of 63 million gallons (239 million liters) per year and an electric load demand of 7.1 megawatts for operating a 50 teraflops platform. Due to continued computer design efficiencies, actual requirements to date have been considerably less. Current water usage for operating the Metropolis Center is about 19 million gallons (72 million liters) per year and an electric load demand is about 5 megawatts (LANL 2006d).

Although the *SCC EA* and associated FONSI indicated that operating the Metropolis Center at up to 50 teraflops would result in no significant environmental impacts, NNSA acknowledged potential environmental concerns associated with facility water and electrical requirements. To address these concerns, the *SCC EA* indicated that: (1) cooling water for the facility would come from the Sanitary Effluent Recycling Facility, which polishes treated effluent from the Sanitary Wastewater Systems Plant; and (2) electric power constraints, common to all parts of Northern New Mexico, would need to be dealt with through mutual LANL and Los Alamos County Power Pool "shedding procedures" to balance the peak demand with load capabilities. Because the Sanitary Effluent Recycling Facility, which has been proposed to supply the Metropolis Center with its cooling water needs, has not been able to effectively meet the Metropolis Center's water requirements, much of this water has been supplied through groundwater. However, recently planned improvements to the Sanitary Effluent Recycling Facility have lead to a greater expectation that Metropolis Center cooling water needs shall increasingly use the recycled effluent and that reliance on groundwater shall diminish substantially.

Table J–4 Metropolis Center Operating Requirements

	Platform Analyzed in SCC EA (No Action) [a]	***Existing 5-Megawatt Platform*** [b]	***Expanded 15-Megawatt Platform (Proposed Project)*** [b]	***Total System Demand (2005)*** [c]	***System Capacity (2005)*** [c]
Water (million gallons per year)	63.1	19	51	1,393 (359)	1,806
Electricity					
Energy (megawatt-hours per year)	62,196 [d]	43,800 [e]	131,400 [e]	550,870 (421,413)	1,138,800 [f]
Peak Load (megawatts)	8.5 [g]	6 [g]	18 [g]	87.8 (69.5)	130 [f]
Workers	300	350	350	Not applicable	Not applicable

[a] DOE 1998a.
[b] LANL 2006d.
[c] Chapter 4, Section 4.8.2, of this SWEIS. Usage values and capacities reflect that of the utility systems that include LANL and other Los Alamos County users. Total usage is provided first, with LANL's usage in parenthesis.
[d] *SCC EA* projected 7.1 megawatt total load demand × estimated 8,760 hours per year.
[e] Megawatt load demand × estimated 8,760 hours per year.
[f] The system capacity of the Los Alamos Power Pool increased by 20 megawatts (equivalent to 175,200 megawatt-hours per year) in September 2007 with the installation of a new gas turbine generator at the TA-3 Co-Generation Complex.
[g] Megawatt load demand × estimated 1.2 peak loading factor.
Note: To convert gallons to liters, multiply by 3.7853.

J.2.3.2 Proposed Project: Modify and Operate the Metropolis Center at an Expanded Computing Platform

Water

The Los Alamos water supply system consists of 14 deep wells, 153 miles (246 kilometers) of main distribution lines, pump stations, and storage tanks. The system supplies potable water to all of Los Alamos County, LANL, and Bandelier National Monument. In September 2001, DOE completed the transfer of ownership of the water production system to Los Alamos County, along with 70 percent of its water rights (1,264 million gallons [4,785 million liters] per year). DOE has leased the remaining 30 percent of the water rights (542 million gallons [2,050 million liters] per year) to the county for 10 years, with the option to renew the lease for four additional 10-year terms (DOE 2003, LANL 2006b). In fiscal year 2005, LANL used approximately 359 million gallons (1,360 million liters) of water, of which 19 million gallons (72 million liters) were attributable to the Metropolis Center (LANL 2006b, 2006d). Los Alamos system and LANL site water use and capacity are compared to the Proposed Project and alternatives as presented in Table J–4.

Under the Proposed Project, NNSA would expand the computing capabilities of the Metropolis Center at TA-3. As shown in Table J–4, expanding to a 15-megawatt maximum operating platform is expected to potentially increase current water usage to 51 million gallons (193 million liters) per year. This higher usage would include the additional water lost to cooling tower evaporation and blowdown. Until the Sanitary Effluent Recycling Facility becomes more effective in supplying the Metropolis Center, most of this cooling water would be supplied through groundwater. Nonetheless, this water need would not exceed available system capacities.

During the operating timeframe evaluated in this SWEIS, continued enhancements to the Metropolis Center could theoretically be approximately 1,000 teraflops (1 petaflops) (LANL 2006d). Because each new generation of computing capability machinery continues to be designed with increased computational speed and more efficient cooling systems, it is anticipated that the net cooling water requirements for the Metropolis Center would not increase beyond 51 million gallons (193 million liters). Should use of the Sanitary Effluent Recycling Facility increase as planned, Metropolis Center groundwater requirements could eventually be reduced to zero (LANL 2006d).

Electricity

Electrical service to LANL is supplied through a cooperative arrangement with Los Alamos County, known as the Los Alamos Power Pool, established in 1985. Within LANL, the Contractor also operates a gas-fired steam and electrical power generating plant at TA-3 (TA-3 Co-Generation Complex), and maintains various low-voltage transformers at LANL facilities and approximately 34 miles (55 kilometers) of 13.8-kilovolt distribution lines. Onsite electrical generating capability for the Power Pool is limited by the TA-3 Co-Generation Complex, which is capable of producing up to 20 megawatts of electric power that is shared by the Power Pool under contractual arrangement. A new generator producing an additional 20 megawatts of electric power became operational in September 2007. Generally, onsite electricity production is used to fill the difference between peak loads and the electric power import capability (LANL 2004b, 2006a, 2006d).

As shown in Table J–4, electric power availability from the Power Pool is estimated at 1,138,800 megawatt-hours (reflecting the lower thermal rating of 110 megawatts for 8,760 hours per year on the existing transmission system plus 20 megawatts from the TA-3 Co-Generation Complex). In fiscal year 2005, LANL and other Los Alamos County users combined for a Power Pool total electric energy consumption of 550,870 megawatt-hours of electricity. The fiscal year 2005 peak load usage was about 69.5 megawatts for LANL and about 18.3 megawatts for the rest of the county (LANL 2006a).

Under the Proposed Project, NNSA would expand the computing capabilities of the Metropolis Center at TA-3 to support a 100-teraflops capability. This action would consist of the installation of additional mechanical and electrical equipment, including chillers, cooling towers, and air-conditioning units. As shown in Table J–4, increasing to a 15-megawatt maximum operating platform is expected to potentially increase current peak electricity consumption to 18 megawatts per year. Nonetheless, this would not exceed available system capacities.

During the operating timeframe evaluated in this SWEIS, continued enhancements to the Metropolis Center could theoretically be approximately 1,000 teraflops (1 petaflops) (LANL 2006d). However, even though the computational capabilities of these computer systems are projected to increase substantially, their power and cooling requirements would not. Because each new generation of computing capability machinery continues to be designed with increased computational speed and enhanced efficiency in electrical requirements, it is anticipated that average electrical requirements associated with such expansion would not exceed 15 megawatts. As newer computing components are installed, older, less efficient components would be retired; therefore, the number of teraflops should increase significantly while the amount of required electrical power stabilizes at less than 15 megawatts (LANL 2006d).

J.3 Increase in the Type and Quantity of Sealed Sources Managed at Los Alamos National Laboratory by the Off-Site Source Recovery Project Impacts Assessment

NNSA proposes to modify the Off-Site Source Recovery Project to recover and store sealed sources[2] having a wider range of isotopes than that analyzed in previous NEPA analyses. The Off-Site Source Recovery Project has the responsibility to identify, recover, and store excess and unwanted sealed sources in cooperation with NRC. In 2004, the mission of the Off-Site Source Recovery Project was expanded. This section analyzes the impacts of receipt and storage of additional sealed sources at LANL. The analysis of environmental consequences relies on the affected environment descriptions in Chapter 4 of the SWEIS. Where information specific to the Off-Site Source Recovery Project is available and adds to the understanding of the affected environment, it is included here. Section J.3.1 provides background information on the Off-Site Source Recovery Project. Section J.3.2 provides a description of the Proposed Project and the No Action Option. Section J.3.3 provides a brief description of the affected environment and presents an impact assessment of the No Action Option and the Proposed Project.

J.3.1 Introduction, Purpose, and Need for Agency Action

From 1979 through 1999, DOE recovered excess and unwanted radioactive sealed sources containing plutonium-239 and beryllium, and other actinides on a case-by-case basis as requested by NRC. Since 1999, the Off-Site Source Recovery Project has successfully managed actinide-

---

[2] *Sealed radioactive source means a radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layers of nonradioactive material, or firmly fixed to a nonradioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material (10 CFR Part 835). Sealed sources are typically small.*

bearing sealed sources, and in 2004 accepted some non-actinide sources. In 2004, following the transfer of management of the project to NNSA as part of the U.S. Radiological Threat Reduction Program, the previous mission of the Off-Site Source Recovery Project was expanded (DOE 2004b). The original scope of the Off-Site Source Recovery Project was to accept sealed sources containing actinide isotopes that exceeded Class C concentrations for these isotopes as listed in the NRC regulation, Title 10 *Code of Federal Regulations* (CFR) Part 61. The expanded scope would include acceptance of sealed sources containing these actinide isotopes in all concentrations (particularly transuranic isotopes), sealed sources containing other isotopes (in any concentration) for which Class C concentration limits are established in 10 CFR Part 61 (particularly strontium-90 and cesium-137), and sealed sources containing cobalt-60, iridium-192, radium-226, and californium-252.

In response to this change, the Off-Site Source Recovery Project began to develop a global inventory and to prepare for the management of a wider range of sealed sources. The Off-Site Source Recovery Project would continue to use commercial or other Federal organizations and facilities where appropriate, and LANL facilities would be used when these organizations and facilities were not appropriate to fulfill the national security mission of the Off-Site Source Recovery Project.

Background

Since the passage of the Atomic Energy Act of 1954, qualified public and private organizations have been licensed to possess and use nuclear materials for a wide variety of applications. These radioactive materials are typically placed within multiple stainless steel jackets and welded closed, or constructed in other ways to meet the NRC definition of a sealed source. During this period of radioactive source manufacture and use, future disposal mechanisms were not defined. Unwanted and excess sealed sources present a public health and safety risk when abandoned, lost, or disposed of inappropriately.

Since 1979, DOE has recovered excess and unwanted radioactive sealed sources containing plutonium-239 and beryllium, and other actinides. Additional sealed sources were recovered from the commercial sector on a case-by-case basis as requested by NRC. These actinide-containing sealed sources were recovered by DOE when there were no other options for their disposition such as reuse or disposal. There was no disposal capacity for commercial waste containing radionuclides in concentrations exceeding Class C limits as defined in 10 CFR Part 61.[3] This waste is commonly called Greater-Than-Class C waste. Commercial sealed sources considered waste may be determined to be Greater-Than-Class C waste due to the quantity of radioactive material and their small physical size. Similarly, there were sealed sources and wastes in the Federal sector that also lacked disposal capacity because of similar

[3] NRC regulations establish a classification system for disposal of commercially-generated low-level radioactive waste. Classification is determined by the concentrations in waste of a small number of specific isotopes. Waste containing the isotopes listed in 10 CFR 61.55 and in concentrations exceeding their Class C limits must be disposed of using technologies having greater confinement capacity or protection than "normal" near-surface disposal (47 FR 57446). This waste is commonly called Greater-Than-Class C waste. In 10 CFR 61.55, Class C limits are established for these isotopes that are commonly found in sealed sources: alpha-emitting transuranic isotopes having half-lives exceeding five years; strontium-90; and cesium-137. Class C limits are also established for these isotopes that are not commonly found in sealed sources: carbon-14, nickel-59, nickel-63, niobium-94, technetium-99, iodine-129, plutonium-241, and curium-242.

DOE restrictions on disposal of actinide (particularly transuranic) isotopes.[4] Therefore, the general criterion for DOE acceptance of these actinide sources was that, if considered as waste, their actinide concentrations would exceed the 10 CFR Part 61 Class C limits for these radionuclides.[5]

Recognizing the public danger posed by excess and unwanted radioactive sealed sources, the Congress addressed their disposition in the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240). This Act assigned the Federal government the responsibility for disposal of commercial low-level radioactive waste containing radionuclides in concentrations exceeding Class C limits as defined in 10 CFR Part 61. This Act also assigned the Federal government the responsibility for disposal of any other low-level radioactive waste owned or generated by DOE, by the U.S. Navy resulting from decommissioning naval vessels, or by the Federal government resulting from research, development, testing, or production of any atomic weapon.

In the early 1990s, DOE had encountered increased costs and inefficiencies associated with the mechanics of case-by-case-type response to NRC requests for the recovery and management of sealed sources. At LANL, these sealed sources were opened, their radioactive contents chemically separated, and the radioactive products and wastes stored separately. Facing the potential recovery of several thousands of these sealed sources, a different approach to recovery and management was required. Consequently, in 1995, DOE chose a management strategy that would continue and enhance the process of chemically separating the radioactive components from certain recovered sources. This nuclear material would be stored for future reuse, and the waste generated from the separation process would be disposed of or stored if a disposal facility was not available. This strategy, identified as the Radioactive Sources Recovery Program, and its environmental effects, were evaluated in DOE's *Environmental Assessment for the Radioactive Source Recovery Program* (DOE 1995) issued December 20, 1995. As of 1999, approximately 1,100 neutron-generating and other sealed sources had been recovered from regulated licensees, DOE sites, and other government agencies and sent to LANL.

An expanded Radioactive Sources Recovery Program was subsequently incorporated into the *1999 SWEIS* (DOE 1999) and the attendant environmental effects assessed. The *1999 SWEIS* Expanded Operations Alternative reflects the activities described for the Radioactive Sources Recovery Program (receiving and storing sealed sources; separating certain radioisotopes such as plutonium-238, plutonium-239, and americium-241; and storing and disposing of radioactive material and waste) at higher rates or greater volumes than analyzed previously in the 1995 environmental assessment. The projected sealed source material chemical separation rate identified in the *1999 SWEIS* was 10,000 curies per year for the 10-year period of analysis (or 100,000 curies total for 10 years). These rates and the resultant process wastes were included in

---

[4] *These wastes are termed transuranic wastes by DOE. The criterion for transuranic waste determination is comparable to the Part 61 Class C limit for transuranic isotopes.*

[5] *In this appendix, the term "actinide source" is used for sealed sources containing actinide isotopes in quantities that could exceed Class C concentrations if disposed of as waste. Actinide sources may exceed Class C concentrations even if the quantity of radioactive material is small. For example, assuming a waste density of 2 grams per cubic centimeter, a 55-gallon (0.21-cubic meter) drum of waste could exceed the Class C concentration limit if it contained more than 0.42 curies of transuranic activity. Nonetheless, numerous sealed sources are in authorized circulation that do not contain sufficient quantities of actinide isotopes to exceed Class C concentration limits.*

the impacts analysis for the Chemistry and Metallurgy Research Building, the Plutonium Facility Complex, and Area G at TA-54.

In its 2000 *Supplement Analysis to the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0238-SA-01), NNSA decided that rather than chemically separating certain radioactive materials from the recovered sources, storing this separated nuclear material, and transferring the resulting process waste material to the Waste Isolation Pilot Plant (WIPP), NNSA would package sealed sources in multi-functional shielded containers (at the origination point or consolidated at a licensed commercial facility under contract to DOE) and ship them directly to LANL for storage (DOE 2000). Except for those containers of defense-related sealed sources that would be eligible for shipment to WIPP as transuranic waste,[6] this waste would be managed pursuant to the Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240).

In response to the events of September 11, 2001, NRC conducted a risk-based evaluation of potential vulnerabilities to terrorist threats involving NRC-licensed nuclear facilities and materials. The NRC concluded that possession of unwanted radioactive sealed sources with no disposal path presents a potential vulnerability.

In 2004, NNSA proposed to recover six strontium-90 radioisotope thermoelectric generators[7] from the commercial sector and to place them in storage at TA-54, Area G, pending future disposal when an appropriate disposal site becomes available. The radioisotope thermoelectric generators contained sealed sources that were different from the actinide-bearing sealed sources previously evaluated through the NEPA compliance process for storage at LANL. The proposed action would result in a small amount of low-level radioactive waste being stored at TA-54 for an indeterminate period of time. After preparation of the *Supplement Analysis to the Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory in the State of* New *Mexico, Recovery and Storage of Strontium-90 (Sr-90) Fueled Radioisotope Thermal Electric Generators at Los Alamos National Laboratory* (DOE/EIS-0238-SA-04), (DOE 2004a), NNSA concluded that this amount of low-level radioactive waste was not projected to exceed the *1999 SWEIS* projections for low-level radioactive waste generation and disposal; four of the strontium-90 radioisotope thermoelectric generators were recovered and stored at LANL's Area G in March 2004. Two additional strontium-90 radioisotope thermoelectric generators were subsequently recovered in 2005.

In March 2004, the mission of the Off-Site Source Recovery Project was expanded as part of NNSA's Radiological Threat Reduction Program. The Project was expanded from recovery of

---

[6] Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; of (3) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61 (DOE 435.1).

[7] A radioisotope thermoelectric generator is a source of self-contained power for various independent types of equipment with a steady voltage ranging typically 7 to 30 volts or less and the power capacity of a few watts up to 80 watts. Radioisotope thermoelectric generators are used in conjunction with various electrotechnical devices that accumulate and transform the electric energy produced by the generators. Common applications for radioisotope thermoelectric generators include uses as power sources for navigation beacons and seamarks, or other low wattage devices employed in remote locations without reliable sources of electrical energy.

sources containing actinide isotopes in quantities that would exceed Class C concentration limits, if determined to be waste, to sources containing these isotopes in all quantities, plus sealed sources containing any quantity of certain other isotopes for which Class C concentration limits are specified. The Off-Site Source Recovery Project was additionally expanded to receive sealed sources containing isotopes of cobalt-60, iridium-192, radium-226, and californium-252 for which Class C concentration limits are not specified in NRC regulations (DOE 2004b). Thus, the question of whether the sealed sources would contain isotopes exceeding Class C concentration limits is not a constraining factor for the recovery of sources; national security is the primary driving factor for determining the need for recovery of sealed sources containing these isotopes.

A number of the sources that have been delivered to LANL have been determined to result from defense activities and are being shipped to WIPP for disposal. It is expected that many of the other sources stored at LANL will also be determined to be eligible for WIPP disposal. The remaining sources will be dispositioned by other means, such as disposal as Greater-Than-Class C waste pursuant to Public Law 99-240. On July 23, 2007, DOE issued a Notice of Intent (NOI) to prepare an *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste* (72 FR 40135). DOE intends that this environmental impact statement (EIS) would support selection of new or existing disposal locations, facilities, and methods for disposal of commercial Greater-Than-Class C waste and DOE waste having similar characteristics. The EIS will include a forecast of sources that would be considered Greater-Than-Class C wastes if disposed of. The forecast will include an estimate of the sources eligible for such disposal and managed by the Off-Site Source Recovery Project, based on the Off-Site Source Recovery Project recovery rate.

Purpose and Need

The NRC has determined that possession of unwanted sealed sources with no disposal path presents a potential vulnerability. Historically, LANL's Off-Site Source Recovery Project and predecessor projects have received actinide sources for recycling or for storage until a disposal method was determined. Six strontium-90 radioisotope thermoelectric generators were received and stored as waste. The Off-Site Source Recovery Project has now been tasked with managing additional numbers and types of sealed sources. The Off-Site Source Recovery Project would use commercial or other Federal organizations and facilities where appropriate, and LANL facilities when management by these organizations and facilities was not appropriate to fulfill its national security mission.

J.3.2 Options Descriptions

J.3.2.1 No Action Option

Under the No Action Option, LANL would continue to receive and store actinide sources at the previous rate. Actinide sources are packaged offsite at the origination point or consolidated at a licensed commercial facility under contract to DOE and shipped to LANL in compliance with U.S. Department of Transportation (DOT) regulations (49 CFR Part 71). Shipping containers are received at the LANL Supply Chain Management receiving warehouse, SM-30. The containers are then transported by truck over LANL roads to TA-54 or TA-55 for storage; because they are packaged to DOT specifications, road closures are not required. If materials in a container require additional handling, or are to be used by the Off-Site Source Recovery Project for specific purposes such as dose rate studies, use as calibration sources, or other needs, the containers are trans-shipped to Wing 9 of the Chemistry and Metallurgy Research Building.

Actinide sources that DOE determines were generated as part of defense activities are eligible for disposal at WIPP as transuranic waste. The Off-Site Source Recovery Project also expects to continue to receive a certain number of actinide sources that are not designated defense waste and are not eligible for disposal at WIPP. As NNSA further documents the origin and history of these actinide sources, some of them may meet the criteria for acceptance at WIPP, and others will be managed pursuant to Public Law 99-240 (see Section J.3.3.1).

As of February 2008, the Off-Site Source Recovery Project had managed about 16,750 sources, of which about 15,300 (91 percent) had been delivered to LANL for safe storage, and the remaining 9 percent had been managed by other means such as reuse or disposal by commercial entities. Of the sources that had been delivered to LANL by this date, about 3,500 were sent off site for disposition, mainly to WIPP. The remaining sources will be sent to WIPP if determined to be eligible for WIPP disposal, disposed of as Greater-Than-Class C waste, or managed by other means such as reuse. It the future, NNSA expects to manage about 2,000 actinide sources per year, most of which would be temporarily stored at LANL pending disposal at WIPP, disposal as Greater-Than-Class C waste, or disposition by other means (LANL 2006d). NNSA expects to begin to phase out or greatly downsize the Off-Site Source Recovery Project as Greater-Than-Class C disposal capacity becomes available, which is not expected before 2015.

J.3.2.2 Proposed Project: Increase in the Type and Quantity of Sealed Sources Managed at Los Alamos National Laboratory by the Off-Site Source Recovery Project

Under the Proposed Project, the contractor would be prepared to receive additional sealed sources at LANL in addition to the actinide sources that are currently received by the Off-Site Source Recovery Project. **Table J–5** gives the additional sealed sources registered as of August 2005. As noted above, the Off-Site Source Recovery Project would use LANL facilities when management by commercial or other Federal entities was not appropriate to fulfill its national security mission. Many of the sources identified in Table J–5 may never require storage at LANL but would be transferred directly after recovery by the Off-Site Source Recovery Project to a disposal or other appropriate facility for disposition.

Table J–5 Additional Sources Registered with the Off-Site Source Recovery Project – Newly Eligible Materials

Nuclide	*Number of Sources*	*Curie Content*
Cobalt-60	354	419,919
Strontium-90	55	3,795,456
Cesium-137	419	9,366
Radium-226	22	5.6
Curium-244	80	135
Californium-252	24	0.1

Sources: LANL 2004d, 2006d.

Management of sealed sources containing additional radionuclides, if directed to LANL, would follow the same approach used for the actinide sources currently under management at LANL. Prior to source packaging and movement to LANL, the Off-Site Source Recovery Project staff would ensure that management at commercial or other Federal locations was not appropriate and would obtain concurrence from NNSA. In addition, existing planning processes would be employed to ensure all prerequisite activities were completed, including:

- Verification that sources meet eligibility requirements for recovery;
- Verification that no recycle or reuse potential exists that would eliminate the necessity for movement of materials to LANL for management;
- Identification that handling and storage facilities exist at LANL for materials to be recovered; and
- Verification that source recovery and management at LANL meet the compliance and authorization envelope of the site.

Upon receipt at LANL, the sealed sources would be managed to minimize impacts on existing and planned NNSA operations within the facilities used to support sealed source management. Shipping containers would be received at the LANL Supply Chain Management receiving warehouse, SM-30, or its replacement. At SM-30, the sealed sources would be subject to standard receiving requirements that include activities such as inspection for damage, radiological survey and, in some cases, verification measurements for special nuclear materials.

Sealed sources that need special handling would be transported to Wing 9 of the Chemistry and Metallurgy Research Building and either stored in DOT-compliant shipping containers or removed from packages for storage in the floor holes. These sealed sources may be moved to the Radiological Sciences Institute at TA-48 after closure of the Chemistry and Metallurgy Research Building (see Section G.3). Most of the remaining sources would remain in their original DOT-compliant shipping containers and would be transported to Area G, TA-54. High activity strontium-90 sources and other high activity sealed sources could be stored in a retrievable configuration in shafts. Radium-226, curium-244 and californium-252, if stored at LANL, would more than likely be stored in pipe overpack containers.

The proposed project would expand the Off-Site Source Recovery Project by a little more than 10 percent. The proposed expansion would require the annual management of about 200 to 250 additional sources compared to the No Action Option. As noted above, many of the additional sources may never require storage at LANL but would be transferred directly to a disposal or other appropriate facility for disposition. Sources delivered to LANL would be safely stored until they could be disposed of as low-level radioactive waste (including Greater-Than-Class C waste if appropriate), or dispositioned by other means such as reuse. NNSA expects to begin to phase out or greatly downsize the Off-Site Source Recovery Project as Greater-Than-Class C disposal capacity becomes available, which is not expected before 2015.

J.3.3 Affected Environment and Environmental Consequences

TA-54 is one of the largest TAs at LANL (943 acres [382 hectares]) (LANL 2003). Its primary function is management of radioactive solid and hazardous chemical wastes. The TA's 3-mile (4.8-kilometer) northern border forms the boundary between LANL and the Pueblo of San Ildefonso, and its southeastern boundary borders the White Rock community in Los Alamos County. Within TA-54, Area G covers approximately 63 acres (25 hectares) at the east end of LANL (LANL 2005). The SM-30 warehouse at TA-3 is LANL's main general warehouse; it can store limited quantities of hazardous or radioactive materials. NNSA has proposed to replace SM-30 with a new warehouse (See Appendix G) that would receive all shipments, including sealed sources.

Because the proposed increase in the type and quantity of increased sealed sources accepted for waste management would potentially affect the waste management and human health areas, this analysis focuses on the affected environment and subsequent potential impacts to these resources. An initial assessment of the potential impacts of the proposed project determined that there would be no or only negligible impacts to the following resource areas and that no further analysis was necessary.

- *Land Resources* – Storage would be in an area that is already disturbed. Activities would comply with land use plans.
- *Geology and Soils* – Activities are not expected to change geology, trigger seismic events, or change slope stability.
- *Water Resources* – Discharges to surface water would not be expected. Groundwater contamination would be highly unlikely because of the containment provided for the sealed sources.
- *Air Quality and Noise* – No air emissions are expected from sealed sources. The only noise would be continued ambient noise at existing levels.
- *Ecological Resources* – Storage of sealed sources would be in developed areas that are devoid of biota.
- *Cultural Resources* – Storage would be in developed areas having no identified cultural resources.
- *Socioeconomics and Infrastructure* – No additional full-time equivalent employees would be expected.
- *Environmental Justice* – No disproportionate impacts to minority or low-income populations are expected.

Transportation, waste management, and human health are discussed in more detail in the following section, because, after arriving at LANL, some of these additional sealed sources would be stored at LANL as waste with no current disposal path.

J.3.3.1 No Action Option

Waste Management

In fiscal year 2003, the DOE General Counsel determined that, due to the source of isotopic materials used in the construction of plutonium-239-bearing sealed sources and the continuous ownership of the contained plutonium-239 by DOE, all plutonium-239 sources resulted from defense activities. This determination made this particular class of sources eligible for disposal at WIPP. As of October 31, 2006, 132 drums of plutonium-239 sealed sources had been shipped to WIPP, and it is expected that remaining plutonium-239 sources will continue to be shipped. This is part of the waste management analysis in the SWEIS.

Table J–6 lists typical types of actinide sources, other than plutonium-239 sources, that have been received or are expected to be received at LANL under the Off-Site Source Recovery Project. Recently, however, the Off-Site Source Recovery Project received a defense determination for some of these plutonium-238 and americium-241 sources. This determination would allow the shipment of 211 drums of plutonium-238 and americium-241 sealed sources from the TA-54 storage site to WIPP. The transportation analysis in this appendix and Chapter 5 addresses the impacts of the shipment of all plutonium-238 and americium-241 sources to WIPP, should a defense determination be made for the remaining material. In addition, there are four strontium-90 radioisotope thermoelectric generators retrievably stored in a below-ground shaft at Area G in TA-54; two other strontium-90 radioisotope thermoelectric generators are being stored above-ground at Area G. The transportation analysis in this appendix and in Chapter 5 addresses the impacts of shipping the generators to the Nevada Test Site, which is being considered for their disposal.

Table J–6 Typical Types of Actinide Sources to be Received at LANL [a]

Source Type [b]	*Typical Activity (curies/each)*
Americium-241 calibration sources	0.005
Plutonium-238 medical sources	8
Americium-241 medical sources	0.1
Americium-241 Be well logging sources	3
Plutonium-238 Be well logging sources	10
Americium-241 Be general neutron sources	1
Americium-241 Be and Cesium-137 portable gauge sources	0.045/0.01
Americium-241 Be portable gauge sources	0.045
Americium-241 fixed gauges	0.124
Americium-241 XRF sources	0.18

Be = beryllium, XRF = x-ray fluorescence.
[a] Some sources may be eligible for disposal at WIPP. Others would be managed pursuant to Public Law 99-240.
[b] Additional plutonium-239 sources from defense activities that may be received by the Project would be disposed of at WIPP.
Note: To convert cubic yards to cubic meters, multiply by 0.76456.
Source: LANL 2004d.

Until DOE identifies a disposal location consistent with the statutory requirements of Public Law 99-240, there would be no defined disposal facility for some of the actinide sources recovered by the Off-Site Source Recovery Project. In July 2007, however, DOE issued an NOI to prepare an *Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste* (72 FR 40135). DOE intends that this EIS would enable DOE to select any new or existing disposal locations, facilities, and methods for disposal of commercial Greater-Than-Class C waste and DOE waste having similar characteristics.

Transportation

The *1999 SWEIS* addressed the shipment of actinide sealed sources to LANL as part of the transportation analysis. The continued shipment of these sources is included in the No Action Alternative transportation impacts in Chapter 5 of this SWEIS.

As discussed above, some of the actinide sources have received a defense determination and are eligible for disposal at WIPP. This section presents the transportation impacts of shipping actinide sources to WIPP; these impacts are included in the No Action Alternative transportation impacts in Chapter 5 of the SWEIS. It was assumed that about 17,000 actinide sources stored at LANL would be shipped to WIPP. The total numbers of waste containers and shipments were assessed assuming the types of actinide sources listed in Table J–6 and using waste packaging efficiencies estimated by the Off-Site Source Recovery Project (LANL 2004d). This estimate would envelope the impacts from shipping all of the roughly 11,000 actinide sources currently stored at LANL to WIPP. (No sealed sources or other transuranic waste would be shipped to WIPP unless they were determined to be defense-related and met the acceptance criteria for disposal at WIPP.)

Transportation impacts would entail radiation exposure to the transportation crew and to the public along the route from LANL to WIPP, as well as potential radiation exposure and fatalities from traffic accidents. The impacts are presented in terms of doses and latent cancer fatalities (LCFs). (See Appendix K of the SWEIS for a description of the analysis methodology.)

Table J–7 shows the results of this analysis. The maximum total dose to the public for shipment to WIPP would be 0.81 person-rem and the likelihood of an excess LCF would be less than 1 (0.00048 LCF). The collective dose to the crew would be 0.58 person-rem, with less than 1 LCF (0.00035). The risk of an LCF in the population from radiation exposure from a traffic accident is less than 1 (9.9×10^{-8}) and no traffic fatalities would be expected.

As noted, the analysis was for shipping about 17,000 actinide sources from LANL to WIPP. Assuming that LANL annually manages an additional 2,000 actinide sources similar to the types listed in Table J–6, and all are brought to LANL for temporary safe storage (see Section J.3.2.1), then over a 10-year period about 20,000 actinide sources would be managed at LANL in addition to the 11,000 discussed above. If all were sent to WIPP, the impacts for shipping 31,000 actinide sources to WIPP would be about twice as large as those listed in Table J–7.

In addition, six strontium-90 radioisotope thermoelectric generators are stored at LANL until they can be disposed of at a low-level radioactive waste disposal site. The data in Table J–7 show the impacts of shipping them to the Nevada Test Site for disposal. No LCFs would be expected to the population along the route (0.000028 LCFs) or to the transportation crew (0.000021 LCFs), and no traffic fatalities would be expected.

Table J–7 Incident-Free and Accident Transportation Impacts – No Action Option

Disposal Location	Number of Shipments	Total Distance Traveled (kilometers)	Crew Dose and Risk		Public Dose and Risk		Accidents Radiological and Nonradiological	
			Dose (person-rem)	Risk (LCF)	Dose (person-rem)	Risk (LCF)	Risk (LCF)	Risk (traffic fatalities)
WIPP	21	25,402	0.58	0.00035	0.81	0.00048	9.9×10^{-8}	0.0003
Nevada Test Site	1	2,500	0.035	0.000021	0.047	0.000028	5.8×10^{-10}	0.000025

LCF = latent cancer fatality, WIPP = Waste Isolation Pilot Plant.
Note: To convert kilometers to miles, multiply by 0.62137.

J.3.3.2 Proposed Project: Increase in the Type and Quantity of Sealed Sources Managed at Los Alamos National Laboratory by the Off-Site Source Recovery Project

Human Health Impacts

All sealed sources received or planned to be received at LANL are encapsulated or otherwise confined, and no release of the enclosed radioisotopes to the environment is expected during normal operations. Transportation, handling, and storage of sealed sources in properly shielded containers would minimize the radiation dose to involved workers from those sources, which are gamma and neutron radiation emitters. The metal of the sealed source itself would shield beta and alpha radiation emitting radioisotopes. The use of proper operating and administrative procedures coupled with appropriate shielding would ensure that involved worker doses are maintained below their appropriate limits. Noninvolved workers and the public are not expected to receive any measurable doses from the Off-Site Source Recovery Project sources during normal operations.

The *Environmental Assessment for the Radioactive Source Recovery Program* (DOE 1995) provided an estimate of 2.3 millirem for the Chemistry and Metallurgy Research Building Wing 9 Hot Cell involved worker dose for all activities associated with each neutron sealed source. At 100 sources per year, the worker dose would be equivalent to the historical average worker dose at the Chemistry and Metallurgy Research Wing 9 Hot Cell Facility. Furthermore, the environmental assessment estimated a total 15-year campaign worker dose of 17.3 person-rem, which is equivalent to a risk of an LCF in this group of workers of 0.01, or 1 chance in 100.

Waste Management

Under the Proposed Project, the Off-Site Source Recovery Project could bring an expanded range of sealed sources to LANL for storage. Stored sources having radionuclides in concentrations smaller or equal to the Part 61 Class C limits would be evaluated for disposal at existing commercial or DOE low-level radioactive waste disposal facilities. Sources having radionuclides in concentrations larger than the Part 61 Class C limits would be stored until a suitable disposal facility is identified. As noted in Section J.3.3.1, preparation of the *Environmental Impact Statement for the Disposal of Greater-Than-Class C Low-Level*

Radioactive Waste would enable DOE to select any new or existing disposal locations, facilities, and methods for disposal of commercial Greater-Than-Class C waste and DOE waste having similar characteristics.

Transportation

This analysis presents the transportation impacts of each shipment of sealed sources to LANL under the Proposed Project. As discussed above, only the sealed sources for which commercial or other Federal management is not appropriate would be transported to LANL. Because the locations of the sealed sources that would be transported to LANL have not been identified, the analysis used a bounding distant location (Bangor, Maine). Each shipment would involve one sealed source transported by a trailer truck. Each package is assumed to have the same characteristics (dimension and dose rate). The maximum inventories per package for cobalt-60 and cesium-137 isotopes are 6,000 and 10,000 curies, respectively. The maximum inventory for strontium-90 is that of a Sentinel 100F with a maximum of 183,400 curies (as of December 2003). The external dose rate one meter from the trailer is assumed to be 10 millirem per hour.

Table J–8 shows the results of this analysis. The maximum total dose to the public per shipment would be 0.0035 person-rem and the likelihood of an excess LCF would be less than 1 (0.000021 LCF). The collective dose to the crew would be 0.42 person-rem, with less than 1 LCF (0.00025). For each shipment the maximum risk of an LCF in the population from radiation exposure from a traffic accident is less than 1 (9.0×10^{-6}) and no traffic fatalities would be expected.

The stored sources would be ultimately shipped to a facility for disposal or other disposition. Although this facility has not been identified, the impacts of shipment would be bounded by those listed in Table J–8. The impacts from shipping to a facility as distant as Bangor, Maine, would be the same as those for shipping from Bangor, Maine.

Table J–8 Per Shipment Incident-Free and Accident Transportation Impacts – Proposed Project

Sealed Source Isotope	*Total Distance Traveled (kilometers)*	*Crew Dose and Risk*		*Public Dose and Risk*		*Accidents Radiological and Nonradiological*	
		Dose (person-rem)	*Risk (LCF)*	*Dose (person-rem)*	*Risk (LCF)*	*Risk (LCF)*	*Risk (traffic fatalities)*
Cesium-137	8,144	0.42	0.00025	0.035	0.000021	1.1×10^{-6}	0.000092
Cobalt-60	8,144	0.42	0.00025	0.035	0.000021	9.5×10^{-7}	0.000092
Strontium-90	8,144	0.42	0.00025	0.035	0.000021	9.0×10^{-6}	0.000092

Note: to convert kilometers to miles, multiply by 0.62137.

Facility Accidents

Results of the sealed source accident analysis are presented for two different facilities, Wing 9 of the Chemistry and Metallurgy Research Building and TA-54, Area G, where sealed sources are planned to be handled, stored, and transported. The Wing 9 of the Chemistry and Metallurgy Research Building accident is analyzed at either TA-3 or TA-48. Unlike many other radiological accidents analyzed for LANL, accidents involving sealed sources involve both an air release and external exposure component because the sealed sources include significant gamma radiation emitters: cobalt-60, cesium-137, and iridium-192. Most other LANL SWEIS accident scenarios involve only plutonium-239 or tritium, neither of which poses an external radiation danger, because they are principally alpha or beta radiation emitters. Therefore, total accident consequences for sealed source bounding accidents are a combination of the airborne release and external radiation contributors. External radiation is a major component of the total noninvolved worker dose, while airborne releases dominate MEI and population dose and contribute to noninvolved worker doses. This is due to the effect of distance on calculated doses. External radiation is reduced by distance and the small, but not insignificant, shielding effect of air over large distances. Airborne releases are diluted over distances, but can maintain significant concentrations, especially if lofted by plume energy resulting from fires and explosions.

As a result of the planning for expanding the project, specific limits on activity of sealed sources to be stored and managed at TA-54, Area G, and Wing 9 of the Chemistry and Metallurgy Research Building were established (LANL 2006d). These limits are based on equivalence to plutonium-239 curies as sources of inhalation dose associated with postulated accidents. The limits refer to the allowable inventory of each nuclide. If one nuclide were present at its limiting inventory, then none of the other nuclides could be present. These limits are presented in **Tables J–9** and **J–10**.

Table J–9 Maximum Allowable Sealed Source Radioisotope Inventory at Technical Area 54, Area G

Radioisotope	*All Domes (curies)*	*Individual Dome (curies)*	*Shipping Container (curies)* [a]
Cobalt-60	8.18×10^5	1.36×10^5	6,000
Strontium-90	5.88×10^7 [b]	9.8×10^6 [b]	431,000 [b]
Cesium-137	1.37×10^6	2.27×10^5	10,000
Iridium-192	2.05×10^4	3.41×10^3	150
Radium-226	630	105	5
Curium-244	13,700	2,270	100
Californium-252	30	30	30

[a] LANL 2006d.
[b] DOE 2004a.

Table J–10 Maximum Allowable Sealed Source Radioisotope Inventory at Chemistry and Metallurgy Research Building Wing 9

Radioisotope	*Total Hot Cell and Corridor (curies)*	*Floor Including the Pit (curies)*	*Each Floor Hole (curies)*	*Security (curies)*	*Shipping Container (curies)*
Cobalt-60	3.42×10^6	88,400	291	1.0×10^7	6,000
Strontium-90	580,000	15,000	3,880	No Limit	431,000 [a]
Cesium-137	2.35×10^7	607,000	4,070	No Limit	10,000
Iridium-192	2.64×10^7	681,000	530	10,000	150
Radium-226	87,400	2,260	156	No Limit	5
Curium-244	2,850	73.7	129	1,000	100
Californium-252	6,100	158	60.3	200	30

[a] DOE 2004a.
Source: LANL 2006d.

This approach provides a conservative estimate of the doses associated with an accident involving storage of sealed sources because the entire allowable plutonium-239-equivalent inventory at a storage location would not be committed to storage of a single type of sealed source. Instead, most of the allowable inventory would be reserved for other operations in the facility and only a portion would be used for storage of sealed sources. In addition, the portion that would be allowed for storage of sealed sources would likely be used for a variety of sources rather than sources containing a single isotope. Therefore, the results presented in the following discussion provide a hypothetical upper limit of the radiological impacts of an accident. This approach is used to provide an enveloping risk because of the unavailability of accurate data on the magnitude of sealed sources of each type that the Off-Site Source Recovery Project may need to manage at LANL. However, the storage of the sealed sources would be coordinated such that the plutonium-239-equivalent inventory would be managed within each facility's allowable inventory limit.

LANL staff evaluated the storage of sealed sources at TA-54, Area G, and determined that the bounding accident for this location would be an aircraft crash into one dome, with a resulting fire of 300 gallons (1,140 liters) of JP-5 fuel carried by the aircraft (LANL 2004e). This accident would result in a 2-minute fire with a fire energy of 294.3 megawatts. This accident, with an annual frequency of 1.3×10^{-5} (1 chance in 77,000) was analyzed using the MACCS2 computer code for airborne release of sealed source radioisotopes and by the ZYLIND computer code for direct external gamma radiation dose from one shipping container with the maximum allowed sealed source radioisotope content exposed without shielding. MACCS2 was used to calculate noninvolved worker, maximally exposed individual (MEI), and 50-mile (80-kilometer) radius population dose from airborne releases. ZYLIND was used to calculate the external radiation dose to the noninvolved worker and MEI. ZYLIND is a digital interactive computer code that calculates gamma radiation dose rate from cylindrical sources with multiple shielding capabilities (ORNL 1990). ZYLIND accounts for dose buildup factors and shielding effects. External exposure to gamma radiation is not a contributor to the 50-mile (80-kilometer) radius population dose. The accident analysis was repeated for each nuclide using the assumptions and inputs indicated in **Tables J–11** and **J–12**.

Cobalt-60 was found to cause the maximum exposure to the noninvolved worker as a result of the external radiation exposure pathway. Inhalation of transuranics, curium-244 from TA-54, and californium-252 from Wing 9, resulted in the maximum MEI exposure; the direct external radiation exposure at these distances was less important. Cesium-137 resulted in maximum exposure to the surrounding population because of its external dose plus its contribution to internal dose through ingestion of food stuffs. **Table J–13** shows the exposure consequences and risks from this accident, assuming that cesium-137 is present at its limits.

Table J–11 Sealed Source Aircraft Impact Crash Accident at Technical Area 54, Area G Dome Airborne Release Source Term for MACCS2 Calculation

Sealed Source Radioisotope	*Damage Ratio*	*Airborne Release Fraction*	*Respirable Fraction*	*Leak Path Factor*	*Source Term*
Impact					
Cobalt-60	0.05	0.001	0.3	1.0	2.04
Strontium-90	0 [a]	0.001	0.3	1.0	0
Cesium-137	0.05	0.001	0.3	1.0	3.41
Iridium-192	0.05	0.001	0.3	1.0	0.0512
Curium-244	0.05	0.001	0.3	1.0	0.0341
Californium-252	0.05	0.001	0.3	1.0	0.00045
Fire					
Cobalt-60	0.05	0.006	0.01	1.0	0.408
Strontium-90	0 [a]	0.006	0.01	1.0	0
Cesium-137	0.05	0.006	0.01	1.0	0.681
Iridium-192	0.05	0.006	0.01	1.0	0.0102
Curium-244	0.05	0.006	0.01	1.0	0.00682
Californium-252	0.05	0.006	0.01	1.0	0.00009

[a] Strontium-90 sources will be kept in a covered belowground shaft a distance from any dome.
Source: LANL 2004e.

Table J–12 Sealed Source Aircraft Impact Crash Accident at Technical Area 54, Area G Dome Air Release and Direct Radiation Source Terms (in curies)

Sealed Source Radioisotope	*Air Release Source Term*	*Direct Radiation Source Term (one shipping container)*
Cobalt-60	2.45	6,000
Strontium-90 [a]	0	0
Cesium-137	4.09	10,000
Iridium-192	0.0614	150
Curium-244	0.0409	100
Californium-252	0.00054	30

[a] Strontium-90 sources will be kept in a covered belowground shaft a distance from any dome.
Source: LANL 2004e.

Table J–13 Dose and Risk Consequences of Sealed Source Aircraft Impact Crash Accident at Technical Area 54, Area G Dome

Accident Component	*Noninvolved Worker at (110 Yards [100 meters])*	*Maximally Exposed Individual*	*50-Mile (80-kilometer) Population*
Airborne Release from One Dome			
Dose	0.017 rem [a]	0.084 rem [b]	111 person-rem [c]
Annual Risk (LCF per year)	1.3×10^{-10}	6.6×10^{-10}	8.7×10^{-7}
2-Hour Exposure to Direct Radiation from One Breached Shipping Container			
Dose	0.5 rem [a]	Insignificant	Insignificant
Annual Risk (LCF per year)	3.9×10^{-9}	Insignificant	Insignificant
Accident Total			
Dose	0.52 rem [a]	0.084 rem [b]	111 person-rem [c]
Risk (LCF per year)	4.0×10^{-9}	6.6×10^{-10}	8.7×10^{-7}

LCF = latent cancer fatality.
[a] Maximum total dose would result from direct exposure to and airborne release of cobalt-60.
[b] Maximum total dose would result from airborne release of curium-244.
[c] Maximum total dose would result from airborne release of cesium-137.

Results of this accident are the total of the airborne release and unshielded shipping container direct external radiation dose calculation. The high plume energy from the burning aircraft fuel decreases the dose to the noninvolved worker and MEI because a portion of the plume is carried beyond these close-in locations. This same higher energy plume, however, contributes to a larger population dose by decreasing deposition near the release location. The accident contribution from just one unshielded shipping container is a significant component of the total dose to the noninvolved worker because the effects of direct exposure to external radiation are largest near the accident. The external radiation dose to the 50-mile (80-kilometer) radius population is small because the dose rate would drop as the square of the distance at the relatively large distances of the population. Only the gamma dose rate was calculated for exposure to external radiation, based on a factor of 1,000 to 10,000 lower source term for the neutron emitters curium-244 and californium-252, compared to the gamma emitters cobalt-60, cesium-137, and iridium-192.

Based on the Chemistry and Metallurgy Research Building's Basis of Interim Operations and other SWEIS calculations of accidents, the bounding, risk-dominant accident was determined to be a severe earthquake collapse followed by a fire in Wing 9.[8] This accident (plume energy of 2.4 megawatts and 30-minute duration) has a frequency of 2.4×10^{-4} (1 chance in 4,200) per year and can be assumed to cause a level of damage to sealed sources in the corridor and hot cell equivalent to the aircraft crash accident at TA-54, Area G. Using the same values of damage ratio, airborne release fraction, respirable fraction, and leak path factor as for TA-54, Area G, but using the material at risk for Wing 9 of the Chemistry and Metallurgy Research Building, **Table J–14** presents the airborne release and external radiation source terms assuming that one shipping container having the maximum allowed sealed source radioisotope content is exposed without any shielding. Calculation results are presented in **Tables J–15** and **J–16** for both the airborne release and external exposure from sealed sources at Wing 9 of the Chemistry and Metallurgy Research Building or TA-48, a proposed future location for hot cell operations (see Appendix G).

Table J–14 Sealed Source Severe Earthquake and Fire Accident at Chemistry and Metallurgy Research Building Wing 9 Air Release and Direct Radiation Source Terms (in curies)

Sealed Source Radioisotope	*Air Release Source Term*	*Direct Radiation Source Term (one shipping container)*
Cobalt-60	61.6	6,000
Strontium-90	10.4	431,000
Cesium-137	423	10,000
Iridium-192	475	150
Radium-226	1.6	5
Curium-244	0.051	100
Californium-252	0.11	30

[8] *Wing 9 of the Chemistry and Metallurgy Research Building has a hot cell, floor holes, and other storage areas. The Wing 9 hot cell capabilities are planned to be part of the Radiological Sciences Institute proposed to be constructed in TA-48. The accident analysis for materials stored in Wing 9 was performed for the current Chemistry and Metallurgy Research Building location in TA-3 as well as for a location in TA-48.*

Table J–15 Sealed Source Severe Earthquake Collapse and Fire Accident at Chemistry and Metallurgy Research Building Wing 9 Dose and Risk Consequences at Technical Area 3 Location

Accident Component	*Noninvolved Worker at 110 Yards (100 meters)*	*Maximally Exposed Individual*	*50-Mile (80-kilometer) Population*
Airborne Release from Wing 9 Total Hot Cell and Corridor			
Dose	0.71 rem [a]	0.099 rem [b]	11,600 person-rem [c]
Annual Risk	1.0×10^{-7}	1.4×10^{-8}	0.0017
2-Hour Exposure to Direct Radiation from One Breached Shipping Container			
Dose	0.5 rem [a]	Insignificant	Insignificant
Annual Risk	7.2×10^{-8}	Insignificant	Insignificant
Accident Total			
Dose	1.2 rem [a]	0.099 rem [b]	11,600 person-rem [c]
Risk	1.7×10^{-7}	1.4×10^{-8}	0.0017

[a] Maximum total dose would result from direct exposure to and airborne release of cobalt-60.
[b] Maximum total dose would result from airborne release of californium-252.
[c] Maximum total dose would result from airborne release of cesium-137.

Table J–16 Sealed Source Severe Earthquake Collapse and Fire Accident Dose and Risk Consequences at Technical Area 48 Location

Accident Component	*Noninvolved Worker at 110 Yards (100 meters)*	*Maximally Exposed Individual*	*50-Mile (80-kilometer) Population*
Airborne Release from Wing 9 Total Hot Cell and Corridor			
Dose	0.71 rem [a]	0.098 rem [b]	11,400 person-rem [c]
Annual Risk	1.0×10^{-7}	1.4×10^{-8}	0.0016
2-Hour Exposure to Direct Radiation from One Breached shipping Container			
Dose	0.5 rem [a]	Insignificant	Insignificant
Annual Risk	7.2×10^{-8}	Insignificant	Insignificant
Accident Total			
Dose	1.2 rem [a]	0.098 rem [b]	11,400 person-rem [c]
Risk	1.7×10^{-7}	1.4×10^{-8}	0.0016

[a] Maximum total dose would result from direct exposure to and airborne release of cobalt-60.
[b] Maximum total dose would result from airborne release of californium-252.
[c] Maximum total dose would result from airborne release of cesium-137.

As addressed in Appendix D, Section D.4, an updated probabilistic seismic hazard analysis providing an improved understanding of the seismic characteristics of LANL was completed in 2007. Based on the updated information, the probability of exceedance for the ground acceleration used in this accident analysis, and the corresponding radiological risk, is higher than previously estimated by 50 percent. This increase results in a risk of an LCF of 2.1×10^{-8} (1 chance in 48 million) for the MEI and 1.5×10^{-7} (1 chance in 6.5 million) for the noninvolved worker, and an increased chance of an LCF in the general population of 0.0025 (1 chance in 400).

The nearest public access to the Chemistry and Metallurgy Research Building, Diamond Drive, which is approximately 164 feet (50 meters) from the Chemistry and Metallurgy Research Building, is closer than the nearest site boundary to this facility. The same assumptions used to calculate dose to the MEI were applied to an individual at this location. The dose to an individual outside at Diamond Drive during the duration of the release would be 4.32 rem, 42 percent of which would be from external exposure to gamma radiation. Such a dose would result in an increased chance of a fatal latent cancer during the lifetime of the individual of 0.0026, or approximately 1 chance in 385.

The total (airborne release and direct radiation) accident dose and risk to the noninvolved worker, MEI, and population for accidents involving sealed sources at TA-54, Area G, Wing 9 of the Chemistry and Metallurgy Research Building at TA-3, and a facility with capabilities equivalent to Wing 9 located at TA-48 are presented in **Table J–17**.

Table J–17 Total Accident Doses and Risks From Sealed Sources at Technical Area 3, Technical Area 48, and Technical Area 54

Dose Receptor	*Aircraft Crash and Fire at TA-54 Area G*	*Severe Seismic Event and Fire CMR Wing 9 TA-3*	*Severe Seismic Event and Fire TA-48*
Noninvolved Worker Dose (rem)	0.52	1.2	1.2
Noninvolved Worker Risk	4.0×10^{-9}	1.7×10^{-7}	1.7×10^{-7}
MEI Dose (rem)	0.084	0.099	0.098
MEI Risk	6.6×10^{-10}	1.4×10^{-8}	1.4×10^{-8}
Population Dose (person-rem)	111	11,600	11,400
Population Risk	8.7×10^{-7}	0.0017	0.0016

TA = technical area, CMR = Chemistry and Metallurgy Research Building, MEI = maximally exposed individual.

The higher doses for the Wing 9 accident are principally due to the larger source term. Its larger risks are attributed to the larger accident frequency along with the larger source term.

All three accident scenarios analyzed involving sealed sources result in a risk of a LCF during the lifetime of a noninvolved worker or MEI at no greater than 1.7×10^{-7} (one chance in 5,900,000) per year of operation. The 50-mile (80-kilometer) population would not receive a fatal radiation dose for any of these accidents. The highest LCF risk to the population would result from the Wing 9 accident.

If mitigation measures are needed for potential sealed source accidents, they would include placing sealed sources in locations where they would not be susceptible to damage from an aircraft crash, fire, or seismic event (kept underground like the strontium-90 radioisotope thermoelectric generators at TA-54). Another potential mitigation measure might include the use of lower limits for maximum allowable source radioisotope activity in shipping containers, the TA-54 domes, or Wing 9 of the Chemistry and Metallurgy Research Building. Storage containers that can be shown to maintain their integrity under fire, crash, and seismic event loads also would mitigate the consequences of these potential accidents.

J.4 References

ACE (U.S. Army Corps of Engineers), 2005, *Wetlands Delineation Report, Los Alamos National Laboratory, Los Alamos, New Mexico*, Albuquerque District, Albuquerque, New Mexico, October.

Bennett, K., D. Keller, and R. Robinson, 2001, *Sandia Wetland Evaluation*, LA-UR-01-66, Los Alamos National Laboratory, Los Alamos, New Mexico.

DMJM H&N, 2005, *Engineering Study, TA-63 Parking Lot*, LANL Project ID: 101492, 13568.264.STDY.001, Rev. A, Los Alamos, New Mexico, June 30.

DOE (U.S. Department of Energy), 1995, *Environmental Assessment, Radioactive Source Recovery Program*, DOE/EA-1059, Los Alamos Area Office, Los Alamos, New Mexico, December 20.

DOE (U.S. Department of Energy), 1998a, *Environmental Assessment for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1250, Los Alamos Area Office, Los Alamos, New Mexico, December 18.

DOE (U.S. Department of Energy), 1998b, *Finding of No Significant Impact for the Proposed Strategic Computing Complex, Los Alamos National Laboratory, Los Alamos, New Mexico*, Los Alamos Area Office, Los Alamos, New Mexico, December 23.

DOE (U.S. Department of Energy), 1999, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 2000, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Modification of Management Methods for Certain Unwanted Radioactive Sealed Sources at Los Alamos National Laboratory*, DOE/EIS-0238-SA-01, Albuquerque, New Mexico, August.

DOE (U.S. Department of Energy), 2002, *Environmental Assessment for Proposed Access Control and Traffic Improvements at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EA-1429, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, August 23.

DOE (U.S. Department of Energy), 2003, *Final Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0350, National Nuclear Security Administration, Los Alamos Site Office, Los Alamos, New Mexico, November.

DOE (U.S. Department of Energy), 2004a, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Recovery and Storage of Strontium-90 (Sr-90) Fueled Radioisotope Thermal Electric Generators at Los Alamos National Laboratory*, DOE/EIS-0238-SA-04, National Nuclear Security Administration, Los Alamos Site Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 2004b, Memorandum to R. Erickson, Manager, Los Alamos Site Operations, from P. Longsworth, Deputy Administrator, Defense Nuclear Nonproliferation, Subject: Expanded Scope for the Off-Site Source Recovery Program, National Nuclear Security Administration, Washington, DC, March 2.

EPA (U.S. Environmental Protection Agency), 2000, *NPDES Permit No. NM0028355 Fact Sheet for the Draft National Pollutant Discharge Elimination System (NPDES) Permit to Discharge to Waters of the United States*, Region 6, Dallas, Texas, December 29.

EPA (U.S. Environmental Protection Agency), 2001, *Authorization to Discharge Under the National Pollutant Discharge Elimination System*, NPDES Permit No. NM0028355, EPA Region 6, Dallas, Texas, February 1.

KSL (Kellog Brown and Root Government Services; Shaw Environmental and Infrastructure International; and Los Alamos Technical Associates, Inc.), 2004, LANL Roads/NM-4/502, 24 Hour Vehicular Traffic Counts, Directional AM and PM Peak Hour Traffic, September 12, 2004 – September 18, 2004 and September 2003 (Map), Los Alamos, New Mexico, November 17.

LANL (Los Alamos National Laboratory), 2000a, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2000b, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Actions taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory, Los Alamos,* New *Mexico*, DOE/SEA-03, Los Alamos Area Office, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2001, *Comprehensive Site Plan 2001*, LA-UR-01-1838, Los Alamos New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2003, *SWEIS Yearbook—2002, Comparison of 1998 to 2002 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-03-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004a, *Nicholas C. Metropolis Center for Modeling and Simulation*, LA-UR-04-9060, Fact Sheet, National Nuclear Security Administration, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2004b, *Information Document in Support of the Five-Year Review and Supplement Analysis for the Los Alamos National Laboratory Site-Wide Environmental Impact Statement (DOE/EIS-0238)*, LA-UR-04-5631, Ecology Group, Los Alamos, New Mexico, August 17.

LANL (Los Alamos National Laboratory), 2004c, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004d, "Request for Approval for Continued Generation of Waste With No Disposal Path, Off-Site Source Recovery Project, U.S. Radiological Threat Reduction," Los Alamos Site Operations, Los Alamos, New Mexico, September 6.

LANL (Los Alamos National Laboratory), 2004e, *Evaluation of OSRP Sealed Sources at TA-54, Area G*, TD-SWO-012, R.0, FWO-Solid Waste Operations, Los Alamos, New Mexico, October 28.

LANL (Los Alamos National Laboratory), 2005, *Status Report for Integrated Closure Activities at Technical Area 54*, DIV-REPORT-0202, R.0, LA-UR-05-6767, NWIS-Division Office, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 2006a, *Area Development Plan: West Pajarito Corridor*, LA-UR-06-6133, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2006b, *SWEIS Yearbook—2005, Comparison of 2005 Data Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, LA-UR-06-6020, Risk Reduction Office, Environmental Protection Division, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2006c, *Biological Assessment of the Continued Operation of Los Alamos National Laboratory on Federally Listed Threatened and Endangered Species*, LA-UR-06-6679, Ecology and Air Quality Group (ENV-EAQ), Los Alamos Site Office, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006d, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2006e, *Environmental Surveillance at Los Alamos during 2005*, LA-14304-ENV, Los Alamos, New Mexico, September.

ORNL (Oak Ridge National Laboratory), 1990, *An Interactive Point Kernel Program for Photon Dose Rate Prediction of Cylindrical Source/Shield Arrangements*, User's Manual, RSICC Computer Code Collection, CCC-557 ZYLIND, Oak Ridge, Tennessee, October.

USGS (U.S. Geological Survey), 1984, *Frijoles Quadrangle, New Mexico, 7.5 Minute Series (Topographic)*.

APPENDIX K
EVALUATION OF HUMAN HEALTH EFFECTS FROM TRANSPORTATION

APPENDIX K
EVALUATION OF HUMAN HEALTH EFFECTS FROM TRANSPORTATION

K.1 Introduction

Transportation of any commodity involves a risk to transportation crewmembers and members of the public. This risk results directly from transportation-related accidents and indirectly from increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of certain materials, such as hazardous or radioactive waste, can pose an additional risk due to the unique nature of the material itself. To permit a complete appraisal of the environmental impacts of the alternatives considered in this Site-Wide Environmental Impact Statement (SWEIS), the human health risks associated with the transportation of radioactive materials are assessed in this appendix.

This appendix provides an overview of the approach used to assess the human health risks that could result from transportation. The topics in this appendix include the scope of the assessment, packaging and determination of potential transportation routes, analytical methods used for the risk assessment (such as computer models), and important assessment assumptions. In addition, to aid in the understanding and interpretation of the results, specific areas of uncertainty are described with an emphasis on how the uncertainties could affect comparisons of the alternatives.

The risk assessment results are presented in this appendix in terms of "per-shipment" risk factors, as well as the total risks for a given alternative. Per-shipment risk factors provide an estimate of the risk from a single shipment. The total risks for a given alternative are estimated by multiplying the expected number of shipments by the appropriate per-shipment risk factors.

K.2 Scope of Assessment

The scope of the transportation human health risk assessment, including the alternatives and options, transportation activities, potential radiological and nonradiological impacts, and transportation modes considered, is described in this section. There are several shipping arrangements for various radioactive materials that cover all alternatives evaluated. This evaluation focuses on using onsite and offsite public highway systems. Additional details of the assessment are provided in the remaining sections of this appendix.

K.2.1 Transportation-related Activities

The transportation risk assessment is limited to estimating the human health risks related to transportation for each alternative. The risks to workers or to the public during loading, unloading, and handling prior to or after shipment are not included in the transportation assessment. The transportation risk assessment does not address possible impacts of increased transportation levels on local traffic flow, noise levels, or infrastructure. The risks from these activities are considered as part of the facility operation impacts.

K.2.2 Radiological Impacts

For each alternative, radiological risks (those risks that result from the radioactive nature of the materials) are assessed for both incident-free (normal) and accident transportation conditions. The radiological risk associated with incident-free transportation conditions would result from the potential exposure of people to external radiation in the vicinity of a shipment. The radiological risk from transportation accidents would come from the potential release and dispersal of radioactive material into the environment during an accident and the subsequent exposure of people.

All radiological impacts are calculated in terms of committed dose and associated health effects in the exposed populations. The radiation dose calculated is the total effective dose equivalent (see Title 10 of the *Code of Federal Regulations* [CFR], Part 20), which is the sum of the effective dose equivalent from external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure. Radiation doses are presented in units of roentgen equivalent man (rem) for individuals and person-rem for collective populations. The impacts are further expressed as health risks in terms of latent cancer fatalities (LCFs) in exposed populations using the dose-to-risk conversion factors recommended by the U.S. Department of Energy (DOE) Office of NEPA (National Environmental Policy Act) Policy and Compliance, based on Interagency Steering Committee on Radiation Safety guidance (DOE 2003a).

K.2.3 Nonradiological Impacts

In addition to the radiological risks posed by transportation activities, vehicle-related risks are also assessed for nonradiological causes (causes related to the transport vehicles only; not their radioactive cargo) for the same transportation routes. The nonradiological transportation risks, which would be incurred for similar shipments of any commodity, are assessed for accident conditions. The nonradiological accident risk refers to the potential occurrence of transportation accidents that directly result in fatalities unrelated to the shipment of cargo.

Nonradiological risks during incident-free transportation conditions could also be caused by potential exposure to increased vehicle exhaust emissions. As explained in Section K.5.2, these emission impacts were not considered.

K.2.4 Transportation Modes

All shipments are assumed to take place by dedicated truck.

K.2.5 Receptors

Transportation-related risks are calculated and presented separately for workers and members of the general public. The workers considered are truck crewmembers involved in transportation and inspection of the packages. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit. For the incident-free operation, the affected population includes individuals living within 0.5 miles (800 meters) of each side of the road. Potential risks are estimated for the affected populations and for the hypothetical maximally exposed individual (MEI). For incident-free operation, the MEI would be a resident living near the transportation route and exposed to all shipments transported on the route. For accident conditions, the affected population includes individuals residing within 50 miles (80 kilometers) of the accident, and the MEI would be an individual located 330 feet (100 meters) directly downwind from the accident. The risk to the affected population is a measure of the radiological risk posed to society as a whole by the alternative being considered. As such, the impact on the affected population is used as the primary means of comparing alternatives.

K.3 Packaging and Transportation Regulations

K.3.1 Packaging Regulations

The primary regulatory approach to promote safety from radiological exposure is the specification of standards for the packaging of radioactive materials. Packaging represents the primary barrier between the radioactive material being transported and radiation exposure to the public, workers, and the environment. Transportation packaging for radioactive materials must be designed, constructed, and maintained to contain and shield its contents during normal transport conditions. For highly radioactive material, such as high-level radioactive waste or spent nuclear fuel, packagings must contain and shield their contents in the event of severe accident conditions. The type of packaging used is determined by the total radioactive hazard presented by the material within the packaging. Four basic types of packaging are used: Excepted, Industrial, Type A, and Type B.

Excepted packagings are limited to transporting materials with extremely low levels of radioactivity. Industrial packagings are used to transport materials that, because of their low concentration of radioactive materials, present a limited hazard to the public and the environment. Type A packagings are designed to protect and retain their contents under normal transport conditions and must maintain sufficient shielding to limit radiation exposure to handling personnel. Type A packaging, typically a 55-gallon (208-liter) drum or standard waste box, is commonly used to transport radioactive materials with higher concentrations or amounts of radioactivity than Excepted, or Industrial packagings. Type B packagings are used to transport material with the highest radioactivity levels, and are designed to protect and retain their contents under transportation accident conditions. They are described in more detail in the following sections. Packaging requirements are an important consideration for transportation risk assessment. Appendix F of the 1999 *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico,* (*1999 SWEIS)* (DOE 1999a) provides a listing and characteristics of the packagings assumed to be used for this SWEIS.

Radioactive materials shipped in Type A containers, or packagings, are subject to specific radioactivity limits, identified as A1 and A2 values in 49 CFR 173.435 ("Table of A1 and A2 Values for Radionuclides"). In addition, external radiation limits, as prescribed in 49 CFR 173.441 ("Radiation Level Limitations"), must be met. If the A1 or A2 limits are exceeded, the material must be shipped in a Type B container unless it can be demonstrated that the material meets the definition of "low specific activity." If the material qualifies as low specific activity as defined in 10 CFR Part 71 ("Packaging and Transportation of Radioactive Material") and 49 CFR Part 173 (Shippers—General Requirements for Shipments and Packagings), it may be shipped in an approved low-specific-activity shipping container. Type B containers, or casks, are subject to the radiation limits in 49 CFR 173.441, but no quantity limits are imposed except in the case of fissile materials and plutonium.

Type A packages are designed to retain their radioactive contents in normal transport. Under normal conditions, a Type A package must withstand:

- Operating temperatures ranging from -40 degrees Celsius (°C) (-40 degrees Fahrenheit [°F]) to 70 °C (158 °F);
- External pressures ranging from 0.25 to 1.4 kilograms per square centimeter (3.5 to 20 pounds per square inch);
- Normal vibration experienced during transportation;
- Simulated rainfall of 5 centimeters (2 inches) per hour for 1 hour;
- Free fall from 0.3 to 1.2 meters (1 to 4 feet), depending on the package weight;
- Water immersion-compression tests; and
- Impact of a 6-kilogram (13-pound) steel cylinder with rounded ends dropped from 1 meter (40 inches) onto the most vulnerable surface.

Type B packages are designed to retain their radioactive contents in both normal and accident conditions. In addition to the normal conditions outlined earlier, under accident conditions, a Type B package must withstand:

- Free drop from 9 meters (30 feet) onto an unyielding surface in a position most likely to cause damage;
- Free drop from 1 meter (3.3 feet) onto the end of a 15-centimeter (6-inch) diameter vertical steel bar;
- Exposure to temperatures of 800 °C (1,475 °F) for at least 30 minutes;
- For all packages, immersion in at least 15 meters (50 feet) of water;
- For fissile material packages, immersion in at least 0.9 meters (3 feet) of water in an orientation most likely to result in leakage; and
- For spent nuclear fuel packages, immersion in at least 200 meters (660 feet) of water for 1 hour.

Compliance with these requirements is demonstrated by using a combination of simple calculation methods, computer modeling techniques, or scale-model or full-scale testing of transportation packages, or casks.

K.3.2 Transportation Regulations

The regulatory standards for packaging and transporting radioactive materials are designed to achieve four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation by specific limitations on the allowable radiation levels;
- Contain radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria);
- Prevent nuclear criticality (an unplanned nuclear chain reaction that could occur as a result of concentrating too much fissile material in one place); and
- Provide physical protection against theft and sabotage during transit.

The U.S. Department of Transportation (DOT) regulates the transportation of hazardous materials in interstate commerce by land, air, and water. DOT specifically regulates the carriers of radioactive materials and the conditions of transport, such as routing, handling and storage, and vehicle and driver requirements. DOT also regulates the labeling, classification, and marking of radioactive material packagings.

The U.S. Nuclear Regulatory Commission (NRC) regulates the packaging and transporting of radioactive material for its licensees, including commercial shippers of radioactive materials. In addition, under an agreement with DOT, NRC sets the standards for packages containing fissile materials and Type B packagings.

DOE, through its management directives, Orders, and contractual agreements, ensures the protection of public health and safety by imposing on its transportation activities standards equivalent to those of DOT and NRC. According to 49 CFR 173.7(d), packagings made by or under the direction of DOE may be used for transporting Class 7 materials (radioactive materials) when the packages are evaluated, approved, and certified by DOE against packaging standards equivalent to those specified in 10 CFR Part 71 ("Packaging and Transportation of Radioactive Material").

The DOT also has requirements that help to reduce transportation impacts. Some requirements affect drivers, packaging, labeling, marking, and placarding. Others specifying the maximum dose rate from radioactive material shipments help to reduce incident-free transportation doses.

The Federal Emergency Management Agency is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with, Federal Executive agencies that have emergency response functions in the event of a transportation incident. The Federal Emergency Management Agency, an agency of the Department of Homeland Security, coordinates Federal and state participation in developing emergency response plans and is responsible for the development of the interim Federal Radiological Emergency Response Plan. This plan is designed to coordinate Federal support to state and local governments, upon request, during the event of a transportation incident involving radioactive materials.

K.4 Transportation Analysis Impact Methodology

The transportation risk assessment is based on the alternatives described in Chapter 3 of the SWEIS. **Figure K–1** summarizes the transportation risk assessment methodology. After the SWEIS alternatives were identified and the requirements of the shipping campaign were understood, data were collected on material characteristics and accident parameters.

Transportation impacts calculated in this SWEIS are presented in two parts: impacts of incident-free or routine transportation and impacts of transportation accidents. Impacts of incident-free transportation and transportation accidents were further divided into nonradiological and radiological impacts. Nonradiological impacts could result from transportation accidents in terms of traffic fatalities. Radiological impacts of incident-free transportation include impacts on members of the public and crew from radiation emanating from materials in the shipment. Radiological impacts from accident conditions consider all foreseeable scenarios that could damage transportation packages leading to releases of radioactive materials to the environment.

The impact of transportation accidents is expressed in terms of probabilistic risk, which is the probability of an accident multiplied by the consequences of that accident and summed over all reasonably conceivable accident conditions. Hypothetical transportation accident conditions ranging from low-speed “fender-bender” collisions to high-speed collisions with or without fires were analyzed. The frequencies of accidents and consequences were evaluated using a method developed by NRC and published in the *Final Environmental Impact Statement on the Transportation of Radioactive Materials by Air and Other Modes*, NUREG-0170 (NRC 1977); *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829 (NRC 1987); and, *Reexamination of Spent Fuel Shipping Risk Estimates*, NUREG/CR-6672 (NRC 2000). Hereafter, these reports are cited as: *Radioactive Material Study*, NUREG-0170; *Modal Study*, NUREG/CR-4829; and *Reexamination Study*, NUREG/CR-6672. Radiological accident risk is expressed in terms of additional LCFs, and nonradiological accident risk is expressed in terms of additional immediate (traffic) fatalities. Incident-free risk is also expressed in terms of additional LCFs.

Transportation-related risks are calculated and presented separately for workers and members of the general public. The workers considered are truck crewmembers involved in the actual transportation. The general public includes all persons who could be exposed to a shipment while it is moving or stopped during transit.

The first step in the ground transportation analysis is to determine the distances and populations along the routes. The Transportation Routing Analysis Geographic Information System (TRAGIS) computer program (Johnson and Michelhaugh 2003) was used to choose representative routes and the associated distances and populations. This information, along with the properties of the material being shipped and route-specific accident frequencies, was entered into the RADTRAN 5 computer code (Neuhauser and Kanipe 2003), which calculates incident and accident risks on a per-shipment basis. The risks under each alternative are determined by summing the products of per-shipment risks for each waste type by its number of shipments.

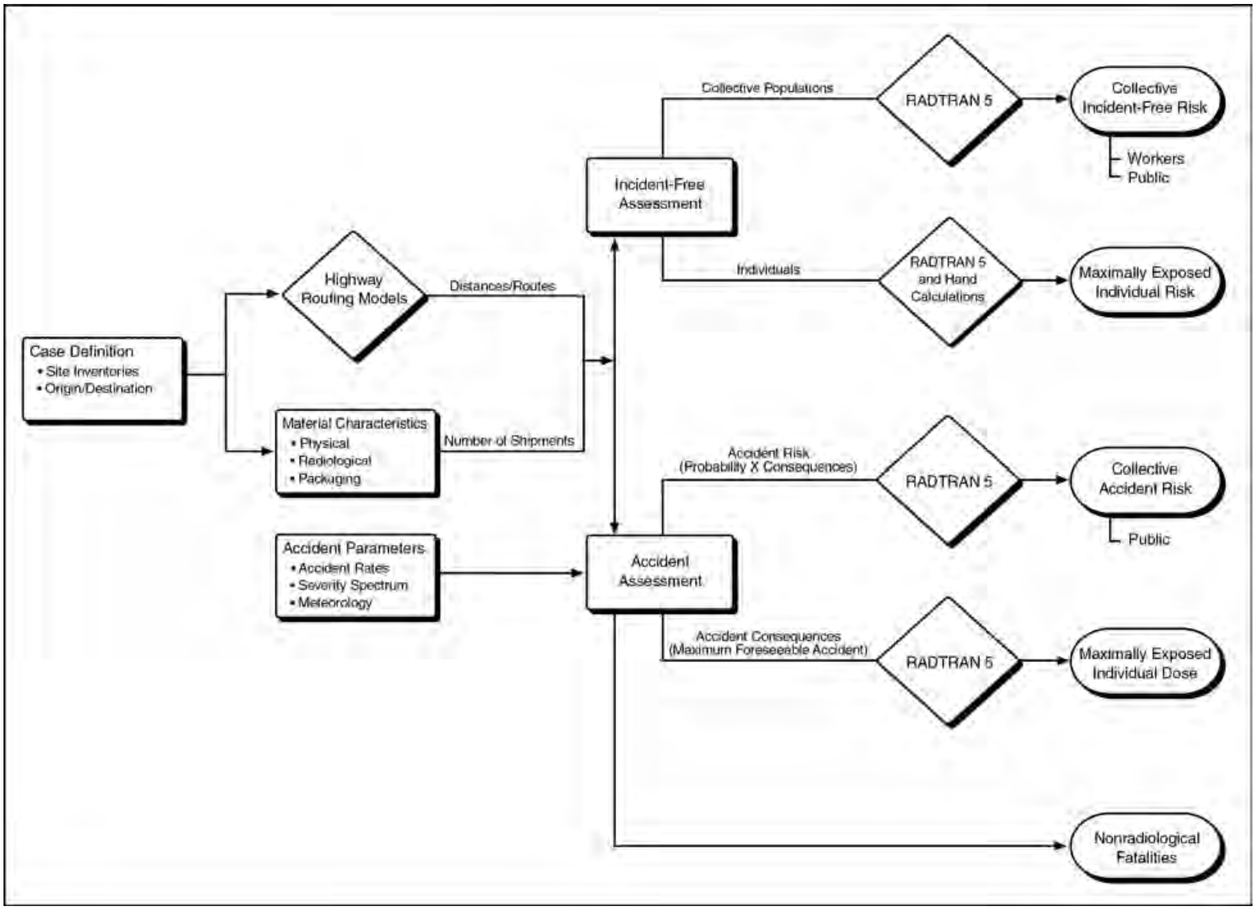


Figure K–1 Transportation Risk Assessment

The RADTRAN 5 computer code (Neuhauser and Kanipe 2003) is used for incident-free and accident risk assessments to estimate the impacts on populations. RADTRAN 5 was developed by Sandia National Laboratories to calculate population risks associated with the transportation of radioactive materials by a variety of modes, including truck, rail, air, ship, and barge. RADTRAN 5 was used to calculate the doses to the MEIs during incident-free operations.

The RADTRAN 5 population risk calculations include both the consequences and probabilities of potential exposure events. The RADTRAN 5 code consequence analyses include cloud shine, ground shine, inhalation, and resuspension exposures. The collective population risk is a measure of the total radiological risk posed to society as a whole by the alternative being considered. As such, the collective population risk is used as the primary means of comparing the various alternatives.

The RISKIND computer code (Yuan et al. 1995) is used to estimate the doses to MEIs and populations for the worst-case maximum reasonably foreseeable transportation accident. The RISKIND computer code was developed for DOE's Office of Civilian Radioactive Waste Management to analyze the exposure of individuals during incident-free transportation. In addition, the RISKIND code was designed to allow a detailed assessment of the consequences to individuals and population subgroups from severe transportation accidents under various environmental settings.

The RISKIND calculations were conducted to supplement the collective risk results calculated using RADTRAN 5. Whereas the collective risk results provide a measure of the overall risks of each alternative, the RISKIND calculations are meant to address areas of specific concern to individuals and population subgroups. Essentially, the RISKIND analyses are meant to address "What if" questions, such as "What if I live next to a site access road?" or "What if an accident happens near my town?"

K.4.1 Transportation Routes

The types of radioactive and nonradioactive materials that would be expected to require offsite transport include special nuclear material, low-level radioactive waste, transuranic waste, irradiated target material, industrial waste, and hazardous waste. These materials would be transported to, from, and on the Los Alamos National Laboratory (LANL) site during routine operations. Offsite shipments, both to and from LANL, are carried by commercial carriers (including truck, air freight, and Government trucks) and by DOE safe secure transport trailers. Air freight transportation is performed for special packages with limited quantities. The amount and form of materials that would be transported using air freight are similar to those evaluated in the *1999 SWEIS* (DOE 1999a) with similar impacts, and therefore are not reevaluated.

For offsite transport, highway routes were determined using the routing computer program TRAGIS (Johnson and Michelhaugh 2003). The TRAGIS computer program is a geographic-information-system-based transportation analysis computer program used to identify and select highway, rail, and waterway routes for transporting radioactive materials within the United States. Both the road and rail network are 1:100,000-scale databases, which were developed from the U.S. Geological Survey digital line graphs and the U.S. Bureau of the Census Topological Integrated Geographic Encoding and Referencing System. The population densities along each route are derived from 2000 Census Bureau data (Johnson and Michelhaugh 2003). The features in TRAGIS allow users to determine routes for shipment of radioactive materials that conform to DOT regulations as specified in 49 CFR Part 397.

Offsite Route Characteristics

Route characteristics that are important to the radiological risk assessment include the total shipment distance and population distribution along the route. The specific route selected determines both the total potentially exposed population and the expected frequency of transportation-related accidents. Route characteristics are expressed in terms of travel distances and population densities in rural, suburban, and urban areas according to the following breakdown:

- Rural population densities range from 0 to 139 persons per square mile (0 to 54 persons per square kilometer);
- Suburban population densities range from 140 to 3,326 persons per square mile (55 to 1,284 persons per square kilometer); and
- Urban population densities include all population densities greater than 3,326 persons per square mile (1,284 persons per square kilometer).

To assess incident-free and transportation accident impacts, route characteristics were determined for offsite shipments from the LANL site to the:

- Pantex Site in Amarillo, Texas;
- Lawrence Livermore National Laboratory, California;
- Y-12 Complex, and Oak Ridge National Laboratory in Oak Ridge, Tennessee;
- Savannah River Site in Aiken, South Carolina;
- Nevada Test Site in Mercury, Nevada;
- EnergySolutions site in Clive, Utah as a representative of a commercial disposal site;
- East Tennessee Waste Treatment Center in Oak Ridge, Tennessee; and
- Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico.

These sites would constitute the locations where the majority of shipments would be transported. **Table K–1** summarizes the route characteristics for these sites.

Table K–1 Offsite Transport Truck Route Characteristics

Origin	*Destination*	*Nominal Distance (kilometers)*	*Distance Traveled in Zones (kilometers)*			*Population Density in Zone (number per square kilometer)*			*Number of Affected Persons* [a]
			Rural	*Suburban*	*Urban*	*Rural*	*Suburban*	*Urban*	
Truck Routes									
LANL	Pantex	668	617	42	9	4.2	451.2	2135.1	63,989
	SRS	2,680	1,987	617	76	11.9	314.8	2,240.1	622,377
	NTS	1,250	1,069	141	40	7.6	338.2	2,626.2	256,117
	Commercial [b]	1,076	938	112	26	6.9	386.2	2,464.3	183,804
	ETWT	2,248	1,759	438	51	10.8	300.4	2,243.2	425,534
	LLNL	1,822	1,632	168	22	8.0	312.6	2,369.9	189,378
	Y-12	2,372	1,848	465	59	11.0	300.8	2,271.4	471,946
	WIPP	605	568	35	2	5.9	251.1	1,891.5	25,541
Truck Routes (local from I-25 to LANL)									
LANL to Pojoaque		31	27	3.8	0.2	5.8	362.6	2,408.5	3,227
Pojoaque to Santa Fe [c]		52	44	8	0	18.9	178.4	0	3,563

SRS = Savannah River Site, NTS = Nevada Test Site, ETWT = East Tennessee Waste Treatment Center (at K-25 site in Oak Ridge, Tennessee), LLNL= Lawrence Livermore National Laboratory, Y-12 = Y-12 Complex at Oak Ridge, WIPP = Waste Isolation Pilot Plant.

[a] The estimated number of persons residing within 0.5 miles (800 meters) along the transportation route.

[b] The EnergySolutions site in Clive, Utah, is a representative commercial disposal facility.

[c] Pass through Santa Fe bypass (New Mexico 599) to Interstate 25.

Note: To convert kilometers to miles, multiply by 0.6214; number per square kilometer to number per square mile, multiply by 2.59.

The affected population for route characterization and incident-free dose calculation includes all persons living within 0.5 miles (800 meters) of each side of the transportation route.

Analyzed truck routes for shipments of radioactive waste materials are shown in **Figure K–2**.

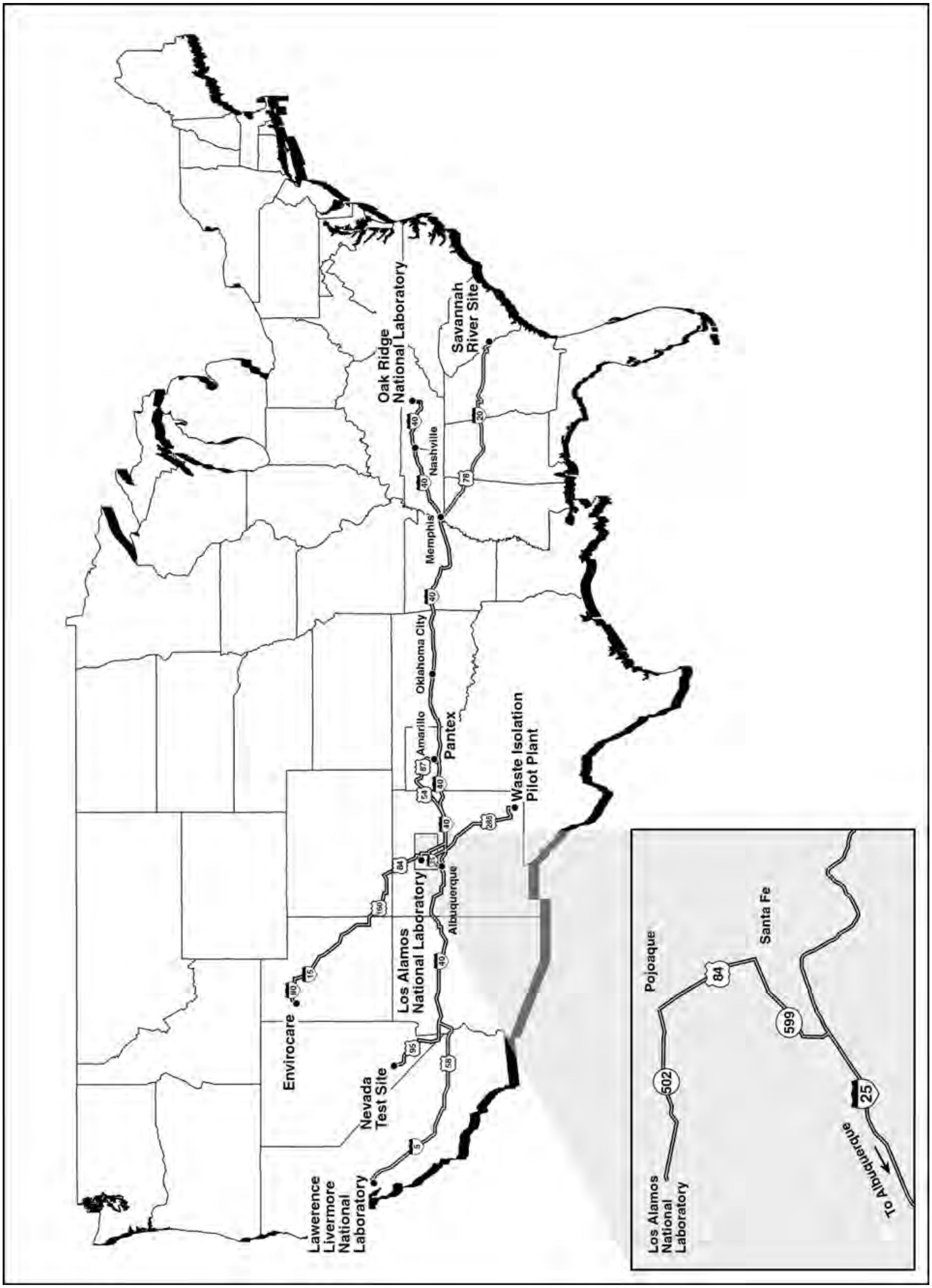


Figure K–2 Analyzed Truck Routes

K.4.2 Radioactive Material Shipments

Transportation of all radioactive material (waste and special nuclear material) types is assumed to be in certified or certified-equivalent packaging on exclusive-use vehicles. Legal-weight heavy-haul combination trucks are used for highway transportation. Type A packages are transported on common flatbed or covered trailers; Type B packages are generally shipped on trailers designed specifically for the packaging being used. For transportation by truck, the maximum payload weight is considered to be about 48,000 pounds (about 22,000 kilograms), based on the Federal gross vehicle weight limit of 80,000 pounds (36,288 kilograms). However, there are large numbers of multitrailer combinations (known as longer combination vehicles) with gross weights in excess of the Federal limit in operation on rural roads and turnpikes in some states (DOT 2003), but for evaluation purposes, the load limit for the legal truck was based on the Federal gross vehicle weight.

Several types of packagings (containers, or casks) would be used to transport the radioactive materials. The various wastes that would be transported under the alternatives in this SWEIS include demolition and construction debris and hazardous waste, low-level radioactive waste, transuranic waste, and mixed low-level radioactive waste. **Table K–2** lists the types of containers used, along with their volumes and the number of containers in a shipment. A shipment is defined as the amount of materials transported on a single truck.

Table K–2 Radioactive Material Type and Container Characteristics

Material Type	*Container*	*Container Volume (cubic meters)* [a]	*Container Mass (kilograms)* [b]	*Number of Containers per Shipment*
Special Nuclear Material	9975, 6M, and FL containers	0.13 and 0.32	113-168	1 to 40 per safe and secure trailer truck
Class A low-level radioactive waste	208-liter drum	0.21	272	80 per truck
Low-level radioactive waste and mixed low-level radioactive waste	B-25 Box	2.55	4,536	5 per truck
Low-level radioactive waste (remote-handled) [c]	208-liter drum	0.21	272	10 per truck cask
Low specific activity waste	Soft liner	7.31	10,886	2 per truck
Transuranic waste (remote-handled)	208-liter drum	0.21	272	3 per truck cask; 1 cask per truck
Transuranic waste (contact-handled)	208-liter drum	0.21	272	14 per TRUPACT II; 3 TRUPACT IIs per truck [d]
Construction and demolition debris	Roll on/Roll off	15.30	Not applicable	1 per truck
Hazardous	208-liter drum	0.21	272	60 to 80 per truck [e]

[a] Container exterior volume. To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, multiply by 0.26417.
[b] Nominal filled container mass. Container mass includes the mass of the container shell, its internal packaging, and the materials within. To convert kilograms to pounds, multiply by 2.2046.
[c] Remote-handled low-level radioactive wastes are packaged in 55-gallons (208-liter) drums and transported in Type B shipping casks.
[d] Nominal number per truck. Depending on the waste density 2 or 3 TRUPACT IIs are shipped per truck. About 30 percent of transuranic wastes are considered to have high density leading to 2 TRUPACT II per truck shipments (LANL 2006).
[e] Depending on the waste density, 60 to 80 drums could be shipped per truck.
Note: Construction debris and hazardous wastes would be shipped to local offsite locations.

The number of shipping containers per shipment was estimated on the basis of the dimensions and weights of the shipping containers; the Transport Index, which is the maximum dose rate at 1 meter (3.3 feet) from a container;[1] limits on special nuclear material mass per shipment; and the transport vehicle dimensions and weight limits. In general, the various wastes were assumed to be transported on standard truck semi-trailers in a single stack.

Special nuclear material is transported on DOE safe and secure transport trailers. Special nuclear material transports include uranium-233, plutonium pits, plutonium oxides and enriched uranium that are used in support of nuclear criticality safety, nuclear weapons, and the production of mixed oxide fuel, or to effect disposition. These materials are transported between LANL, Pantex, Lawrence Livermore National Laboratory, Savannah River Site, Nevada Test Site, Y-12 Complex, and Oak Ridge National Laboratory.

For the purposes of analysis, it was assumed that all low-level radioactive waste would be disposed of at LANL, a DOE site (the Nevada Test Site, in Nevada), or a commercial site (EnergySolutions, in Utah) depending on waste classification. The commercial site only accepts the low-level and mixed low-level radioactive waste known as Class A waste per 10 CFR 61.55, and provided that the waste can be contact-handled. The DOE site accepts all classes of low-level and mixed low-level radioactive waste. Mixed low-level radioactive waste could also be transported to a facility (such as East Tennessee Waste Treatment Center) for treatment and temporary storage, but eventually would have to be transported to an acceptable waste disposal site. The generated transuranic waste would be disposed of at WIPP.

K.5 Incident-Free Transportation Risks

K.5.1 Radiological Risk

During incident-free transportation of radioactive materials, radiological dose results from exposure to the external radiation field that surrounds the shipping containers. The population dose is a function of the number of people exposed, their proximity to the containers, their length of time of exposure, and the intensity of the radiation field surrounding the containers.

Radiological impacts were determined for crewmembers and the general population during incident-free transportation. For truck shipments, the crewmembers are the drivers of the shipment vehicle. The general population is composed of the persons residing within 0.5 miles (800 meters) of the truck routes (off-link), persons sharing the road (on-link), and persons at stops. Exposures to workers who would load and unload the shipments are not included in this analysis, but are included in the occupational estimates for plant workers. Exposures to the inspectors are evaluated and presented separately.

Collective doses for the crew and general population were calculated by using the RADTRAN 5 computer code (Neuhauser and Kanipe 2003). The radioactive material shipments were assigned an external dose rate based on their radiological characteristics. Offsite transportation of the radioactive material has a defined regulatory limit of 10 millirem per hour at 2 meters (6.6 feet) from the cask (10 CFR 71.47 and 49 CFR 173.441). If a waste container shows a high external dose rate that could exceed the DOT limit of 10 millirem per hour 2 meters from the outer, or

[1] *Based on the Transport Index definition provided in 10 CFR 71.43 and 49 CFR 173.410.*

lateral, edge of the vehicle, it would be transported in a Type A or Type B shielded shipping cask or container.

Waste container dose rate, or its Transport Index, depends on distribution and quantities of radionuclides, waste density, shielding provided by the packaging, and self-shielding provided by the waste mixture. The most important gamma emitting radionuclides in the waste are cobalt-60 and cesium-137. The MicroShield computer program (Grove 2003) was used to estimate the external dose rates for the various waste containers based on unit concentrations of cobalt-60 and cesium-137. Dose rate calculations were performed assuming both shielded and bare containers. For the shielded option, waste containers were assumed to be in appropriate Type A or Type B shipping casks. For example, remote-handled transuranic wastes were assumed to be shipped in CNS 10-160B or RH-72B casks (both are Type B casks), and remote-handled low-level radioactive waste in a CNS 10-160B cask or a CNS 14-195 (a Type A shielded cask).

Waste and nuclear materials that are expected to be transported both on site and off site are usually of low dose rate, on the order of one millirem per hour at 1 meter (3.3 feet). However, exhumation of wastes from material disposal areas (MDAs) would be expected to result in multiple waste types having various levels of radioactive inventory and dose rates. Using an enveloping waste composition for each waste type, a conservative dose rate for its container was calculated. These dose rates were compared with those used in other DOE NEPA documentations, and an appropriate conservative value was assigned to each waste type. The remote-handled and contact-handled transuranic waste package dose rates at 1 meter (3.3 feet) were assigned at 10 millirem per hour and 4 millirem per hour, respectively (DOE 1997). Dose rates for low-level radioactive waste and mixed low-level radioactive waste were assigned at 1 millirem per hour at 1 meter (3.3 feet). Dose rate for low specific activity waste was assigned at 0.10 millirem per hour at 1 meter (3.3 feet). Dose rate for the remote handled low-level radioactive wastes in Type A or Type B casks were assigned at 1 millirem per hour at 1 meter (3.3 feet). Dose rates for the special nuclear material shipments of uranium-233, plutonium, and enriched uranium are assigned at 10, 5 and 1 millirem per hour at 1 meter (3.3 feet), respectively.

To calculate the collective dose, a unit risk factor was developed to estimate the impact of transporting one shipment of radioactive material over a unit distance of travel in a given population density zone. The unit risk factors were combined with routing information, such as the shipment distances in various population density zones, to determine the risk for a single shipment (a shipment risk factor) between a given origin and destination. Unit risk factors were developed on the basis of travel on interstate highways and freeways, as required by 49 CFR Parts 171 to 177 for highway-route-controlled quantities of radioactive material within rural, suburban, and urban population zones, by using RADTRAN 5 and its default data. In addition, it was assumed that 10 percent of the time, travel through suburban and urban zones would encounter rush-hour conditions, leading to lower average speed and higher traffic density. Note that the size of the waste package and assumptions regarding public shielding afforded by the general housing structure within each zone would be major contributing factors in the calculated dose.

The radiological risks from transporting radioactive materials were estimated in terms of the number of LCFs among the crew and the exposed population. A health risk conversion factor of 0.0006 LCFs per person-rem of exposure was used for both the public and workers (DOE 2003a).

K.5.2 Nonradiological Risk

The nonradiological risks, or vehicle-related health risks, resulting from incident-free transport that may be associated with the generation of air pollutants by transport vehicles during shipment are independent of the radioactive nature of the shipment. Historically, the health endpoint assessed under incident-free transport conditions is the excess latent mortality due to inhalation of vehicle emissions. Unit risk factors for pollutant inhalation in terms of mortality have been generated (Rao et al. 1982). The unit risk factors account for the potential fatalities from emissions of particulates and sulfur dioxide, but they are applicable only to the urban population zone. The emission unit risk factor for truck transport in the urban area is estimated to be 5.0×10^{-8} fatalities per kilometer; for rail transport, it is 2.0×10^{-7} fatalities per kilometer (DOE 2002a). These risk factors were only used for estimating emission risk while the transport is in the urban area. The emergence of considerable data regarding threshold values for various chemical constituents of vehicle exhaust has made linear extrapolation to estimate the risks from truck or rail emissions untenable. This calculation has been eliminated from RADTRAN in its recent revision (Neuhauser and Kanipe 2003). Therefore, no risk factors have been assigned to the vehicle emissions in this SWEIS.

K.5.3 Maximally Exposed Individual Exposure Scenarios

The maximum individual doses for routine offsite transportation were estimated for transportation workers and for members of the general population. Three hypothetical scenarios were evaluated to determine the MEI in the general population. These scenarios are (DOE 2002a):

- A person caught in traffic and located 4 feet (1.2 meters) from the surface of the shipping container for 30 minutes;
- A resident living 98 feet (30 meters) from the highway used to transport the shipping container; and
- A service station worker at a distance of 52 feet (16 meters) from the shipping container for 50 minutes.

The hypothetical MEI doses were accumulated over a single year for all transportation shipments. However, for the scenario involving an individual caught in traffic next to a shipping container, the radiological exposures were calculated for only one event because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments. For truck shipments, the maximally exposed transportation worker is the driver who was assumed to have been trained as a radiation worker and to drive shipments for up to 2,000 hours per year, or accumulate an exposure of 2 rem per year. The maximum exposure rate for a member of a truck crew as a nonradiation worker is 2 millirem per hour (10 CFR 71.47).

K.6 Transportation Accident Risks and Maximum Reasonably Foreseeable Consequences

K.6.1 Methodology

The offsite transportation accident analysis considers the impact of accidents during the transportation of waste. Under accident conditions, impacts on human health and the environment could result from the release and dispersal of radioactive material. Transportation accident impacts were assessed using an accident analysis methodology developed by NRC. This section provides an overview of the methodologies; detailed descriptions of various methodologies are found in the *Radioactive Material Transportation Study,* NUREG-0170, *Modal Study,* NUREG/CR-4829, and *Reexamination Study,* NUREG/CR-6672 (NRC 1977, 1987, 2000). Accidents that could potentially breach the shipping container are represented by a spectrum of accident severities and radioactive release conditions. Historically, most transportation accidents involving radioactive materials have resulted in little or no release of radioactive material from the shipping container. Consequently, the analysis of accident risks takes into account a spectrum of accidents ranging from high-probability accidents of low severity to hypothetical high-severity accidents that have a correspondingly low probability of occurrence. The accident analysis calculates the probabilities and consequences from this spectrum of accidents.

To provide DOE and the public with a reasonable assessment of radioactive waste transportation accident impacts, two types of analysis were performed. First an accident risk assessment was performed that takes into account the probabilities and consequences of a spectrum of potential accident severities using a methodology developed by the NRC (NRC 1977, 1987, 2000). For the spectrum of accidents considered in the analysis, accident consequences in terms of collective "dose risk" to the population within 50 miles (80 kilometers) were determined using the RADTRAN 5 computer program (Neuhauser et al. 2000). The RADTRAN 5 code sums the product of consequences and probability over all accident severity categories to obtain a probability-weighted risk value referred to in this appendix as "dose risk," which is expressed in units of person-rem. Second, to represent the maximum reasonably foreseeable impacts to individuals and populations should an accident occur, maximum radiological consequences were calculated in an urban or a suburban population zone for an accidental release with a likelihood of occurrence greater than 1-in-10 million per year using the RISKIND computer program (Yuan et al. 1995).

K.6.2 Accident Rates

For the calculation of accident risks, vehicle accident and fatality rates were taken from data provided in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination,* ANL/ESD/TM-150 (Saricks and Tompkins 1999). Accident rates are generically defined as the number of accident involvements (or fatalities) in a given year per unit of travel in that same year. Therefore, the rate is a fractional value, with accident involvement count as the numerator of the fraction and vehicular activity (total travel distance in truck kilometers) as the denominator. Accident rates were generally determined for a multiyear period. For assessment purposes, the total number of expected accidents or fatalities was calculated by multiplying the total shipment distance for a specific case by the appropriate accident or fatality rate.

For commercial truck transportation, the rates presented are specifically for heavy-haul combination trucks involved in interstate commerce (Saricks and Tompkins 1999). Heavy-haul combination trucks are rigs composed of a separable tractor unit containing the engine and one to three freight trailers connected to each other. Heavy-haul combination trucks are typically used for radioactive material shipments. The truck accident rates are computed for each state based on statistics compiled by the Federal Highway Administration, Office of Motor Carriers, from 1994 to 1996. A fatality caused by an accident is the death of a member of the public who is killed instantly or dies within 30 days due to the injuries sustained in the accident.

For offsite truck transportation, separate accident rates and accident fatality risks were used for rural, suburban, and urban population zones. The values selected were the "mean" accident and fatality rates given in ANL/ESD/TM-150 (Saricks and Tompkins 1999) under interstate, primary, and total categories for rural, suburban, and urban population zones, respectively. The accident rates were 3.15, 3.52, and 3.66 per 10 million truck kilometers, and the fatality rates were 0.88, 1.49, and 2.32 per 100 million truck kilometers for rural, suburban, and urban zones, respectively.

For DOE safe secure trailer truck transport, the DOE operational experience between 1984 and 1999 was used. The mean probability of an accident requiring towing of a disabled trailer truck was about 6 per 100 million kilometers (DOE 2000). The number of safe and secure trailer accidents is too small to support allocating this overall rate among the various types of routes (interstate, primary, others) used in the accident analysis. Therefore, data for the relative rate of accidents on these route types, or influence factor, provided in *Determination of Influence Factor and Accident Rates for Armored Tractor/Safe Secure Trailer* (Phillips, Clauss, and Blower 1994), were used to estimate accident frequencies for rural, urban, and suburban transports. Accident fatalities for the safe secure trailer transports were estimated using the commercial truck transport fatality per accident ratios within each zone.

For local and regional transport, New Mexico State accident and fatality rates were used. The data were provided in ANL/ESD/TM-150 (Saricks and Tompkins 1999). The rates used were 1.13 accidents per 10 million truck kilometers and 1.18 fatalities per 100 million truck kilometers.

K.6.3 Accident Severity Categories and Conditional Probabilities

Accident severity categories for potential radioactive waste transportation accidents are described in the *Radioactive Material Transportation Study* (NRC 1977) for radioactive waste in general and in the *Modal Study* (NRC 1987) and the *Reexamination Study* (NRC 2000) for spent nuclear fuel. The methods described in the *Modal Study* and the *Reexamination Study* are applicable to transportation of radioactive materials in a Type B spent fuel cask. The accident severity categories presented in the *Radioactive Material Transportation Study* would be applicable to all other waste transported offsite.

The *Radioactive Material Transportation Study* (NRC 1977) originally was used to estimate conditional probabilities associated with accidents involving transportation of radioactive materials. The *Modal Study* and the *Reexamination Study* (NRC 1987, 2000) are initiatives taken by NRC to refine more precisely the analysis presented in *Radioactive Material Transportation Study* for spent nuclear fuel shipping casks.

Whereas the *Radioactive Material Transportation Study* (NRC 1977) analysis was primarily performed using best engineering judgments and presumptions concerning cask response, the later studies rely on sophisticated structural and thermal engineering analysis and a probabilistic assessment of the conditions that could be experienced in severe transportation accidents. The latter results are based on representative spent nuclear fuel casks assumed to have been designed, manufactured, operated, and maintained according to national codes and standards. Design parameters of the representative casks were chosen to meet the minimum test criteria specified in 10 CFR Part 71. The study is believed to provide realistic, yet conservative, results for radiological releases under transport accident conditions.

In the *Modal Study* and the *Reexamination Study*, potential accident damage to a cask is categorized according to the magnitude of the mechanical forces (impact) and thermal forces (fire) to which a cask may be subjected during an accident. Because all accidents can be described in these terms, severity is independent of the specific accident sequence. In other words, any sequence of events that results in an accident in which a cask is subjected to forces within a certain range of values is assigned to the accident severity region associated with that range. The accident severity scheme is designed to take into account all potential foreseeable transportation accidents, including accidents with low probability but high consequences, and those with high probability but low consequences.

As discussed earlier, the accident consequence assessment considers the potential impacts of severe transportation accidents. In terms of risk, the severity of an accident must be viewed in terms of potential radiological consequences, which are directly proportional to the fraction of the radioactive material within a cask that is released to the environment during the accident. Although accident severity regions span the entire range of mechanical and thermal accident loads, they are grouped into accident categories that can be characterized by a single set of release fractions and are, therefore, considered together in the accident consequence assessment. The accident category severity fraction is the sum of all conditional probabilities in that accident category.

For the accident risk assessment, accident “dose risk” was generically defined as the product of the consequences of an accident and the probability of occurrence of that accident, an approach consistent with the methodology used by RADTRAN 5 computer code. The RADTRAN 5 code sums the product of consequences and probability over all accident categories to obtain a probability-weighted risk value referred to in this appendix as “dose risk,” which is expressed in units of person-rem.

K.6.4 Atmospheric Conditions

Because it is impossible to predict the specific location of an offsite transportation accident, generic atmospheric conditions were selected for the risk and consequence assessments. On the basis of observations from National Weather Service surface meteorological stations at over 177 locations in the United States, on an annual average, neutral conditions (Pasquill Stability Classes C and D) occur 58.5 percent of the time, and stable (Pasquill Stability Classes E and G) and unstable (Pasquill Stability Classes A and B) conditions occur 33.5 percent and 8 percent of the time, respectively (DOE 2002a). The neutral weather conditions predominate in each season, but most frequently in the winter (nearly 60 percent of the observations).

Neutral weather conditions (Pasquill Stability Class D) compose the most frequently occurring atmospheric stability condition in the United States and are thus most likely to be present in the event of an accident involving a radioactive waste shipment. Neutral weather conditions are typified by moderate windspeeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Stable weather conditions are typified by low windspeeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants. The atmospheric condition used in RADTRAN 5 is an average weather condition that corresponds to a stability class spread between Class D (for near distance) and Class E (for farther distance).

The accident consequences for the maximum reasonably foreseeable accident (an accident with likelihood of occurrence greater than 1 in 10 million per year) were assessed under both stable (Class F with a windspeed of 1 meter per second [2.2 miles per hour]) and neutral (Class D with a windspeed of 4 meters per second [8.8 miles per hour]) atmospheric conditions. These calculations provide an estimate of the potential dose to an individual and a population within a zone, respectively. The individual dose would represent the MEI in an accident under worst-case weather conditions (stable condition, with minimum diffusion and dilution). The population dose would represent an accident under average weather conditions.

K.6.5 Radioactive Release Characteristics

Radiological consequences were calculated by assigning radionuclide release fractions on the basis of the type of waste, the type of shipping container, and the accident severity category. The release fraction is defined as the fraction of the radioactivity in the container that could be released to the atmosphere in a given severity of accident. Release fractions vary according to material type and the physical or chemical properties of the radioisotopes. Most solid radionuclides are nonvolatile and are, therefore, relatively nondispersible.

Representative release fractions were developed for each waste and container type on the basis of DOE and NRC reports (DOE 1994, 2002b, 2003a; NRC 1977, 2000). The severity categories and corresponding release fractions provided in the NRC documents cover a range of accidents from no impact (zero speed) to impacts with speed in excess of 120 miles (193 kilometers) per hour onto an unyielding surface. Traffic accidents that could occur at the LANL site would be of minor impact due to lower local speed, with no release potential.

For radioactive materials transported in a Type B cask, the particulate release fractions were developed consistent with the models in the *Reexamination Study* (NRC 2000) and adapted in the *West Valley Demonstration Project Waste Management Environmental Impact Statement* (DOE 2003b). For materials transported in Type A containers (such as 55-gallon [208-liter] drums, boxes, and soft liners), the fractions of radioactive material released from the shipping container were based on recommended values from *Radioactive Material Transportation Study* and *DOE Handbook on Airborne Release and Respirable Fractions* (NRC 1977, DOE 1994). For contact-handled and remote-handed transuranic waste, the release fractions corresponding to the *Radioactive Material Transportation Study* severity categories (NRC 1977) and adapted in the *WIPP Supplemental Environmental Impact Statement* were used (DOE 1997, 2002b).

K.6.6 Acts of Sabotage or Terrorism

In the aftermath of the tragic events of September 11, 2001, DOE is continuing to assess measures to minimize the risk or potential consequences of radiological sabotage. While it is not possible to determine terrorists' motives and targets with certainty, DOE considers the threat of terrorist attacks to be real, and makes all efforts to reduce any vulnerability to this threat. DOE considers, evaluates, and plans for potential terrorist attacks during transportation and storage of special nuclear materials such as plutonium and enriched uranium. These materials would be transported using DOE's safe and secure transport equipment escorted by protective force personnel. DOE has a proven record of protecting these assets; no diversion of any DOE nuclear material has occurred. The details of any postulated terrorist attack, as well as DOE's plans for the security of its facilities and terrorist countermeasures are classified. A classified appendix has been prepared for this SWEIS that includes impact analyses for intentional acts of destruction related to transportation.

Additionally, DOE has evaluated the impacts of acts of sabotage and terrorism on transportation of spent nuclear fuel and high-level radioactive waste shipments (DOE 1996, 2002a). The spectrum of events considered ranges from direct attack on the shipping cask from afar to hijacking and exploding the cask in an urban area. Both of these actions would result in damaging the cask and its contents and releasing radioactive materials. The fraction of the materials released is dependent on the nature of the attack (type of explosive or weapon used). The sabotage event evaluated in the *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Yucca Mountain EIS)* was considered as an enveloping analysis for most transportation activities in this LANL SWEIS. The event was assumed to involve either a truck-sized, or a rail-sized cask containing light water reactor spent nuclear fuel. The consequences of such an act were calculated to result in an MEI dose (at 140 meters [460 feet]) of 40 to 110 rems for events involving a rail-sized or truck-sized cask, respectively. These events would lead to an increase in risk of fatal cancer to the MEI by 2 to 7 percent (DOE 2002a). The quantity of radioactive materials transported under all LANL SWEIS alternatives and the associated transuranic radionuclide source term would be less than that considered in this analysis. Therefore, estimates of risk in the *Yucca Mountain EIS* envelope the risks from an act of sabotage or terrorism involving the radioactive waste transported under all alternatives in this LANL SWEIS.

K.7 Risk Analysis Results

Per-shipment risk factors have been calculated for the collective populations of exposed persons and for the crew for all anticipated routes and shipment configurations. Radiological risks are presented in doses per-shipment for each unique route, material, and container combination. Radiological risk factors per-shipment for incident-free transportation and accident conditions for the offsite disposal locations are presented in **Table K–3**. **Table K–4** presents the radiological risk factors per-shipments for travel on two route segments between LANL and Santa Fe. This analysis was performed to be consistent with those evaluated in the *1999 SWEIS* (DOE 1999a).

Table K–3 Risk Factors per Truck Shipment of Radioactive Material

Waste Materials	Transport Origin or Destination	Incident-Free				Accident	
		Crew Dose (person-rem)	Crew Risk (LCF)	Population Dose (person rem)	Population Risk (LCF)	Radiological Risk (LCF)	Non-radiological Risk (traffic fatalities)
LLW (B) [a]	Nevada Test Site	0.0124	7.46×10^{-6}	0.00392	2.35×10^{-6}	1.67×10^{-8}	0.0000249
LLW (D) [b]		0.0149	8.97×10^{-6}	0.00664	3.99×10^{-6}	2.18×10^{-8}	0.0000249
High activity [c]		0.0124	7.46×10^{-6}	0.00392	2.35×10^{-6}	1.67×10^{-8}	0.0000249
LLW (RH) [d]		0.0108	6.49×10^{-6}	0.00203	1.22×10^{-6}	3.28×10^{-13}	0.0000249
DD&D bulk [e]		0.00137	8.21×10^{-7}	0.000274	1.64×10^{-7}	1.80×10^{-10}	0.0000249
LSA		0.00137	8.21×10^{-7}	0.000274	1.64×10^{-7}	1.30×10^{-8}	0.0000249
LSA	Commercial [f]	0.00118	7.06×10^{-7}	0.000234	1.40×10^{-7}	9.63×10^{-9}	0.0000211
DD&D bulk [e]		0.00118	7.06×10^{-7}	0.000234	1.40×10^{-7}	1.34×10^{-10}	0.0000211
LLW (B) [a]		0.0107	6.41×10^{-6}	0.00334	2.01×10^{-6}	1.41×10^{-8}	0.0000211
LLW (D) [b]		0.0129	7.71×10^{-6}	0.00567	3.40×10^{-6}	1.84×10^{-8}	0.0000211
CH-TRU	WIPP	0.0228	0.0000137	0.00725	4.35×10^{-6}	3.30×10^{-11}	0.0000143
RH-TRU		0.0346	0.0000208	0.00919	5.51×10^{-6}	7.66×10^{-13}	0.0000143
SNM	Pantex	0.00637	3.82×10^{-6}	0.00726	4.36×10^{-6}	9.23×10^{-11}	1.73×10^{-6}
SNM	LLNL	0.00349	2.09×10^{-6}	0.00396	2.37×10^{-6}	3.56×10^{-10}	4.83×10^{-6}
SNM	Y-12	0.00459	2.75×10^{-6}	0.00529	3.18×10^{-6}	1.01×10^{-15}	6.94×10^{-6}
SNM	SRS	0.0260	1.56×10^{-5}	0.0302	1.81×10^{-5}	8.89×10^{-10}	8.08×10^{-6}
SNM	NTS	0.00240	1.44×10^{-6}	0.00281	1.68×10^{-6}	2.76×10^{-10}	3.50×10^{-6}
PuO_2 [g]	SRS	0.00785	4.71×10^{-6}	0.00804	4.82×10^{-6}	4.35×10^{-8}	8.08×10^{-6}
PuO_2 [h]	SRS	0.0393	0.0000236	0.0270	0.0000162	9.25×10^{-8}	8.08×10^{-6}
U-233 [i, j]	ORNL	0.0516	0.000031	0.0705	0.000042	1.25×10^{-9}	6.94×10^{-6}
U-233 [i]	NTS	0.0435	0.000026	0.0371	0.000022	4.91×10^{-10}	3.50×10^{-6}
U-233R [k]	WIPP	0.0346	0.0000208	0.00919	5.51×10^{-6}	1.61×10^{-11}	0.0000143

LCF = latent cancer fatality, LLW = low-level radioactive waste, RH = remote-handled, DD&D = decontamination, decommissioning, and demolition, LSA = low specific activity waste, CH = contact-handled, TRU = transuranic waste, WIPP = Waste Isolation Pilot Plant, LLNL = Lawrence Livermore National Laboratory, NTS = Nevada Test Site, Y-12 = Y-12 Complex in Oak Ridge, SNM = special nuclear material, PuO_2 = plutonium dioxide, SRS = Savannah River Site, U-233 = uranium-233.

[a] Low-level radioactive waste transported in Type A B-25 boxes.
[b] Low-level radioactive waste transported in 55-gallon (208-liter) drums.
[c] High activity low-level radioactive waste containing more than 10 nanocuries per gram of transuranic waste transported in Type A, B-25 boxes. This waste is comparable to Class B or Class C of 10 CFR Part 61 waste classification.
[d] Remote-handled low-level radioactive waste transported in 55-gallon (208-liter) drums.
[e] Decommissioning and demolition bulk managed waste, with a radioactive inventory of equivalent 0.0001 curies of plutonium-239 per cubic yard.
[f] Commercial site is in Utah.
[g] Polished plutonium oxide (very low decay impurities).
[h] Unpolished plutonium oxide (high concentration of decay impurities).
[i] Uranium-233 oxide and metal suitable for the support of criticality experiment programs with very low uranium-232 impurities.
[j] Uranium-233 oxide that is currently at LANL and is considered surplus material to be shipped to ORNL for processing for disposal.
[k] Uranium-233 oxide residue that is contaminated with plutonium and to be disposed as RH-TRU waste at WIPP.

Table K–4 Risk Factors per Truck-Shipment of Radioactive Material at Nearby Routes

Waste Materials	Transport Route Segment	Incident-Free				Accident	
		Crew Dose (person-rem)	Crew Risk (LCF)	Population Dose (person rem)	Population Risk (LCF)	Radiological Risk (LCF)	Non-radiological Risk (traffic fatalities)
LLW (B) [a]	LANL to Pojoaque	0.000309	1.85×10^{-7}	0.0000938	5.63×10^{-8}	3.95×10^{-10}	7.34×10^{-7}
LLW (D) [b]		0.000371	2.23×10^{-7}	0.000159	9.55×10^{-8}	5.16×10^{-10}	7.34×10^{-7}
High activity [c]		0.000309	1.85×10^{-7}	0.0000938	5.63×10^{-8}	3.95×10^{-10}	7.34×10^{-7}
LLW (RH) [d]		0.000269	1.61×10^{-7}	0.0000486	2.92×10^{-8}	4.84×10^{-15}	7.34×10^{-7}
DD&D bulk [e]		0.0000340	2.04×10^{-8}	6.56×10^{-6}	3.94×10^{-9}	2.66×10^{-12}	7.34×10^{-7}
LSA		0.0000340	2.04×10^{-8}	6.56×10^{-6}	3.94×10^{-9}	1.92×10^{-10}	7.34×10^{-7}
CH-TRU		0.00118	7.08×10^{-7}	0.000384	2.30×10^{-7}	4.25×10^{-12}	7.34×10^{-7}
RH-TRU		0.00179	1.08×10^{-6}	0.000486	2.92×10^{-7}	9.87×10^{-14}	7.34×10^{-7}
SNM [f]		0.000298	1.79×10^{-7}	0.000336	2.02×10^{-7}	5.92×10^{-12}	8.33×10^{-8}
PuO_2 [g]		0.000090	5.40×10^{-8}	0.000090	5.4×10^{-8}	2.89×10^{-10}	8.33×10^{-8}
PuO_2 [h]		0.00045	2.70×10^{-7}	0.00030	1.80×10^{-7}	6.16×10^{-10}	8.33×10^{-8}
U-233		0.00067	4.02×10^{-7}	0.000889	5.33×10^{-7}	1.05×10^{-11}	8.33×10^{-8}
LLW (B) [a]	Pojoaque to Santa Fe [i]	0.000517	3.10×10^{-7}	0.000154	9.22v$\times 10^{-8}$	6.31×10^{-10}	1.23×10^{-6}
LLW (D) [b]		0.000622	3.73×10^{-7}	0.000261	1.56×10^{-7}	8.25×10^{-10}	1.23×10^{-6}
High activity [c]		0.000517	3.10×10^{-7}	0.000154	9.22×10^{-8}	6.31×10^{-10}	1.23×10^{-6}
LLW (RH) [d]		0.000450	2.70×10^{-7}	0.0000797	4.78×10^{-8}	5.62×10^{-15}	1.23×10^{-6}
DD&D bulk [e]		0.0000569	3.42×10^{-8}	0.0000108	6.45×10^{-9}	3.09×10^{-12}	1.23×10^{-6}
LSA		0.0000569	3.42×10^{-8}	0.0000108	6.45×10^{-9}	2.23×10^{-10}	1.23×10^{-6}
CH-TRU		0.00198	1.19×10^{-6}	0.000629	3.77×10^{-7}	4.94×10^{-12}	1.23×10^{-6}
RH-TRU		0.00300	1.80×10^{-6}	0.000797	4.78×10^{-7}	1.15×10^{-13}	1.23×10^{-6}
SNM [f]		0.000500	3.00×10^{-7}	0.000552	3.31×10^{-7}	1.45×10^{-11}	1.40×10^{-7}
PuO_2 [g]		0.000151	9.05×10^{-8}	0.000138	8.28×10^{-8}	8.49×10^{-10}	1.40×10^{-7}
PuO_2 [h]		0.000754	4.53×10^{-7}	0.000493	2.96×10^{-7}	1.81×10^{-9}	1.40×10^{-7}
U-233		0.00112	6.74×10^{-7}	0.00146	8.73×10^{-7}	3.10×10^{-11}	1.40×10^{-7}

LCF = latent cancer fatality, LLW = low-level radioactive waste, RH = remote-handled, DD&D = decontamination, decommissioning, and demolition, LSA = low specific activity waste, CH = contact-handled, TRU = transuranic waste, SNM = special nuclear material, PuO_2 = plutonium dioxide, U-233 = uranium-233.

[a] Low-level radioactive waste transported in Type A B-25 boxes.
[b] Low-level radioactive waste transported in 55-gallon (208-liter) drums.
[c] High activity low-level radioactive waste containing more than 10 nanocuries per gram of transuranic waste transported in Type A, B-25 boxes. This waste is comparable to Class B or Class C of 10 CFR Part 61 waste classification.
[d] Remote-handled low-level radioactive waste transported in 55-gallon (208-liter) drums.
[e] Decommissioning and demolition bulk managed waste, with a radioactive inventory of equivalent 0.0001 curies of plutonium-239 per cubic yard.
[f] Calculations are based on the shipment transport index of 5. Transport indices for SNM shipments are 1 and 5, as explained in Section K.5.1.
[g] Polished plutonium oxide (very low decay impurities).
[h] Unpolished plutonium oxide (high concentration of decay impurities).
[i] Shipments pass through the Santa Fe bypass (New Mexico 599) to Interstate 25.

All radioactive material transports would pass through the LANL to Pojoaque route segment, and those that would be destined for the Nevada Test Site, WIPP, Savannah River Site, and Pantex would pass through the second segment; that is, Pojoaque to Santa Fe. Therefore, the populations in these route segments would receive the maximum impacts.

In these tables, for incident-free transportation, both dose and LCF risk factors are provided for the crew and exposed population. The radiological risks would result from potential exposure of people to external radiation emanating from the packaged radioactive materials. The exposed population includes the off-link public (people living along the route), on-link public (pedestrian and car occupants along the route) and public at rest and fuel stops. Doses are calculated for the crew and public (people living along the route, pedestrians and drivers along the route, and the public at rest and fueling stops). For onsite shipments, the stop dose (doses to the public at rest and refueling stops) is set at zero, because a truck is not expected to stop during a shipment that takes less than an hour. For transportation accidents, the risk factors are given for both the radiological, in terms of potential LCF in the exposed population, and the nonradiological, in terms of number of traffic fatalities. The LCF represents the number of additional latent fatal cancers among the exposed population.

Both the radiological dose risk factor and the nonradiological risk factor for transportation accidents are presented in Tables K–3 and K–4. The radiological and nonradiological accident risk factors are provided in terms of potential fatalities per shipment. The radiological risks are in terms of LCFs. For the population, the radiological risks were calculated by multiplying the accident dose risks by the health risk factor of 6×10^{-4} latent cancer fatalities per person-rem of exposure. The nonradiological risk factors are nonoccupational traffic fatalities resulting from transportation accidents.

As stated earlier (see Section K.6.3), the accident dose is called “dose risk” because the values incorporate the spectrum of accident severity probabilities and associated consequences (such as dose). The accident dose risks are very low because accident severity probabilities (the likelihood of accidents leading to confinement breach of a package or shipping cask and release of its contents) are small, and the content and form of the wastes (solid dirt-like contamination) are such that would lead to nondispersible and mostly noncombustible release. Although persons reside in a 50-mile (80-kilometer) radius along the transportation route, they are generally quite far from the route. Because RADTRAN 5 uses an assumption of homogeneous population, it would greatly overestimate the actual doses.

At LANL, radioactive materials are transported both on site, between the Technical Areas (TAs), and off site to multiple locations. Onsite transport constitutes the majority of activities that are part of routine operations in support of various programs. The radioactive materials transported onsite between TAs are mainly of limited quantities, short travel distances, and frequently on closed roads. The impacts of these activities are part of the normal operations at these areas. For example, worker dose from handling and transporting the radioactive materials are included as part of operational activities. Specific analyses performed in the *1999 SWEIS* (DOE 1999a) indicated that the projected collective radiation dose for LANL drivers from a projected 10,750 onsite shipments to be 10.3 person-rem per year, or on the average, less than one millirem per transport. Review of the onsite radioactive materials transportation within the last 4 years indicates a much smaller number of shipments than those projected in the *1999 SWEIS*. Therefore, the *1999 SWEIS* projection of impacts would envelop the impacts for the routine onsite transportation. The nonroutine onsite transport activities, such as waste transport from facility decommissioning and demolition or from MDA remediation, were evaluated and presented in the SWEIS where applicable.

Offsite transports would occur using both trucks and air freight. Materials transported by air freight would be similar in number, type, and forms as those considered in the *1999 SWEIS*, and would hence result in similar impacts. The aircrew dose from air freight radioactive transport was estimated at 2.4 person-rem per year (DOE 1999a). Therefore, only truck (both commercial and DOE safe secure trailer) transport is analyzed here. The *1999 SWEIS* provides a comprehensive listing of various radioactive material types, forms, origin-destination, quantities and the projected number of shipments. The radioactive materials transported included tritium, plutonium, uranium (both depleted and enriched), offsite source recovery project sealed sources, medical isotopes, small quantities of activation products, low-level radioactive waste, and transuranic waste. The specific origins-destinations, except for Rocky Flats, are expected to be applicable for future transports. For analysis purposes in this SWEIS, the focus was on those origins-destinations that would have the greatest effect, including Pantex and Savannah River Site (for plutonium transports) and waste disposal sites (such as the Nevada Test Site, a commercial site in Utah, and WIPP). Transports of other radioactive materials would remain similar to those projected in the *1999 SWEIS*.

Table K–5 provides the estimated number of shipments for various materials under each alternative. In addition, this table provides the estimated number of shipments from activities associated with the MDA removal and capping options and those resulting from increase in pit production from 20 to 80 pits per year. The waste shipments under the No Action Alternative include those expected to be generated during LANL operations over the next 10 years (between 2007 and 2016), baseline remediation of MDAs, and transport of transuranic wastes currently stored above ground. The shipments under the Expanded Operations Alternative include operational wastes, the TA-18 and TA-21 decommissioning and demolition wastes, demolition and refurbishment wastes from implementation of selected project-specific actions as detailed in Appendices G and H, and a range of generated wastes from remediation options on MDAs as detailed in Appendix I. The MDA remediation options include capping and remediation, and removal and remediation of various MDAs and other potential release sites under the Consent Order. The shipments under the Reduced Operations Alternative include generated wastes from LANL operations, the TA-18 decommissioning and demolition activities, and baseline remediation of MDA activities. For the remediation options for MDAs, see Appendix I. In addition, Table K-5 provides the required number of shipments of special nuclear material in support of pit production and Advanced Recovery and Integrated Extraction System, uranium-233 for the criticality safety program, and polished plutonium oxides for the mixed oxide fabrication program under each alternative, as applicable.

LANL currently possess about 16.5 pounds (7.5 kilograms) of uranium-233 metal and oxides. The impacts of shipping about 9.9 to 11 pounds (4.5 to 5 kilograms) of these materials to Oak Ridge National Laboratory for processing and disposition are evaluated in the LANL SWEIS. Further investigation of the uranium-233 needs has identified that 6.2 pounds (2.8 kilograms) are considered surplus, of which 0.5 pounds (240 grams) may not meet acceptance requirements at Oak Ridge National Laboratory. The revised requirement reduces the number of uranium-233 shipments to Oak Ridge, and therefore the current analysis encompasses the impacts of the proposal to transport a lesser quantity.

Table K–5 Estimates of the Number of Radioactive Shipments Under Each Alternative and Selected Activities

Alternative (Activities)	*Number of Shipments*										
	Radioactive Materials									*Miscellaneous*	
	LSA	*DD&D Bulk*	*LLW (B)* [a]	*High Activity* [b]	*LLW-RH* [c]	*Mixed LLW*	*TRU* [d]	*SNM*	*PuO_2*	*Hazardous*	*Others* [e]
No Action	624	812	9,217	312	0	196	1,460	958	20	946	10,778
Reduced Operations	624	812	7,883	312	0	196	1,460	958	20	932	10,778
Expanded Operations [f]	1,436-49,940	9,538	9,919	3,418-36,521	196-856	297-9,019	2,405-5,044	1,558	50	2,781-4,749	35,419-41,506
Expanded Operations (without MDA Remediation) [g]	681	9,538	9,919	3,418	196	240	2,397	1,558	50	1,000	31,856
(MDA Remediation) [h]	755-49,259	0	0	0-33,103	0-660	57-8,779	8-2,647	0	0	1,781-3,749	3,563-9,650
(Increase in Pit Production) [i]	0	0	701	0	0	6	246	600	0	0	0

LSA = low specific activity, DD&D = decontamination, decommissioning, and demolition, LLW = low-level radioactive waste, RH = remote handled, TRU = transuranic waste, SNM = special nuclear material, PuO_2 = plutonium dioxide.

[a] Low-level radioactive waste transported in drums or Type A, B-25 boxes. The values here also include shipments of evaporator bottoms from Radioactive Liquid Waste Treatment Facility to an offsite location and the returned dried wastes.

[b] High activity low-level radioactive waste containing more than 10 nanocuries per gram of transuranic waste transported in Type A, B-25 boxes. This waste is comparable to Class B or Class C of 10 CFR Part 61 waste classification. This waste is generated during MDA waste retrieval, and from decontamination and demolishing of some of the buildings. The shipments also include one shipment of strontium-90 radioisotope thermoelectric generators under all alternatives.

[c] Remote-handled low-level radioactive waste transported in 55-gallon (208-liter) drums.

[d] The sum of remote-handled and contact-handled transuranic waste shipments.

[e] Others include industrial, sanitary, and asbestos wastes.

[f] The range of values represent the estimated number of shipments for options of capping and remediation and removal and remediation of all MDAs.

[g] Expanded Operations Alternative with baseline MDA remediation (without capping or removal).

[h] The range values represent the estimated number of shipments for options of capping and removal of all MDAs.

[i] The waste shipment values presented are based on the differences between the No Action and the Expanded Operation Alternatives' projected waste volumes for routine operation.

In order to provide flexibility for potential disposition of all surplus uranium-233 at WIPP, per shipment and total transportation impacts for shipment of 6.2 pounds (2.8 kilograms) uranium-233 to WIPP is provided in this appendix. The surplus materials are assumed to be packaged in pipe overpack containers and shipped as remote-handled transuranic waste. Pipe overpack containers could be transported in either of two certified casks; 10 drums per cask could be transported in the CNS10-160 B or 3 drums per cask could be transported in the RH-72B. For purposes of analysis, it was assumed that the RH-72B cask, which results in a higher number of shipments, would be used. The per-shipment doses and risks to the transport crew and the population are provided in Table K–3. Use of RH-72B cask would require a total of 63 shipments. Therefore, the total dose to the crew and population would be 2.18 and 0.58 person-rem, respectively. This is small fraction of the total dose under any one of the alternatives analyzed.

Table K–6 shows the risks of transporting radioactive materials under each alternative, and for the MDA remediation options and the increased pit production activities. The risks are calculated by multiplying the previously given per-shipment factors by the number of shipments over the duration of the program and, for radiological doses, by the health risk conversion factors. The risks are for the total offsite transport of the radioactive materials between 2007 and 2016. The risks to the individuals and population from transport of radioactive materials beyond 2016 would be slightly greater than those provided under the No Action Alternative.

Table K–6 Ten-Year Risks of Transporting Radioactive Materials Under Each Alternative and Selected Activities

				Incident-Free				*Accident*	
				Crew		*Population*			
Transport Segments	*Offsite Disposal Option* [a]	*Number of Shipments*	*Round Trip Kilometers Traveled (million)*	*Dose (person-rem)*	*Risk* [b]	*Dose (person-rem)*	*Risk* [b]	*Radio-logical Risk* [b]	*Nonradio-logical Risk* [b]
No Action									
LANL to Pojoaque	NTS	13,599	0.85	5.04	0.00303	1.81	0.00109	3.9×10^{-6}	0.0093
Pojoaque to Santa Fe		13,599	1.15	8.77	0.00526	3.29	0.00198	7.1×10^{-6}	0.0164
Total		13,599	31.88	163.75	0.09825	58.37	0.03502	0.00017	0.3041
LANL to Pojoaque	Commercial	13,599	0.85	5.04	0.00303	1.81	0.00109	3.9×10^{-6}	0.0093
Pojoaque to Santa Fe		2,893 [c]	0.30	3.89	0.00233	1.85	0.00111	1.1×10^{-6}	0.0032
Total		13,599	28.16	147.30	0.08838	52.99	0.03179	0.00014	0.263
Reduced Operations									
LANL to Pojoaque	NTS	12,265	0.76	4.63	0.00278	1.69	0.00101	3.4×10^{-6}	0.0088
Pojoaque to Santa Fe		12,265	1.05	8.08	0.00485	3.09	0.00185	6.2×10^{-6}	0.0147
Total		12,265	28.54	147.17	0.08830	53.14	0.03188	0.00015	0.271
LANL to Pojoaque	Commercial	12,265	0.76	4.63	0.00278	1.69	0.00101	3.4×10^{-6}	0.0088
Pojoaque to Santa Fe		2,893 [c]	0.30	3.89	0.00233	1.85	0.00111	1.1×10^{-6}	0.0032
Total		12,265	25.28	133.05	0.07983	48.53	0.02912	0.00013	0.235
Expanded Operations (with MDA Removal Option)									
LANL to Pojoaque	NTS	122,445	7.62	25.94	0.01556	8.14	0.00488	0.000032	0.089
Pojoaque to Santa Fe		122,445	9.70	43.46	0.02608	13.31	0.00799	0.000047	0.149
Total		122,445	299.94	910.31	0.54619	286.77	0.17206	0.0016	2.96
LANL to Pojoaque	Commercial	122,445	7.62	25.94	0.01556	8.14	0.00488	0.000032	0.089
Pojoaque to Santa Fe		44,205 [c]	3.52	30.37	0.01822	9.79	0.00587	0.000024	0.0532
Total		122,445	272.76	866.16	0.51970	273.62	0.16417	0.0014	2.67
Expanded Operations (with MDA Capping Option)									
LANL to Pojoaque	NTS	28,817	1.79	8.04	0.00482	2.84	0.00171	5.7×10^{-6}	0.0205
Pojoaque to Santa Fe		28,817	2.31	13.47	0.00808	4.64	0.00278	9.8×10^{-6}	0.0343
Total		28,817	69.28	255.88	0.15353	89.07	0.05344	0.00025	0.660
LANL to Pojoaque	Commercial	28,817	1.79	8.04	0.00482	2.84	0.00171	5.7×10^{-6}	0.0205
Pojoaque to Santa Fe		7,803 [c]	0.65	7.65	0.00459	2.98	0.00179	3.1×10^{-6}	0.0085
Total		28,817	61.98	236.26	0.14175	82.86	0.04972	0.00022	0.580

Transport Segments	Offsite Disposal Option [a]	Number of Shipments	Round Trip Kilometers Traveled (million)	Incident-Free				Accident	
				Crew		Population			
				Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Nonradiological Risk [b]
Expanded Operations (without MDA Removal or Capping Options)									
LANL to Pojoaque	NTS	27,997	1.74	7.98	0.00479	2.83	0.00170	5.5×10^{-6}	0.0199
Pojoaque to Santa Fe		27,997	2.24	13.38	0.00803	4.62	0.00277	9.6×10^{-6}	0.0333
Total		27,997	67.24	253.96	0.15237	88.58	0.05315	0.00024	0.640
LANL to Pojoaque	Commercial	27,997	1.74	7.98	0.00479	2.83	0.00170	5.5×10^{-6}	0.0199
Pojoaque to Santa Fe		7,795 [c]	0.64	7.63	0.00458	2.97	0.00178	3.1×10^{-6}	0.0085
Total		27,997	60.22	234.58	0.14075	82.44	0.04946	0.00021	0.563
MDA Removal Option Activities									
LANL to Pojoaque	NTS	94,448	5.87	17.95	0.01077	5.31	0.00319	0.000026	0.069
Pojoaque to Santa Fe		94,448	7.46	30.08	0.01805	8.70	0.00522	0.000037	0.088
Total		94,448	232.70	656.35	0.39381	198.19	0.11892	0.0013	2.320
LANL to Pojoaque	Commercial	94,448	5.87	17.95	0.01077	5.31	0.00319	0.000026	0.069
Pojoaque to Santa Fe		36,410 [c]	2.88	22.73	0.01364	6.82	0.00409	0.000021	0.034
Total		94,448	212.54	631.58	0.37895	191.18	0.11471	0.0012	2.100
MDA Capping Option Activities									
LANL to Pojoaque	NTS	820	0.05	0.05	0.00003	0.01	0.00001	1.7×10^{-7}	0.0006
Pojoaque to Santa Fe		820	0.06	0.09	0.00005	0.02	0.00001	2.0×10^{-7}	0.00076
Total		820	2.04	1.92	0.00115	0.49	0.00029	0.00001	0.0203
LANL to Pojoaque	Commercial	820	0.05	0.05	0.00003	0.01	0.00001	1.7×10^{-7}	0.00060
Pojoaque to Santa Fe		8 [c]	0.0006	0.02	0.00001	0.005	0.000003	3.9×10^{-11}	0.00001
Total		820	1.76	1.68	0.00101	0.42	0.00025	0.000008	0.0172
Increase in Pit Production Activities									
LANL to Pojoaque	NTS	1,553	0.097	0.68	0.00041	0.36	0.00022	2.7×10^{-7}	0.00075
Pojoaque to Santa Fe		1,553	0.15	1.14	0.00068	0.59	0.00035	1.9×10^{-6}	0.00125
Total		1,553	3.63	18.0	0.01083	8.95	0.00537	0.000011	0.0239
LANL to Pojoaque	Commercial	1,553	0.097	0.68	0.00041	0.36	0.00022	2.7×10^{-7}	0.00075
Pojoaque to Santa Fe		879 [c]	0.08	0.79	0.00047	0.49	0.00029	1.4×10^{-6}	0.00043
Total		1,553	3.39	16.87	0.01012	8.56	0.00514	9.6×10^{-6}	0.0214

NTS = Nevada Test Site, MDA = material disposal area.

[a] Under this option, low-level radioactive waste would be shipped to either the Nevada Test Site or a commercial site in Utah. Transuranic wastes would be shipped to WIPP. Pantex, Y-12, Oak Ridge, Nevada Test site, Lawrence Livermore and the Savannah River Site would ship or receive special nuclear materials. Also note that the number of shipments along the Pojoaque to Santa Fe segment would be lower when the commercial site in Utah is used as an offsite disposal option for low-level radioactive waste.

[b] Risk is expressed in terms of latent cancer fatalities, except for the nonradiological risk, where it refers to the number of traffic accident fatalities.

[c] Shipments of low-level radioactive waste to a commercial disposal site in Utah would not pass along the Pojoaque to Santa Fe segment of highway.

The values presented in Table K–6 show that the total radiological risks (the product of consequence and frequency) are very small under all alternatives. It should be noted that the maximum annual dose to a transportation worker would be 100 millirem per year, unless the individual is a trained radiation worker who would have an administratively controlled annual dose limit of 2,000 millirem (DOE 1999b). The potential for a trained radiation worker to develop a latent fatal cancer from the maximum annual exposure is 0.0012 (about 1 chance in 800). Therefore, no individual transportation worker would be expected to develop a latent fatal cancer from exposures during the activities under all alternatives.

Nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. Considering that the transportation activities analyzed in this SWEIS would occur over a 10-year period and the average number of traffic fatalities in the United States is about 40,000 per year (DOT 2006), the traffic fatality risk under all alternatives would be very small.

The risks to various exposed individuals under incident-free transportation conditions have been estimated for hypothetical exposure scenarios identified in Section K.5.3. The estimated doses to workers and the public are presented in **Table K–7**. Doses are presented on a per-event basis (person-rem per event), as it is unlikely that the same person would be exposed to multiple events; for those that could have multiple exposures, the cumulative dose could be calculated. The maximum dose to a crewmember is based on the same individual being responsible for driving every shipment for the duration of the campaign. Note that the potential exists for larger individual exposures if multiple exposure events occur. For example, the dose to a person stuck in traffic next to a shipment of remote-handled transuranic waste for one-half hour is calculated to be 0.012 rem (12 millirem). This is considered a one-time event for that individual.

Table K–7 Estimated Dose to Maximally Exposed Individuals During Incident-Free Transportation Conditions

Receptor	*Dose to Maximally Exposed Individual*
Workers	
Crewmember (truck drivers)	2 rem per year [a]
Inspector	0.028 rem per event per hour of inspection
Public	
Resident (along the truck route)	3.0×10^{-7} rem per event
Person in traffic congestion	0.012 rem per event per one-half hour stop
Persons at a rest stop or gas station	0.00020 rem per event per hour of stop
Gas station attendant	0.00026 rem per event

[a] Maximum administrative dose control level per year for a trained radiation worker (truck crewmember).

A member of the public residing along the route would likely receive multiple exposures from passing shipments. The cumulative dose to this resident can be calculated assuming all shipments passed his or her home. The cumulative dose is calculated assuming that the resident is present for every shipment and is unshielded at a distance of about 98 feet (30 meters) from the route. Therefore, the cumulative dose depends on the number of shipments passing a particular point and is independent of the actual route being considered. If one assumes the maximum resident dose provided in Table K–7 for all transports, then the maximum dose to this resident would be about 37 millirem if all radioactive materials were shipped via this route. This dose corresponds to that for shipments under the Expanded Operations Alternative with the MDA

Removal Option, which has an estimated number of shipments of about 122,450 over 10 years. This dose translates to less than 4 millirem per year, with a risk of developing a latent fatal cancer of 2.4×10^{-6} per year (or one chance in 41,700 that the exposed individual would develop a latent fatal cancer from exposure to all shipments over 10 years).

The accident risk assessment and the impacts shown in Table K–6 take into account the entire spectrum of potential accidents, from a fender-bender to extremely severe accidents. To provide additional insight into the severity of accidents in terms of the potential dose to a MEI and the public, an accident consequence assessment has been performed for a maximum reasonably foreseeable hypothetical transportation accident with a likelihood of occurrence greater than 1 in 10 million per year. The results, presented in Table K–6, include all conceivable accidents, irrespective of their likelihood.

The following assumptions were used to estimate the consequences of maximum reasonably foreseeable offsite transportation accidents:

- The accident is the most severe with the highest release fraction; high-impact and high-temperature fire accident (highest severity category).
- The individual is 330 feet (100 meters) downwind from a ground release accident.
- The individual is exposed to airborne contamination for 2 hours and ground contamination for 24 hours with no interdiction or cleanup. A stable weather condition (Pasquill Stability Class F) with a wind speed of 1 meter per second (2.2 miles per hour) is considered.
- The population is assumed at a uniform density to a radius of 50 miles (80 kilometers), and exposed to the entire plume passage and 7 days of ground exposure without interdiction and cleanup. A neutral weather condition (Pasquill Stability Class D) with a wind speed of 4 meters per second (8.8 miles per hour) is considered. Since the consequences are proportional to the population density, the accident is assumed to occur in an urban area with the highest density, see Table K–1.
- The number of containers involved in the accident is listed in Table K–2. When multiple Type B or shielded Type A shipping casks are transported in a shipment, a single cask is assumed to have failed in the accident. It is unlikely that a severe accident would breach multiple casks.

Table K–8 provides the estimated dose and risk to an individual and population from a maximum foreseeable truck or rail transportation accident with the highest consequences under each alternative and disposal option.

Table K–8 Estimated Dose to the Population and to Maximally Exposed Individuals during Most Severe Accident Conditions

Alternative	*Material in the Accident With the Highest Consequences*	*Likelihood of the Accident (per year)* [a]	*Population* [a]		*Maximally Exposed Individual* [b]	
			Dose (person-rem)	*Risk (LCF)*	*Dose (rem)*	*Risk (LCF)*
No Action	CH-TRU	1.9×10^{-7}	310	0.186	0.0062	3.7×10^{-6}
Reduced Operations	CH-TRU	1.9×10^{-7}	310	0.186	0.0062	3.7×10^{-6}
Expanded Operations, MDA Removal Option	CH-TRU	5.2×10^{-7}	310	0.186	0.0062	3.7×10^{-6}
Expanded Operations, MDA Capping Option [c]	CH-TRU	2.7×10^{-7}	310	0.186	0.0062	3.7×10^{-6}

LCF = latent cancer fatality, CH-TRU = contact-handled transuranic waste, MDA = material disposal area.

[a] The population doses, risks, and the likelihood of the accident are presented for an urban area on the transportation route. Population extends at a uniform density to a radius of 50 miles (80 kilometers). The weather condition was assumed to be Pasquill Stability Class D with a wind speed of about 9 miles per hour (4 meters per second).

[b] The individual is assumed to be 330 feet (100 meters) downwind from the accident and exposed to the entire plume of the radioactive release. The weather condition is assumed to be Pasquill Stability Class F with a wind speed of 2.2 miles per hour (1 meter per second).

[c] The values presented here are also applicable to Expanded Operations without MDA removal or capping.

K.8 Impact of Construction and Hazardous Material Transport

This section evaluates the impacts of transporting materials required to construct new facilities, as well as nonradioactive and hazardous materials generated during each alternative. The construction materials considered are concrete, cement, sand, gravel, dirt, and steel. The impacts were evaluated based on the number of truck shipments required for each of the materials and the distances from their point of origin to the LANL site. The origins of construction materials were assumed to be at an average distance of 100 miles (160 kilometers) from the site. The truck kilometers for all material shipments under each alternative were calculated by summing all of the activities from construction through closure (where applicable). The truck accident and fatality rates were assumed to be those that were provided earlier for the onsite and local area transports. **Table K–9** summarizes the impacts in terms of total number of kilometers, accidents, and fatalities for all alternatives. The results in Table K–9 indicate that there are no large differences in the impacts among all alternatives. Under all alternatives, the expected potential traffic fatalities are very low.

Table K–9 Estimated Impacts of Construction and Operational Material Transport

Alternative	*Total Distance Traveled (kilometers)*	*Number of Accidents*	*Number of Fatalities*
No Action	5.67×10^{6}	0.64	0.070
Reduced Operations	5.53×10^{6}	0.62	0.070
Expanded Operations			
Without MDA Capping or Removal	22.08×10^{6}	2.50	0.26
With MDA Capping	24.52×10^{6}	2.77	0.29
With MDA Removal	28.12×10^{6}	3.18	0.33

MDA = material disposal area.
Note: To convert kilometers to miles, multiply by 0.6214.

K.9 Conclusions

Based on the results presented in the previous section, the following conclusions have been reached (see Tables K–5 through K–9):

- It is unlikely that the transportation of radioactive waste would cause an additional fatality as a result of radiation either from incident-free operation or postulated transportation accidents.

- The highest risk to the public would be under the Expanded Operations Alternative (with the MDA Removal Option) and the Nevada Test Site disposal site option, where about 122,450 truck shipments of radioactive materials would be transported to the Nevada Test Site, WIPP, Pantex, Lawrence Livermore National Laboratory, Oak Ridge (Y-12 Complex and K-25), and the Savannah River Site.

- The lowest risk to the public would be under the Reduced Operations Alternative and a commercial site disposal option, with about 12,270 truck shipments of radioactive materials to similar locations as those in the Expanded Operations Alternative.

The nonradiological accident risks (the potential for fatalities as a direct result of traffic accidents) present the greatest risks. The maximum risks would occur under the Expanded Operations Alternative (with the MDA Removal Option) and the Nevada Test Site disposal site option. Considering that the transportation activities would occur over a 10-year period and that the average number of traffic fatalities in the United States is about 40,000 per year, the traffic fatality risks under all alternatives are very small.

K.10 Long-Term Impacts of Transportation

The *Yucca Mountain EIS* (DOE 2002a, 2007) analyzed the cumulative impacts of the transportation of radioactive material, consisting of impacts of historical shipments of radioactive waste and spent nuclear fuel, reasonably foreseeable actions that include transportation of radioactive material, and general radioactive material transportation that is not related to a particular action. The collective dose to the general population and workers was the measure used to quantify cumulative transportation impacts. This measure of impact was chosen because it may be directly related to LCFs using a cancer risk coefficient. **Table K–10** provides a summary of the total worker and general population collective doses from various transportation activities. The table shows that the impacts of this program are quite small compared with the overall transportation impacts. The total collective worker dose from all types of shipments (historical, the alternatives, reasonably foreseeable actions, and general transportation) was estimated to be about 382,400 person-rem (229 LCFs) for the period 1943 through 2073 (131 years). The total general population collective dose was estimated to be about 343,900 person-rem (206 LCFs). The majority of the collective dose for workers and the general population was due to the general transportation of radioactive material. Examples of these activities are shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level waste to commercial disposal facilities. The total number of LCFs (among the workers and the general population) estimated to result from radioactive material transportation over the period between 1943 and 2073 is about 435, or an average of less than

4 LCFs per year. Over this same period (131 years), approximately 73 million people would die from cancer, based on the National Center for Health Statistics data on the average annual number of cancer death in the United States of about 554,000, with less than 1 percent fluctuation in the number of cancer fatalities in any given year (CDC 2007). The transportation-related LCFs would be 0.0006 percent of the total number of cancers, therefore, it is indistinguishable from the natural fluctuation in the total annual death rate from cancer.

Table K–10 Cumulative Transportation-Related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2073)

Category	*Collective Worker Dose (person-rem)*	*Collective General Population Dose (person-rem)*
Transportation Impacts in this SWEIS [a]	910 [a]	287 [a]
Other Nuclear Material Shipments		
Historical	330	230
Reasonably Foreseeable Actions [b]	25,300	42,200
General Radioactive Material Transport (1943 to 2073)	350,000	300,000
Yucca Mountain EIS [c] (maximum transport) (up to 2073)	5,900	1,200
Total collective dose [d] (up to 2073)	382,400	343,900
Total latent cancer fatalities	229	206

[a] Maximum values from Tables K–6 for transports from 2007 through 2016.
[b] Includes transportation impacts associated with Complex Transformation activities related to radioactive material transports (DOE 2007b, Table 6.3.2-1).
[c] Impacts for the Proposed Action in the *Draft Yucca Mountain Supplemental EIS* (DOE 2007, Table 8-14). [Similar impacts in the *Yucca Mountain EIS* (DOE 2002a) were 4600, and 1,600 person-rem for workers and population, respectively.] If DOE decides to expand the program to include all potential high-level and Greater-Than-Class C wastes and spent nuclear fuel (implement inventory Module 2), then the worker and public doses would be about 15,000 and 2,700 person-rem, respectively.
[d] The values are rounded to the nearest hundred.
Source: DOE 2002a, 2007.

K.10.1 Uncertainty and Conservatism in Estimated Impacts

The sequence of analyses performed to generate the estimates of radiological risk for transportation includes: 1) determination of the inventory and characteristics, 2) estimation of shipment requirements, 3) determination of route characteristics, 4) calculation of radiation doses to exposed individuals (including estimating of environmental transport and uptake of radionuclides), and 5) estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models; in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns caused simply by the future nature of the actions being analyzed); and in the calculations themselves (such as the approximate algorithms used in the computer programs used for the analyses).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result; however, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure, through uniform and judicious selection of scenarios, models, and input parameters, that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this design is accomplished by uniformly applying common input parameters and assumptions to each alternative. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for the assessment steps enumerated above. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. The reality and conservatism of the assumptions are addressed. Where practical, the parameters that most affect the risk assessment results are identified.

K.10.2 Uncertainties in Material Inventory and Characterization

The inventories and physical and radiological characteristics are important input parameters to the transportation risk assessment. The potential number of shipments for all alternatives is primarily based on the projected dimensions of package contents, the strength of the radiation field, the heat that must be dissipated, and assumptions concerning shipment capacities. The physical and radiological characteristics are important in determining the material released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

Uncertainties in inventory and characterization are reflected in the transportation risk results. If the inventory is overestimated (or underestimated), the resulting transportation risk estimates are also overestimated (or underestimated) by roughly the same factor. However, the same inventory estimates are used to analyze the transportation impacts of each of the alternatives. Therefore, for comparative purposes, the observed differences in transportation risks among the alternatives, as given in Table K–6, are believed to represent unbiased, reasonably accurate estimates from current information in terms of relative risk comparisons.

K.10.3 Uncertainties in Containers, Shipment Capacities, and Number of Shipments

The transportation required for each alternative is based in part on assumptions concerning the packaging characteristics and shipment capacities for commercial trucks. Representative shipment capacities have been defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities such that the projected number of shipments and, consequently, the total transportation risk, would change. However, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among alternatives would remain about the same.

K.10.4 Uncertainties in Route Determination

Analyzed routes have been determined between all origin and destination sites considered in the SWEIS. The routes have been determined to be consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the representative ones with regard to distances and total population along the routes. Moreover, because materials could be transported over an extended time starting at some time in the future, the highway infrastructure and the demographics along routes could change. These effects have not been accounted for in the transportation assessment; however, it is not anticipated that these changes would substantially affect relative comparisons of risk among the alternatives considered in the SWEIS. Specific routes for certain shipments cannot be identified in advance because the routes are classified to protect national security interests.

K.10.5 Uncertainties in the Calculation of Radiation Doses

The models used to calculate radiation doses from transportation activities introduce a further uncertainty in the risk assessment process. Estimating the accuracy or absolute uncertainty of the risk assessment results is generally difficult. The accuracy of the calculated results is closely related to the limitations of the computational models and to the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN, or any computer code of this type, is the scarcity of data for certain input parameters. Populations (off-link and on-link) along the transportation routes, shipment surface dose rates, and individuals residing near the routes are the most uncertain data in dose calculations. In preparing these data, one makes assumptions that the off-link population is uniformly distributed; the on-link population is proportional to the traffic density, with an assumed occupancy of two persons per car; the shipment surface dose rate is the maximum allowed dose rate; and a potential exists for an individual to be residing at the edge of the highway. It is clear that not all assumptions are accurate. For example, the off-link population is mostly heterogeneous, and the on-link traffic density varies widely within a geographic zone (urban, suburban, rural). Finally, added to this complexity are the assumptions regarding the expected distance between the public and the shipment at a traffic stop, rest stop, or traffic jam and the afforded shielding.

Uncertainties associated with the computational models are reduced by using state-of-the-art computer codes that have undergone extensive review. Because many uncertainties are recognized but difficult to quantify, assumptions are made at each step of the risk assessment process that are intended to produce conservative results (such as overestimating the calculated dose and radiological risk). Because parameters and assumptions are applied consistently to all alternatives, this model bias is not expected to affect the meaningfulness of relative comparisons of risk; however, the results may not represent risks in an absolute sense.

K.11 References

CDC (Centers for Disease Control and Prevention), 2007, "Total Number of Deaths for 113 Selected Causes, 1999-2004," National Center for Health Statistics, Hyattsville, Maryland, August.

DOE (U.S. Department of Energy), 1994, *DOE Handbook, Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*, DOE-HDBK-3010-94, Washington, DC, December.

DOE (U.S. Department of Energy), 1996, *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel*, DOE/EIS-0218, Office of Environmental Management, Washington, DC, February.

DOE (U.S. Department of Energy), 1997, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad Area Office, Carlsbad, New Mexico, September.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, Los Alamos, New Mexico*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, July.

DOE (U.S. Department of Energy), 2000, *Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*, DOE/EIS-0310, Office of Nuclear Energy, Science and Technology, Washington, DC, December.

DOE (U.S. Department of Energy), 2002a, *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, Washington, DC, February.

DOE (U.S. Department of Energy), 2002b, *A Resource Handbook on DOE Transportation Risk Assessment*, DOE/EM/NTP/HB-01, Office of Environmental Management, National Transportation Program, Albuquerque, New Mexico, July.

DOE (U.S. Department of Energy), 2003a, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE), ISCORS Technical Report No. 1*, DOE/EH-412/0015/0802, Rev. 1, Office of Environmental Policy and Guidance, Washington, DC, January.

DOE (U.S. Department of Energy), 2003b, *West Valley Demonstration Project Waste Management Environmental Impact Statement*, DOE/EIS-0337, West Valley Area Office, West Valley, New York, December.

DOE (U.S. Department of Energy), 2007a, *Draft Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1D, Volume 1, Table 8-14, Office of Civilian Radioactive Waste Management, Las Vegas, Nevada, October.

DOE (U.S. Department of Energy), 2007b, *Draft Complex Transformation Supplemental Programmatic Environmental Impact Statement*, DOE/EIS-0236-S4, Section 6.3.2.3, National Nuclear Security Administration, Washington, DC, December.

DOT (U.S. Department of Transportation), 2003, *Comprehensive Truck Size and Weight Study*, Executive Summary, Federal Highway Administration, Washington, DC, May 19.

DOT (U.S. Department of Transportation), 2006, *Traffic Safety Facts 2004, A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, DOT HS 809 919, National Center for Statistics and Analysis, National Highway Traffic Safety Administration, Washington, DC, January.

Grove (Grove Engineering), 2003, *MicroShield Version 6 User's Manual*, Rockville, Maryland, March.

Johnson, P. E., and R. D. Michelhaugh, 2003, *Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual*, ORNL/NTRC-006, Rev. 0, Oak Ridge National Laboratory, Oak Ridge, Tennessee, June.

LANL (Los Alamos National Laboratory), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

Neuhauser, K. S., F. L. Kanipe, and R. F. Weiner, 2000, *RADTRAN 5 Technical Manual*, SAND2000-1256, Sandia National Laboratories, Albuquerque, New Mexico, May.

Neuhauser, K. S., and F. L. Kanipe, 2003, *RADTRAN 5 User Guide*, Revised by R. F. Weiner, SAND2003-2354, Sandia National Laboratories, Albuquerque, New Mexico, July.

NRC (U.S. Nuclear Regulatory Commission), 1977, *Final Environmental Statement on the Transportation of Radioactive Material By Air and Other Modes*, NUREG-0170, Vol. 1, Office of Standards Development, Washington, DC, December.

NRC (U.S. Nuclear Regulatory Commission), 1987, *Shipping Container Response to Severe Highway and Railway Accident Conditions*, NUREG/CR-4829, Vol. 1, UCID-20733, Washington, DC, Accessed through http://ttd.sandia.gov/nrc/docs.htm, February.

NRC (U.S. Nuclear Regulatory Commission), 2000, *Reexamination of Spent Fuel Shipment Risk Estimates*, NUREG/CR-6672, Vol. 1, SAND2000-0234, Office of Nuclear Material Safety and Safeguards, Washington, DC, Accessed through http://ttd.sandia.gov/nrc/docs.htm, March.

Phillips, J. S., D. B. Clauss, and D. F. Blower, 1994, *Determination of Influence Factors and Accident Rates for the Armored Tractor/Safe Secure Trailer*, SAND93-0111, Sandia National Laboratories, Albuquerque, New Mexico, April.

Rao, R. K., E. L. Wilmot, and R. E. Luna, 1982, *Non-Radiological Impacts of Transporting Radioactive Material*, SAND81-1703, Sandia National Laboratories, Albuquerque, New Mexico, February.

Saricks, C., and M. M. Tompkins, 1999, *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*, ANL/ESD/TM-150, Center for Transportation Research, Argonne National Laboratory, Argonne, Illinois, April.

Yuan, Y. C., S. Y. Chen, B. M. Biwer, and D. J. LePoire, 1995, *RISKIND — A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel*, ANL/EAD-1, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois, November.

Appendix L
Categorical Exclusion Summary

APPENDIX L
CATEGORICAL EXCLUSION SUMMARY

The U.S. Department of Energy (DOE) National Environmental Policy Act (NEPA) Implementing Procedures identify classes of actions that DOE has determined do not individually or cumulatively have a significant effect on the human environment (Title 10 *Code of Federal Regulations* [CFR] Part 1021 Subpart D). Appendix B of Subpart D, "Categorical Exclusions Applicable to Specific Agency Actions," identifies conditions that are integral elements of the classes of action that are categorically excluded. These conditions are that a proposed activity would not threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety or health, including requirements of DOE and Executive Orders; require siting and construction or major expansion of waste storage, disposal, recovery, or treatment facilities; disturb hazardous substances, pollutants, or contaminants that preexist in the environment such that there would be uncontrolled or unpermitted releases; or adversely affect environmentally sensitive resources. These classes of items are normally "categorically excluded" from the need for the preparation of an environmental assessment or environmental impact statement. The Los Alamos National Laboratory (LANL) experience has shown that there are groups of actions or activities that meet the standard for receiving a categorical exclusion from further NEPA analysis. These activities range from facility work, such as routine maintenance and safety and environmental improvements, to research and development activities in chemistry, materials science, detector technology, geology, and other areas. The following sections describe the range and types of activities (LANL 2007) that are performed in Key or non-Key Facilities at LANL that would typically receive a categorical exclusion.

Routine Maintenance Activities

Maintenance activities are frequently and routinely performed for operational support of LANL facilities and property. These actions range from ongoing custodial services to corrective, preventive, and predictive actions required to maintain and preserve buildings, structures, roads, infrastructure, and equipment in a condition suitable for fulfillment of their designated purpose. Such activities are intended to maintain current operations and do not substantially extend the useful life of a facility or allow for substantial upgrades or improvements. Routine maintenance includes maintenance, repair, replacement, removal, relocation, fabrication, and installation actions.

Safety, Environmental, and Equipment Improvements

LANL staff routinely conducts safety and environmental improvements to facilities, including the installation of and improvements to equipment for personnel safety and health. This includes installation, replacement, or improvements to alarm systems and monitors, bottled gas racks, electrical components, guardrails, air and water filtration devices, safeguards and security equipment, nondestructive assay instruments, remote monitoring systems, emergency exits, radiation shielding, door interlocks, and similar systems. Facility safety risks are reduced by improving containment of hazardous materials, installing remote handling equipment, providing firebreaks and fire roads, and other related actions. Risks to the public are reduced by eliminating contaminants in outfalls, removing underground storage tanks, and installing water disinfection tanks, among other activities. Environmental improvements include minor operational changes and equipment additions or modifications that reduce the volume of waste produced, and facilitate reuse and recycling of materials.

Support Structure Activities

LANL staff constructs, modifies, and operates support buildings and other structures within or contiguous to developed areas. Support buildings and structures are those used for offices, health services, welding shops, storage space, vehicle maintenance, waste collection and staging areas, and other purposes. Construction and modification activities include providing elements needed for proper functioning of the structures, such as fencing, aboveground storage tanks, parking lots, utilities, and ducting. LANL staff constructs short new access roads and modifies existing roads to improve access to and within technical areas (TAs), to facilitate traffic and pedestrian flow, and to improve worker safety. New support buildings and structures are constructed, and existing structures (such as transportables, trailers, and tension domes), their contents, and processes are relocated. Support buildings and structures that are vacated and determined to be excess to current and foreseeable needs are decommissioned. Decommissioning may include decontamination activities and removal or demolition. Cultural resource evaluations are completed prior to demolition.

General Shop Operations

LANL activities and operations are supported by a variety of shops, including machine shops, carpentry shops, and electronics shops. Many different types of equipment are used, including drill presses, lathes, bench grinders, table saws, sanders, welding equipment, small power tools, hand tools, and other common shop equipment. Commonly used materials include nonhazardous metals, ceramics, wood, plastics, rubber, epoxies and glues, paint, solder, sealant, small quantities of cleaning solvents, and other common shop materials. Specialized shops may also use a variety of hazardous or radioactive materials in fabrication and construction.

Security and Protection Operations

A live firing range and a live-fire shoot house at TA-72 are used to train protective force personnel to meet DOE and LANL protective force requirements. LANL's TA-49 firing site facility is used to train LANL employees and other Federal and state agency personnel to identify suspect devices and properly respond to bomb threats. This training includes demonstration of a variety of standard explosive materials and response devices (such as a disrupter that uses a high-pressure jet of liquid to quickly disassemble electronics within a simulated suspect explosive device).

Radiation Detection and Monitoring Training

LANL trains personnel from LANL, other DOE facilities, and other Federal and state agencies in the use of radiation detectors and monitors. The purpose of the training is teach and demonstrate procedures for determining the contents of vehicles, equipment, buildings, or other structures that contain radiation sources, hazardous material surrogates, or radioactive materials, including small quantities of special nuclear material. Training is conducted in buildings and outdoor areas that meet the appropriate safety and authorization basis criteria.

Wildfire Response

The Interagency Helibase Operation is located at the junction of the entrance road to TA-49 and State Road 4 and is used for wildfire response and storage for interagency wildfire response equipment and supplies. Personnel from LANL, Los Alamos County, the National Park Service, and the U.S. Forest Service staff the facility, which consists of three helicopter pads (helipads), two at-grade dip tanks (one 1500-gallon (5,680-liter) and one 3500-gallon (13,250-liter)); a building that houses two fire engines, fire equipment, and office space for emergency management; an office trailer; and other associated infrastructure. During fire season, helicopter crews plus additional maintenance staff also staff the facility.

Environmental Characterization and Limited Removals

LANL staff routinely conducts short-term, low-cost environmental actions to characterize and reduce risks to human health or the environment from the release or threat of release of hazardous substances. Field investigations that include screening for radiological materials or volatile organic vapors are used to determine the types and locations of contaminants. Temporary onsite immunoassay laboratory and equipment are used to aid the screening process. Corrective actions may include excavation or consolidation of contaminated soils or materials; removal of containers of hazardous substances or petroleum products; removal of underground storage tanks; repair or replacement of leaking containers; containment of contaminated soils or sludges; drainage or closing of manmade surface impoundments; use or stabilization of berms or other above- or belowground barriers to the spread of contamination; or installing runoff or runon diversion structures. Additional actions may include segregation of potentially reactive wastes; use of chemicals or other materials to neutralize wastes or to retard the spread of contaminants, or to mitigate their consequences; installation of ventilation systems in soil to remove methane or petroleum vapors; or installation of fences, signs, or other site control precautions. Finally, if the water supply of a household or industry becomes contaminated, an alternative water supply may be provided until the contaminated water source is remedied.

Hydrology, Geology, and Geochemistry Research

Basic and applied hydrology, geology, and geochemistry research studies are conducted on rock, concrete, soil, and other geological samples. Outdoor hydrological and geochemistry field experiments are conducted at TA-51 and other LANL locations. Laboratory and outdoor research is focused on various areas including transport of contaminants in saturated and unsaturated hydrologic systems, carbon sequestration, basin-scale hydrology, zero-emission coal technology, volcanic geology and hazards, and planetary astrobiology and geology. Thousands of geological samples are analyzed annually, and instrumentation for conducting these studies is designed, tested, or modified. A number of different laboratories and capabilities are used, including a wet chemistry laboratory, an x-ray diffraction laboratory, thermal analysis capabilities, optical equipment, a light-stable isotope laboratory, electron microanalysis, an x-ray fluorescence laboratory, and a mass spectrometry laboratory. Equipment used includes, but is not limited to, electron microprobes, infrared spectrometers, optical microscopes, scanning electron microscopes, scanning probe microscopes, inductively coupled plasma emission spectrometers, gas chromatographs, mass spectrometers, ion-liquid chromatographs, atomic absorption spectrometers, high-pressure liquid chromatographs, gas chromatographs, x-ray diffractometers, x-ray fluorescent spectrometers, autoclaves, and similar equipment.

Atmospheric, Climate and Environmental Dynamics

Research is performed using modeling, simulation, field measurements, and data analysis in the atmospheric, ocean, and ecohydrologic sciences. Types of projects include: (1) atmospheric, climate, and ocean modeling (wildfire behavior modeling, biogeochemistry and ocean carbon cycle modeling, climate applications to high performance computing); (2) ecology (semiarid systems ecology, soil science, carbon sequestration, micrometeorological instrumentation and analysis); (3) hydrology (surface and subsurface modeling, water resource prediction, contaminant fate and transport, erosion); and (4) weapons phenomenology and infrasound (physics and chemistry of atmospheric composition, theory and modeling of electromagnetic radiation, data analysis from satellites and ground sensors) and (5) others in these fields.

Geotechnical Engineering and Research

Geotechnical research includes underground and surface geologic, seismic, volcanic, hydrologic, hydrogeologic, geophysical, and geochemical field testing, monitoring experiments, and managing of samples. Research includes studies in support of geologic repositories such as Yucca Mountain, including evaluating engineering barrier systems, coordinating field testing, and studying the potential effects of a volcanic eruption.

Environmental Geology and Spatial Analysis

Environmental geology and spatial analysis research focuses on studying uncertainties associated with complex natural environmental systems and solving problems that arise as the result of human activities. Research capabilities include volcanic and seismic hazards, geomorphology and surface processes, geochemistry, geographic information systems, environmental modeling and risk assessment, and quality assurance and data validation. Researchers conduct the quality assurance program at Yucca Mountain; perform environmental restoration work at LANL to evaluate existing human health and ecological risks from contaminants that have entered the canyon areas; evaluate seismic hazards to LANL's nuclear facilities; and conduct paleoseismic and structural geology studies.

Geophysics

Basic and applied geophysics research at LANL involves exploring the seismic and acoustic signals that provide information about natural and manmade disturbances within the Earth's crust. Research is conducted in the following areas: (1) nuclear explosion monitoring (processing and interpreting geophysical and geological data for the national ground-based nuclear explosion monitoring program); (2) geodynamics (developing and applying computational tools and experimental methods for predicting the response of geological materials to large and rapid deformations); (3) seismic modeling and imaging (conducting basic and applied research in wave propagation, seismic imaging, scattering, and the interaction of acoustic waves with rock mass structure, fabric, and pore fluids); (4) drilling (developing advanced drilling methods and tools for drilling operations for LANL environmental restoration activities and for oil exploration for National Energy Security); and (5) national defense (offering geology/geophysics expertise in the geologic phenomena associated with explosion dynamics both subsurface and above ground, and intelligence gathering and interpretation using remote sensing techniques).

Planetary Physics

Scientists promote and coordinate basic research on the origin, structure, and evolution of the Earth, the Solar System, and the Universe and develop the science base to predict future changes as they affect human life. Research is conducted in the following areas: (1) astrophysics (theoretical, observational, and instrumentation research on gamma-ray astrophysics, space instrumentation, stellar dynamics, and other topics); (2) space physics (theoretical, computational, and observational research into the plasma environment of the Earth); and (3) solid planetary geoscience (numerical, seismic, paleomagnetic, and laboratory studies of the geophysical and geochemical structure, properties, processes, and fluid dynamics of terrestrial and giant planets).

Archaeological Site Evaluation

Qualified LANL personnel evaluate archaeological sites in LANL TAs and surrounding locations (such as U.S. Forest Service land) to establish site integrity that would subsequently be used to determine National Register of Historic Places eligibility. Both invasive and noninvasive evaluation techniques are used. Geophysical instrumentation (such as ground penetrating radar) is used to identify the location of potential subsurface archaeological deposits. Auger holes or shovel tests are used to determine if intact subsurface cultural deposits exist at specific grid locations across the site. Test pits are used to verify the existence of deposits that have been suggested by other tests.

Biological Field Studies

LANL biologists conduct field studies to inventory, monitor, and assess vegetation and animal populations. Vegetation, fruit, and produce samples may be collected from LANL or offsite locations for analysis of biomass, fuel-loading, contamination, or other attributes. Small-scale netting or live trapping is conducted to collect specimens for examination. Reproductive patterns, species distribution and densities, and habitat use are recorded. Specimens may be marked before release for later identification. LANL scientists may also conduct phytoremediation and bioremediation studies in both natural and constructed settings.

Water and Soil Monitoring

Water monitoring stations are installed, maintained, and operated to measure flows, evaluate water quality, and test for contamination. Locations for monitoring stations are based on the characteristics to be studied. The locations are reviewed by cultural and biological resources specialists to ensure protection of sensitive resources. Soils and sediments are sampled regularly from a variety of LANL and offsite locations.

Groundwater monitoring wells are used to monitor groundwater characteristics and determine the presence of contamination. Locations are reviewed by cultural and biological resources specialists to ensure protection of sensitive resources. The monitoring wells are designed to prevent surface contamination from reaching subsurface water.

Automation and Robotics Research and Fabrication

Researchers develop automated and robotic systems (such as mills and lathes) in support of the National Nuclear Security Administration's Stockpile Stewardship Program. These systems increase worker productivity, reduce human exposure to hazardous situations, and minimize overall waste production. Prototypes are developed and tested in nonradioactive laboratories, then transferred to radioactive facilities throughout the DOE nuclear complex. Personnel design parts and conduct small-scale production, mechanical and electrical assembly and integration, system operation and integration, and prototype instrument testing on nonhazardous materials.

Electronic Control Systems Fabrication

Electronic control systems are fabricated for industrial, academic, and Federal agency applications. These systems control many different apparatuses, such as remote-handling systems, radiofrequency systems, lasers, experimental devices, surveillance equipment, alarm and safety equipment, measurement systems, and many others; they monitor performance, control operating parameters, and serve other similar functions. Personnel construct control systems, write software to control those systems, and then integrate them with the apparatus being controlled.

Antenna and Pulse Power Outdoor Test Range

The Antenna and Pulse Power Outdoor Test Range is a 1400-acre facility that is used for open air testing and field development of very-high-power radiofrequency and high-power-microwave sources and antennas to support DOE and Department of Defense equipment requirements. Antenna design and fabrication is conducted within laboratory space at TA-49. The facility also is used to design, construct, and test specialized diagnostic equipment for testing high-power radiofrequency and microwave sources.

Small-Scale Basic Laser Science Research and Development

Basic laser science research focuses on combining traditional analytical instrumentation with lasers. Research areas include chemical kinetics, materials processing and characterization, fluid chemistry, spectroscopic characterization, chemical diagnostics, and mass spectrometry diagnostics. Researchers use traditional analytical instrumentation and lasers in new ways, for example by combining two methodologies into one instrument, developing field-usable instruments for measuring samples in real-time, developing new sampling techniques, or developing new uses for existing analytical instrumentation. Many types of equipment are used, such as mass spectrometers, radiation detectors, gas chromatographs, infrared and visible lasers, and light detecting and ranging systems.

Industrial Hygiene Research and Development

Personnel conduct industrial-hygiene-related research and development activities that anticipate, recognize, evaluate, and control health and safety hazards in the workplace. This work includes design and testing of respiratory protection and other personal protective devices, including respirators, respirator cartridges or canisters, protective suits, self-contained breathing apparatus, and similar equipment. Both commercially available equipment and LANL shop-fabricated equipment are used.

Radiation Monitoring Techniques

Researchers develop and test techniques and instrumentation for nondestructive monitoring and detection of radiation sources. These nondestructive measurements work by detecting and analyzing radioactive emissions from nuclear materials. Both active and passive techniques are used to accurately measure the mass of nuclear materials in an object. Active techniques involve bombarding nuclear materials with neutrons or gamma rays, then detecting emitted radiation. Such techniques may use a variety of sources including isotopic sources, deuterium-tritium neutron generators, or portable linear accelerators. Passive techniques do not involve active bombardment of the material to be measured, but measure some characteristic of the material or constituents of the material using such techniques as calorimetry, which involves measuring the heat generated by nuclear materials. Most instrumentation consists of printed circuit boards, electronics equipment, and mechanical assemblies, constructed both in LANL shops and by external vendors.

Physical Detector Research and Development

For physical science research, researchers develop and use a wide variety of detectors capable of identifying and measuring ionizing radiation, x-rays, photons, electrical and magnetic fields, chemicals, gases, pressure, gravity, explosives, biological materials, dense materials, and other materials. The detectors consist of a medium that responds to the primary condition of interest, such as liquid (for example, mineral oil), solid (for example, crystalline materials), or gaseous materials (for example, isobutane) in a support housing for mechanical and electrical stability, coupled to electronic circuitry and assemblies. Researchers characterize physical media, then fabricate and test detectors using a variety of equipment and materials.

Advanced Image Sensor Research and Development

Sensitive and fast sensors and imaging systems are developed for weapons and nonweapons applications, including "smart" weapons, tracking systems, and high-speed data acquisition. Equipment used to develop these sensors and imaging systems includes computers, oscilloscopes, voltmeters, arbitrary function generators, image monitors, optical light sources, high-voltage power supplies, charge-coupled device cameras, commercial image intensifiers, and lasers.

Space and Atmospheric Instrumentation

Flight hardware, satellite instrumentation, and small satellite systems are developed at LANL. Flight hardware and satellite instrumentation are used for remote sensing applications, such as nonproliferation, detection of nuclear explosions, climate studies, and environmental measurements. Types of instrumentation typically developed include optical and infrared remote sensing instruments; x-ray, gamma-ray, neutron, alpha particle, radiofrequency, and energetic particle measurement instruments; astrophysical instruments for conducting studies of the atmosphere, ionosphere, magnetosphere, and solar wind; and other instrumentation for deployment on satellites or other atmospheric testing vehicles. Outdoor experiments are often conducted as part of this research, to measure fluctuations in the atmosphere and ionosphere and to calibrate satellite receivers that are in orbit. Outdoor experiments are conducted at various locations around LANL, the United States, and around the world.

Materials Characterization Research and Development

Researchers study a number of different materials to determine molecular structure, thermal conductivity, electronic magnetization, heat capacity, thermal expansion, resistance, and other properties. Materials characterized include transition metals and metal oxides, rare earth metal and intermetallic compounds, ceramics, crystals, polymers, amino acids, and others. Personnel prepare samples as necessary and characterize them using equipment such as magnetic resonance imagers, magnetometers, laser interferometers, ultraviolet lights, and x-rays. Research also includes developing techniques for improving equipment sensitivity in detecting certain responses.

General Optical Characterization and Calibration

LANL staff performs optical characterization for a variety of applications; this includes measuring solar radiation and reflectance from computer chips and wafer samples. Staff members use light signals such as lamps having different wavelengths, including visible, infrared, ultraviolet, and vacuum ultraviolet. Light is shone onto the component, and calibrated detectors and other measuring devices (such as reflectometers) are used to measure the reflectance or transmission of the light. Low-level lasers are used to align the light signal onto the test component being characterized and onto the detector.

Ion Beam Materials Science Laboratory Research

Researchers characterize and modify surfaces using ion beams at the Ion Beam Materials Science Laboratory at TA-3, Building 34. The main experimental equipment includes a 3-megavolt tandem accelerator and a 200-kilovolt ion source implanted together with several beam lines. A series of experimental stations are attached to each beam line; they include the nuclear microprobe, surface modification, ultra-high vacuum, small stainless steel, and general-purpose experimental chambers. Samples used in the Ion Beam Materials Science Laboratory include geological samples, metallic films, polymers, ceramics, metal alloys, plutonium-contaminated metal, and metal semiconductors.

High Magnetic Field Research

Researchers study the behavior of materials under very high strength magnetic fields that are produced by pulsed magnets powered by high-voltage stored energy systems. Research is normally conducted at TA-35, Building 125. Magnets currently in operation have maximum magnetic field intensities ranging from 20 to 300 tesla. Very small samples of a wide variety of materials are studied, including plutonium-239 and plutonium-242, depleted uranium, thorium compounds, high-temperature superconductors, and other metals and semiconductors.

Ultra-High Strength and High Energy Density Materials Research and Development

LANL researchers investigate, evaluate, and demonstrate new ultra-high strength materials and very high energy density materials. Ultra-high strength materials are produced using a variety of metals, including copper, silver, or aluminum, which are encapsulated in glass and heated and drawn into small wires. Thin-film samples of high-density materials are synthesized under nonequilibrium conditions. Both materials are characterized by measuring the material composition, chemical structure, mechanical and thermal properties, and energy content and release of these materials.

X-Ray Tomography and Ultrasound Testing

Researchers x-ray (using computed tomography) and ultrasonically analyze samples of sand, soil, plastics, foam, mock high explosives, composite materials, pressure vessels, or other nonradioactive specimens, as well as specimens containing naturally occurring radioactivity such as rocks and soils. The computed tomography equipment is used to generate three-dimensional images and density maps and to detect cracks or flaws, or precisely locate parts or features within an object. The ultrasonic equipment is used to detect cracks, voids, inclusions, and density variations. Techniques are combined to determine if data from the two methods improve evaluation of the sample.

Materials Science Research and Development at the Los Alamos Neutron Science Center

Small-scale experiments using the beam at the Los Alamos Neutron Science Center encompass a wide range of research topics, including materials science, engineering, condensed-matter physics, geoscience, chemical science, biological sciences, and fundamental neutron science. Research includes viewing and studying defects in light materials that lie inaccessibly beneath heavy materials, well beyond the range of x-rays; measuring the behavior of materials under extreme conditions, such as high temperature or pressure; studying the interior of materials to obtain either microscopic or structural information; and imaging hydrogenous material, such as water or oil, in parts or components to deduce lifetimes, corrosion, safety, and quality control issues. Both neutron- and proton-induced experiments are conducted.

Energetic Neutral Beam Facility Research and Development

The Energetic Neutral Beam Facility, located at TA-46, Building 31, consists of two neutral beam sources and is used by personnel from other Federal agencies, universities, and industry. The beam sources have diagnostic capabilities that include mass spectrometry and time-of-flight. The primary activity at this facility is to investigate surfaces, specifically gas-surface interactions, including scattering or reaction mechanisms, or both. Thin film work and detector studies using sealed sources are also conducted. The first beam source produces continuous high-energy atomic beams with energies from approximately 1 to 5 electron volts. The second beam source is a continuous medium-energy molecular beam source.

Basic and Applied Chemistry Research and Development

Chemistry research and development at LANL supports a number of programs. The programs and purpose of chemistry research include: 1) nuclear weapons support that focuses on planning the next generation of nuclear facilities for safely handling actinide metals and their compounds; 2) nonproliferation and counterproliferation and Homeland Security support that focuses on detecting, preventing, assessing, and responding to nuclear, chemical, and biological threats; 3) isotope science support that focuses on the production of medical radioisotopes and the development of a national isotope strategy with other DOE laboratories to rejuvenate the U.S. isotope production capability and encourage research; 4) applied energy research that studies novel methods of hydrogen production, storage, and utilization; carbon measurement, management, and carbon dioxide sequestration; and other research areas; and 5) nanoscale science and engineering that focuses on nanoscale chemical synthesis and processing, chemical kinetics and molecular dynamics, and instrumentation and diagnostics. Chemistry operations are focused on instrumental analysis and spectroscopy, synthetic chemistry, materials chemistry, analytical chemistry and sample preparation, beryllium work, pressure work, radiochemistry and radiological work, biological chemistry, and explosives work. These operations use a variety of equipment and materials and occur LANL-wide.

Electronic and Electrochemical Materials and Devices Research and Development

LANL staff conducts research on electronic and electrochemical materials and devices that are relevant to a wide range of areas, including electrochemistry and the fuel cell program; semiconductor physics research and device development; high temperature superconductivity; general electronic materials characterization and theory; and nondestructive testing through acoustic techniques. Researchers develop and fabricate prototype electronic and electrochemical devices (including fuel cells, sensors, polymer light emitting diodes, and others) and conduct physical and chemical material analyses in support of these activities. Part of this effort involves synthesizing and processing materials, such as polymers and complex oxides.

Advanced Oxidation Technology Research and Development

Advanced oxidation technology research involves the generation and use of highly reactive free radicals, such as oxygen, hydroxide, hydrogen, and nitrogen, as efficient chemical energy sources for breaking molecular bonds in organic compounds. Advanced oxidation technologies are nonthermal and require no chemical additives; therefore, large secondary waste streams are not generated. Advanced oxidation technology can be used to treat a variety of hazardous components in aqueous- and gaseous-based effluents, such as contaminated soil or groundwater, diesel- or aircraft-engine exhaust, and incinerator offgases. The free radicals involved in advanced oxidation technologies either reduce or oxidize chemicals to simpler, less hazardous, or benign components. Nonthermal plasma is a technique currently used; similar nonthermal techniques are also being studied.

High-Temperature/High-Pressure Fluids Research and Development

Research is conducted to develop, test, and verify high-temperature and high-pressure fluid technologies, including hydrothermal processing, "supercritical" water oxidation, "supercritical" carbon dioxide, and similar technologies. When certain fluids are driven by high temperatures and pressure to the "supercritical" region, they may be used as a gas and as a liquid. These supercritical fluids are particularly useful as solvents. Researchers explore these technologies by conducting basic research on the physical properties of fluids and other materials, reaction kinetics and process parameters, oxidation and reduction chemistry, and related chemical reactions. They also apply these technologies to many uses, including precision cleaning, extraction of contaminants and residual solvents, chemical synthesis, polymer synthesis, chemical waste destruction (such as hazardous, mixed, or high explosives waste), semiconductor processing, chemical separations, materials modification, and other applications.

References

LANL (Los Alamos National Laboratory), 2007, *Site-wide Operations in Support of the Mission of Los Alamos National Laboratory*, LA-UR-07-2983, Environmental Protection Division, Risk Reduction Office, Los Alamos, New Mexico, April.

APPENDIX M
CONTRACTOR DISCLOSURE STATEMENT

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SITE-WIDE EIS FOR CONTINUED OPERATION OF LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)," 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal)

(a) ___X________ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ______________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:

Signature

Elizabeth C. Saris
Name

Vice President
Energy Solutions Operations

November 2005
Date

Science Applications International Corporation

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SITE-WIDE EIS FOR CONTINUED OPERATION OF LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm=s other clients)," 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal)

(a) ___X___ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ______ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:

Signature

Timothy G. George
Name

President
Time Solutions Corporation

June 2005
Date

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF A SITE-WIDE EIS FOR CONTINUED OPERATION OF LOS ALAMOS NATIONAL LABORATORY, LOS ALAMOS, NEW MEXICO

CEQ regulations at 40 CFR 1506.5(c), which have been adopted by DOE (10 CFR 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project," for the purposes of this disclosure, is defined in the March 23, 1981 guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project 'includes' any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)," 46 FR 18026-18038 at 18031.

In accordance with these requirements, the offeror and any proposed subcontractors hereby certify as follows: (check either (a) or (b) to assure consideration of your proposal)

(a) ___X___ Offeror and any proposed subcontractor have no financial interest in the outcome of the project.

(b) ________ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interests:

1.
2.
3.

Certified by:

Toby Walters

____
Signature

Toby Walters, Program Manager
URS Corporation
____
Name

5/17/07
____
Date