DOE/EIS-0380D
June 2006

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

Volume 2 Book 1


Present


Past


Future

National Nuclear Security Administration

**Availability of
the Draft 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
Los Alamos Site Office
National Nuclear Security Administration
U.S. Department of Energy
528 35th Street
Los Alamos, NM 87544-2201
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: *Draft Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (SWEIS) (DOE/EIS-0380D)

Location: Los Alamos, New Mexico

For additional information or for copies of this draft SWEIS, contact:

Elizabeth Withers, EIS Document Manager
Los Alamos Site Office
National Nuclear Security Administration
U.S. Department of Energy
538 35th Street
Los Alamos, NM 87544-2201
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
Office of Environment, Safety and Health
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1290
Telephone: 202-586-4600, or leave a message at 1-800-472-2756

This document is available on the NNSA Los Alamos Site Office website (http://www.doeal.gov/LASO) for viewing and downloading.

***Abstract*:** NNSA proposes to continue operating the Los Alamos National Laboratory (LANL) 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. Expanded Operations is NNSA's Preferred Alternative. In the No Action Alternative, NNSA would continue the historical mission support activities LANL has conducted at currently approved operational levels. Under the Reduced Operations Alternative, NNSA would eliminate selected activities and limit the operations of other selected activities. In the Expanded Operations Alternative, NNSA would operate LANL at the highest levels of activity currently foreseeable, including full implementation of the mission assignments. 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 among alternatives for 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.

Public Comments: In preparation of this Draft SWEIS, NNSA considered comments received from the public during the scoping period (January 19, 2005 to February 17, 2005). Locations and times of public hearings on this document will be announced in the *Federal Register* in June 2006. Comments on this Draft SWEIS will be accepted at the address listed above for a period of 60 days following its issuance and will be considered for preparation of the Final SWEIS. Any comments received after the 60-day period will be considered to the extent practicable for the preparation of the Final EIS.

TABLE OF CONTENTS

Cover Sheet iii
Table of Contents vii
List of Figures xviii
List of Tables xxi
Acronyms, Abbreviations, and Conversion Charts xxxi

Volume 2 Book 1
Appendices A through H

Appendix A
Federal Register Notices

Appendix B
Nonradiological Air Quality

B.1 Introduction B-1
B.1.1 Assumptions, Data Sources, Standards, and Models B-1
B.1.1.1 Applicable Guidelines and Standards and Emission Sources B-1
B.1.1.2 Receptors and Receptor Sets B-4
B.1.1.3 Air Quality Dispersion B-5
B.1.2 Criteria Pollutants – General Approach B-5
B.1.2.1 Criteria Pollutants – Methodology B-6
B.1.2.2 Results of Criteria Pollutant Analysis B-6
B.1.3 Toxic Air Pollutants – General Approach B-6
B.1.3.1 Toxic Pollutants – Methodology for Individual Pollutants B-8
B.1.3.2 Toxic Pollutants – Results of Individual Pollutants Analysis B-9
B.1.3.3 Toxic Pollutants – Methodology for Combined Impacts Analyses B-10
B.1.3.4 Toxic Pollutants – Results of Combined Impact Analysis B-11

B.2 References B-12

Appendix C
Evaluation of Human Health Impacts from Normal Operations

C.1 Impacts on Human Health from Radiological Exposure C-1
C.1.1 About Radiation and Radioactivity C-2
C.1.1.1 What Is Radiation? C-2
C.1.1.2 Units of Radiation Measure C-3
C.1.1.3 Sources of Radiation C-4
C.1.1.4 Exposure Pathways C-5
C.1.1.5 Limits of Radiation Exposure C-6
C.1.2 Health Effects C-6
C.1.2.1 Health Effect Risk Estimators Used in this SWEIS C-9
C.1.2.2 Material of Interest at Los Alamos National Laboratory C-10

C.1.3 Methods Used to Estimate Radiological Impacts from Normal Operations C-11
C.1.3.1 Key Facilities Modeled C-11
C.1.3.2 CAP-88 Model C-12
C.1.3.3 Model Input Parameters C-13
C.1.3.4 Results of Analyses C-21
C.1.4 Impacts to Offsite Resident, Recreational User and Special Pathways Receptors from Radionuclides and Chemical Contaminants in the Environment C-26
C.1.4.1 Methodology C-26
C.1.4.2 Estimates of Ingestion Pathway Radiation Dose and Risk C-29

C.2 Impacts on Human Health from Nonradioactive Contaminants in the Environment C-40
C.2.1 Methods Used to Estimate Risks from Ingestion of Nonradioactive Contaminants C-41

C.3 Impacts on Human Health from Biological Agents C-57
C.3.1 Introduction C-57
C.3.2 Principles of Biosafety C-57
C.3.2.1 Safety Equipment (Primary Barriers) C-58
C.3.2.2 Facility Design and Construction (Secondary Barriers) C-58
C.3.2.3 Waste C-58
C.3.2.4 Biological Release C-59
C.3.3 Biosafety Levels C-59
C.3.3.1 Biosafety Level 1 ..... C-59
C.3.3.2 Biosafety Level 2 ..... C-59
C.3.3.3 Biosafety Level 3 ..... C-60
C.3.3.4 Biosafety Level 4 ..... C-60
C.3.4 Detection C-61
C.3.5 Select Biological Agents C-62
C.3.6 Transmission C-62

C.4 Key Differences Between Biological, Radiological, and Chemical Agents C-63

C.5 References C-64

Appendix D
Evaluation of Human Health Impacts from Facility Accidents

D.1 Introduction D-1

D.2 Data and Analysis Changes from the *1999 SWEIS* D-1

D.3 Radiological and Chemical Accidents D-2
D.3.1 Radiological and Chemical Scenarios and Source Terms D-10
D.3.2 Radiological Accident Impacts D-10
D.3.2.1 No Action Alternative D-16
D.3.2.2 Reduced Operations Alternative D-16
D.3.2.3 Expanded Operations Alternative D-16
D.3.3 Chemical Accident Impacts D-23
D.3.3.1 No Action Alternative D-25
D.3.3.2 Reduced Operations Alternative D-25
D.3.3.3 Expanded Operations Alternative D-25

D.4 Site-wide Seismic Impacts D-26
D.4.1 Source Term Data D-27
D.4.2 No Action Alternative Impacts D-27
D.4.2.1 Site-wide Seismic 1 – Radiological Impacts D-27
D.4.2.2 Site-wide Seismic 2 – Radiological Impacts D-32
D.4.2.3 Site-wide Seismic 1 – Chemical Impacts D-33
D.4.2.4 Site-wide Seismic 2 – Chemical Impacts D-34
D.4.3 Reduced Operations Alternative Impacts D-37

D.4.4 Expanded Operations Alternative Impacts ... D-37
D.4.4.1 Site-wide Seismic 1 – Radiological Impacts ... D-37
D.4.4.2 Site-wide Seismic 2– Radiological Impacts ... D-37
D.4.4.3 Site-wide Seismic 1 – Chemical Impacts ... D-38
D.4.4.4 Site-wide Seismic 2 – Chemical Impacts ... D-38

D.5 Wildfire Accidents ... D-38
D.5.1 Background ... D-38
D.5.1.1 Consuming Combustible Structures and Vegetation ... D-38
D.5.1.2 Recent Widespread Environmental Changes ... D-39
D.5.1.3 Wildfire Occurrence ... D-40
D.5.1.3.1 General Approach ... D-40
D.5.1.3.2 Region of Interest ... D-41
D.5.1.3.3 Lightning Strike Densities and Intensities ... D-41
D.5.1.3.4 Modeled Fire Polygons ... D-41
D.5.1.3.5 Fuel Conditions ... D-42
D.5.1.3.6 Wildfire Model Development ... D-42
D.5.1.3.7 Wildfire Model Results ... D-43
D.5.2 Current Wildfire Hazard Conditions ... D-43
D.5.2.1 Changes to the Fuels and Fire Hazard Conditions in the Past 5 Years ... D-43
D.5.2.2 Potential Wildfire Scenarios ... D-46
D.5.2.3 Frequency of Wildfires ... D-47
D.5.2.4 Conditions that Favor Wildfire ... D-48
D.5.2.5 Determining the Joint Probability of Occurrence of Weather and Fire Danger Conditions ... D-48
D.5.3 General Wildfire Scenario ... D-49
D.5.3.1 Description ... D-49
D.5.3.2 Dispersion Meteorology, Thermal Energy, and Soil Resuspension Following the Fire ... D-50
D.5.3.3 Exposures from Burning Vegetation and Suspended Soil ... D-51
D.5.4 Methodology ... D-53
D.5.4.1 Evaluation of Building Fires ... D-53
D.5.4.2 Public Exposure from Burning Buildings ... D-55
D.5.4.3 Effects of Hazardous Chemicals ... D-56
D.5.4.4 Onsite Workers and Offsite Population ... D-56
D.5.5 Wildfire Accident Impacts Analysis ... D-57
D.5.5.1 Facility Source Terms ... D-57
D.5.5.2 Radiological Impacts ... D-57
D.5.5.3 Chemical ... D-62
D.5.5.4 Additional Environmental Effects ... D-63
D.5.6 Mitigation ... D-66

D.6 Involved Worker Hazards ... D-66

D.7 Maximally Exposed Individual-Type Doses versus Distance ... D-67

D.8 MACCS2 Code Description ... D-73

D.9 ALOHA Code Description ... D-75

D.10 References ... D-78

Appendix E
Current Understanding of the Groundwater Regime at Los Alamos National Laboratory

E.1 Introduction ... E-1

E.2 Regional Setting ... E-2

E.3 Structural Setting ... E-3

E.4 Volcanic Setting E-5

E.5 Stratigraphic Framework of the Pajarito Plateau E-7
E.5.1 Santa Fe Group E-8
E.5.2 Upper Pliocene and Quaternary Units E-12

E.6 Hydrogeology E-15
E.6.1 Comparison of the Bedrock Geologic Framework with the Hydrologic Framework E-15
E.6.2 Groundwater Occurrence E-15
E.6.2.1 Alluvial Groundwater E-18
E.6.2.2 Deep Perched Groundwater E-18
E.6.2.3 Regional Groundwater E-19
E.6.3 Hydrogeologic Units E-20

E.7 Conceptual Models E-22
E.7.1 Geochemical Conceptual Model E-23
E.7.1.1 Contaminant Distributions E-27
E.7.2 Geohydrologic Conceptual Model E-29

E.8 Numerical Modeling Studies E-31
E.8.1 A Vadose Zone Flow and Transport Model for Los Alamos Canyon, Los Alamos, New Mexico E-31
E.8.2 Hydrologic Behavior of Unsaturated, Fractured Tuff: Interpretation and Modeling of a Wellbore Injection Test E-32
E.8.3 Development and Application of Numerical Models to Estimate Fluxes through the Regional Aquifer beneath the Pajarito Plateau E-33
E.8.4 Observations and Modeling of Deep Perched Water beneath the Pajarito Plateau E-35

E.9 References E-37

Appendix F
Environmental Sample Data

F.1 Environmental Monitoring Selection F-1

F.2 Evaluation of Los Alamos National Laboratory Environmental Sampling Data F-1

F.3 Environmental Sample Data F-19

F.4 References F-59

Appendix G
Impacts Analyses of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities

G.1 Center for Weapons Physics Research Construction and Operation Impact Assessment G-8
G.1.1 Introduction G-9
G.1.2 Options Considered G-9
G.1.2.1 No Action Option G-9
G.1.2.2 Proposed Project G-10
G.1.3 Affected Environment and Environmental Consequences G-11
G.1.3.1 No Action Option G-12
G.1.3.2 Proposed Project G-12

G.2 Replacement Office Buildings Impact Assessment G-20
G.2.1 Introduction G-20
G.2.2 Options Considered G-21
G.2.2.1 No Action Option G-21
G.2.2.2 Proposed Project G-21

G.2.3 Affected Environment and Environmental Consequences G-22
G.2.3.1 No Action Option G-23
G.2.3.2 Proposed Project G-23

G.3 Radiological Sciences Institute, Including Phase I – The Institute for Nuclear Nonproliferation Science and Technology Impact Assessment G-29
G.3.1 Introduction G-30
G.3.2 Options Considered G-30
G.3.2.1 No Action Option G-31
G.3.2.2 Proposed Project G-33
G.3.3 Affected Environment and Environmental Consequences G-34
G.3.3.1 No Action Option G-35
G.3.3.2 Proposed Project G-40

G.4 Radioactive Liquid Waste Treatment Facility Upgrade Impact Assessment G-60
G.4.1 Introduction G-60
G.4.2 Options Considered G-63
G.4.2.1 No Action Option G-63
G.4.2.2 Option 1: Single Liquid Waste Treatment Building Option – Proposed Project G-65
G.4.2.3 Option 2: Two Liquid Waste Treatment Buildings Option G-66
G.4.2.4 Option 3: Two Liquid Waste Treatment Buildings and Renovation Option G-69
G.4.2.5 Auxiliary Actions G-70
G.4.2.6 Options Considered but Dismissed G-70
G.4.3 Affected Environment and Environmental Consequences G-70
G.4.3.1 No Action Option G-71
G.4.3.2 Option 1: Single Liquid Waste Treatment Building Option – Proposed Project G-72
G.4.3.3 Option 2: Two Liquid Waste Treatment Buildings Option G-81
G.4.3.4 Option 3: Two Liquid Waste Treatment Buildings and Renovation Option G-85

G.5 Los Alamos Neutron Science Center (LANSCE) Refurbishment Impacts Assessment G-88
G.5.1 Introduction G-88
G.5.2 Options Considered G-89
G.5.2.1 No Action Option G-89
G.5.2.2 Proposed Project G-89
G.5.2.3 Options Considered but Dismissed G-91
G.5.3 Affected Environment and Environmental Consequences G-91
G.5.3.1 No Action Option G-93
G.5.3.2 Proposed Project G-93

G.6 Technical Area 55 Radiography Facility Impacts Assessment G-97
G.6.1 Introduction G-97
G.6.2 Options Considered G-98
G.6.2.1 No Action Option G-98
G.6.2.2 Option 1: New Radiography Building Option G-99
G.6.2.3 Option 2: Hybrid Option G-99
G.6.2.4 Option 3: Renovation Option G-100
G.6.2.5 Options Considered but Dismissed G-100
G.6.3 Affected Environment and Environmental Consequences G-101
G.6.3.1 No Action Option G-102
G.6.3.2 Option 1: New Radiography Building Option G-103
G.6.3.3 Option 2: Hybrid Option G-108
G.6.3.4 Option 3: Renovation Option G-109

G.7 Plutonium Facility Complex Refurbishment Project Impact Assessment G-110
G.7.1 Introduction G-110
G.7.2 Options Considered G-112
G.7.2.1 No Action Option G-112
G.7.2.2 Proposed Project G-112

G.7.2.3 Options Considered but Dismissed ... G-115
G.7.3 Affected Environment and Environmental Consequences ... G-115
G.7.3.1 No Action Option ... G-116
G.7.3.2 Proposed Project ... G-117

G.8 Science Complex Impact Assessment ... G-124
G.8.1 Introduction ... G-124
G.8.2 Options Considered ... G-125
G.8.2.1 No Action Option ... G-125
G.8.2.2 Option 1: Northwest Technical Area 62 Site Option ... G-125
G.8.2.3 Option 2: Research Park Site Option ... G-126
G.8.2.4 Option 3: South Technical Area 3 Site Option ... G-127
G.8.2.5 Options Considered but Dismissed ... G-127
G.8.3 Affected Environment and Environmental Consequences ... G-127
G.8.3.1 No Action Option ... G-128
G.8.3.2 Option 1: Northwest Technical Area 62 Site Option ... G-128
G.8.3.3 Option 2: Research Park Site Option ... G-136
G.8.3.4 Option 3: South TA-3 Site Option ... G-139

G.9 Remote Warehouse and Truck Inspection Station Impact Assessment ... G-144
G.9.1 Introduction ... G-144
G.9.2 Options Considered ... G-145
G.9.2.1 No Action Option ... G-145
G.9.2.2 Proposed Project ... G-145
G.9.2.3 Options Considered but Dismissed ... G-147
G.9.3 Affected Environment and Environmental Consequences ... G-147
G.9.3.1 No Action Option ... G-147
G.9.3.2 Proposed Project ... G-148

G.10 References ... G-155

Appendix H
Impacts Analyses of Closure and Remediation Actions

H.1 Technical Area 18 Closure, Including Remaining Operations Relocation, and Structure Decontamination, Decommissioning, and Demolition Impacts Assessment ... H-4
H.1.1 Introduction and Purpose and Need for Agency Action ... H-4
H.1.2 Options Description ... H-10
H.1.2.1 Disposition of Remaining Security Category III and IV ... H-11
H.1.2.2 Disposition of Technical Area 18 Facilities ... H-11
H.1.3 Affected Environment and Environmental Consequences ... H-12
H.1.3.1 Disposition of Remaining Security Category III and IV Capabilities and Materials ... H-12
H.1.3.2 Disposition of Technical Area 18 Buildings and Structures ... H-13

H.2 Technical Area 21 Structure Decontamination, Decommissioning, and Demolition Project Impact Assessment ... H-22
H.2.1 Introduction and Purpose and Need for Agency Action ... H-22
H.2.2 Options Description ... H-30
H.2.2.1 No Action Option ... H-31
H.2.2.2 Technical Area 21 Complete Decontamination, Decommissioning, and Demolition Option ... H-31
H.2.2.3 Compliance Support Option – Partial Decontamination, Decommissioning, and Demolition to Allow Consent Order Compliance ... H-32
H.2.3 Affected Environment and Environmental Consequences ... H-34
H.2.3.1 No Action Option ... H-34
H.2.3.2 Technical Area 21 Complete Decontamination, Decommissioning, and Demolition Option ... H-35

H.2.3.3 Compliance Support Option – Decontamination, Decommissioning, and Demolition to Support the Consent Order Activities H-55

H.3 Waste Management Facilities Transition Impacts Assessment H-59
H.3.1 Introduction and Purpose and Need for Agency Action H-59
H.3.2 Options Description H-64
H.3.2.1 No Action Option H-64
H.3.2.2 Option 1: Accelerated Actions for Meeting the Consent Order H-64
H.3.2.3 Option 2: Interim Actions Necessary for Meeting Consent Order and Other Options H-73
H.3.2.4 Options Considered but Eliminated H-74
H.3.3 Affected Environment and Environmental Consequences H-75
H.3.3.1 No Action Option H-76
H.3.3.2 Option 1: Accelerated Actions for Meeting the Consent Order H-76
H.3.3.3 Option 2: Interim Actions Necessary for Meeting Consent Order and Other Alternatives H-103

H.4 References H-109

Volume 2 Book 2
Appendices I through M

Appendix I
Major Material Disposal Area Remediation, Canyon Cleanups, and Other Consent Order Actions

I.1 Introduction I-1
I.1.1 Need for Agency Action I-1
I.1.2 Purpose and Approach I-2
I.1.3 Options Considered in This Project-Specific Analysis I-5
1.1.4 Related National Environmental Policy Act Analyses I-6

I.2 Background I-7
I.2.1 General Setting I-7
I.2.2 The Los Alamos National Laboratory Environmental Restoration Project I-7
I.2.2.1 The Los Alamos National Laboratory Environmental Restoration Project Background I-7
I.2.2.2 Consent Order I-9
I.2.3 Firing Sites and Other PRSs within Testing Hazard Zones I-10
I.2.3.1 Technical Area 15: Firing Site E-F I-11
I.2.3.2 Firing Site R-44 .... I-15
I.2.3.3 Technical Area 6: Material Disposal Area F I-16
I.2.3.4 Technical Area 15: Material Disposal Area Z I-19
I.2.3.5 Technical Area 36: Material Disposal Area AA I-19
I.2.3.6 Technical Area 39: Material Disposal Area Y I-20
I.2.3.7 Technical Area 49: Material Disposal Area AB I-20
I.2.4 Canyons I-20
I.2.5 Technical Area Investigations I-21
I.2.5.1 Technical Area 10: Bayo Canyon Site I-21
I.2.5.2 Technical Area 21: Material Disposal Areas A, B, T, and U I-22
I.2.5.3 Technical Area 49: Material Disposal Area AB I-41
I.2.5.4 Technical Area 50: Material Disposal Area C I-50
I.2.5.5 Technical Area 54: Material Disposal Areas G, H, and L I-55
I.2.6 Other Solid Waste Management Units and Areas of Concern, Including Aggregate Areas I-70
I.2.7 Continuing Investigations I-70
I.2.7.1 Solid Waste Management Unit 3-010(a): Vacuum Oil Disposal Area I-72
I.2.7.2 Solid Waste Management Unit 16-003(O): Fish Ladder Site I-72

I.2.7.3 Solid Waste Management Unit 16-008(a): Inactive Pond I-72
I.2.7.4 Solid Waste Management Unit 16-018 (Material Disposal Area P) and Technical Area 16-387 .... I-73
I.2.7.5 Solid Waste Management Units 16-021(c) and 16-003(k): 260 Outfall I-73
I.2.7.6 Solid Waste Management Unit 21-001(k): Technical Area 21 Outfall I-75
I.2.7.7 Technical Area 35 (Middle Mortandad–Ten Site Aggregate Area) I-76
I.2.7.8 Technical Area 49: Areas 5, 6, and 10 .... I-78
I.2.7.9 Solid Waste Management Unit 53-002 (a and b): Impoundments I-78
I.2.7.10 Solid Waste Management Unit 73-001 (a–d) and 73-004 (d): Airport Landfill I-79
I.2.7.11 Solid Waste Management Unit 73-002: Incinerator Ash Pile I-79
I.2.8 Additional Material Disposal Areas I-80
I.2.8.1 Technical Area 8: Material Disposal Area Q I-80
I.2.8.2 Technical Area 9: Material Disposal Area M I-80
I.2.8.3 Technical Area 15: Material Disposal Area N I-81
I.2.8.4 Technical Area 16: Material Disposal Area R I-81
I.2.8.5 Technical Area 33: Material Disposal Areas D, E, and K I-82

I.3 Description of Options I-84
I.3.1 Overview of Options I-84
I.3.2 Continuing Environmental Restoration Work I-85
I.3.2.1 Existing Waste Forecasts I-85
I.3.2.2 Investigations I-88
I.3.2.3 Maintenance of Nuclear Environmental Sites I-90
I.3.3 Remediation of Material Disposal Areas I-92
I.3.3.1 Corrective Measure Technologies Possibly Suitable for Material Disposal Areas I-93
I.3.3.2 Options for Remediation of Material Disposal Areas I-111
I.3.4 Remediation of PRSs other than Material Disposal Areas I-167
I.3.4.1 Possible Treatment Technologies I-167
I.3.4.2 Remediation of Representative PRSs I-168
I.3.4.3 Waste Generation Estimates I-171
I.3.5 Waste Transportation and Disposal Assumptions I-171
I.3.6 Waste, Materials, Shipment, and Personnel Projections Under Options I-174
I.3.6.1 Waste Generation I-174
I.3.6.2 Transportation and Disposal of Waste I-176
I.3.6.3 Cover Materials, Excavated Soil, and Materials Transport I-179
I.3.6.4 Equipment, Emissions, and Personnel Assumptions I-184
I.3.6.5 Affected Area Assumptions I-191

I.4 Affected Environment I-193
I.4.1 Land Resources I-193
I.4.1.1 Land Use I-193
I.4.1.2 Visual Environment I-197
I.4.2 Geology and Soils I-200
I.4.3 Water Resources I-200
I.4.4 Air Quality and Noise I-203
I.4.4.1 Climatology and Meteorology I-203
I.4.4.2 Air Quality and Visibility I-204
I.4.4.3 Noise, Air Blasts, and Vibration I-204
I.4.5 Ecological Resources I-205
I.4.6 Human Health I-211
I.4.7 Cultural Resources I-211
I.4.7.1 Archaeological Resources and Historic Buildings and Structures I-211
I.4.7.2 Traditional Cultural Properties I-214
I.4.8 Socioeconomics and Infrastructure I-214
I.4.8.1 Socioeconomics I-214
I.4.8.2 Infrastructure I-214
I.4.9 Waste Management I-215

I.4.10 Transportation I-215
I.4.11 Environmental Justice I-219

I.5 Environmental Consequences I-219
I.5.1 Land Resources I-219
I.5.1.1 No Action Option I-219
I.5.1.2 Capping Option........ I-220
I.5.1.3 Removal Option........ I-223
I.5.2 Geology and Soils........ I-225
I.5.2.1 No Action Option I-225
I.5.2.2 Capping Option........ I-226
I.5.2.3 Removal Option........ I-226
I.5.3 Water Resources........ I-227
I.5.3.1 No Action Option I-227
I.5.3.2 Capping Option........ I-230
I.5.3.3 Removal Option........ I-233
I.5.4 Air Quality and Noise........ I-234
I.5.4.1 No Action Option I-234
I.5.4.2 Capping Option........ I-236
I.5.4.3 Removal Option........ I-240
I.5.5 Ecological Resources........ I-243
I.5.5.1 No Action Option I-243
I.5.5.2 Capping Option........ I-244
I.5.5.3 Removal Option........ I-245
I.5.6 Human Health........ I-246
I.5.6.1 No Action Option I-246
I.5.6.2 Capping Option........ I-247
I.5.6.3 Removal Option........ I-248
I.5.7 Cultural Resources........ I-254
I.5.7.1 No Action Option I-254
I.5.7.2 Capping Option........ I-254
I.5.7.3 Removal Option........ I-255
I.5.8 Socioeconomics and Infrastructure........ I-255
I.5.8.1 No Action Option I-255
I.5.8.2 Capping Option........ I-255
I.5.8.3 Removal Option........ I-256
I.5.9 Waste Management I-256
I.5.9.1 No Action Option I-256
I.5.9.2 Capping Option........ I-257
I.5.9.3 Removal Option........ I-257
I.5.10 Transportation I-258
I.5.10.1 No Action Option I-258
I.5.10.2 Capping Option........ I-260
I.5.10.3 Removal Option........ I-263
I.5.11 Environmental Justice I-266
I.5.11.1 No Action Option I-266
I.5.11.2 Capping Option........ I-266
I.5.11.3 Removal Option........ I-267
I.5.12 Accidents........ I-267
I.5.12.1 Risks to Public........ I-268
I.5.12.2 Risks to Workers I-275
I.5.13 Cumulative Effects........ I-276

I.6 References........ I-279

Appendix J
Impacts Analyses of Projects Associated with New Infrastructure or Levels of Operation

J.1 Security-Driven Transportation Modifications Impacts Assessment....J-3
J.1.1 Introduction, Purpose, and Need for Agency Action.... J-3
J.1.2 Options Descriptions.... J-6
J.1.2.1 No Action Option.... J-6
J.1.2.2 Proposed Project: Construct Security-Driven Transportation Modifications in the Pajarito Corridor West.... J-6
J.1.3 Affected Environment and Environmental Consequences.... J-14
J.1.3.1 No Action Option.... J-15
J.1.3.2 Proposed Project: Construct Security-Driven Transportation Modifications in the Pajarito Corridor West.... J-15
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.... J-30
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.... J-34

J.2 Metropolis Center Increase in Levels of Operation Impacts Assessment....J-38
J.2.1 Introduction, Purpose, and Need for Agency Action.... J-38
J.2.2 Options Descriptions.... J-40
J.2.2.1 No Action Option: Continue Metropolis Center Operations Using the Existing Computing Platform.... J-40
J.2.2.2 Proposed Project: Modify and Operate the Metropolis Center at an Expanded Computing Platform.... J-40
J.2.3 Affected Environment and Environmental Consequences.... J-40
J.2.3.1 No Action Option.... J-41
J.2.3.2 Proposed Project: Modify and Operate the Metropolis Center at an Expanded Computing Platform.... J-42

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....J-43
J.3.1 Introduction, Purpose, and Need for Agency Action.... J-44
J.3.2 Options Descriptions.... J-47
J.3.2.1 No Action Option.... J-47
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.... J-48
J.3.3 Affected Environment and Environmental Consequences.... J-49
J.3.3.1 No Action Option.... J-50
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.... J-51

J.4 References....J-59

Appendix K
Evaluation of Human Health Effects from Transportation

K.1 Introduction....K-1

K.2 Scope of Assessment....K-1
K.2.1 Transportation-related Activities.... K-1
K.2.2 Radiological Impacts.... K-2
K.2.3 Nonradiological Impacts.... K-2
K.2.4 Transportation Modes.... K-2
K.2.5 Receptors.... K-2

K.3 Packaging and Transportation Regulations ... K-3
K.3.1 Packaging Regulations ... K-3
K.3.2 Transportation Regulations ... K-5

K.4 Transportation Analysis Impact Methodology ... K-6
K.4.1 Transportation Routes ... K-8
K.4.2 Radioactive Material Shipments ... K-11

K.5 Incident-Free Transportation Risks ... K-12
K.5.1 Radiological Risk ... K-12
K.5.2 Nonradiological Risk ... K-14
K.5.3 Maximally Exposed Individual Exposure Scenarios ... K-14

K.6 Transportation Accident Risks and Maximum Reasonably Foreseeable Consequences ... K-15
K.6.1 Methodology ... K-15
K.6.2 Accident Rates ... K-15
K.6.3 Accident Severity Categories and Conditional Probabilities ... K-16
K.6.4 Atmospheric Conditions ... K-17
K.6.5 Radioactive Release Characteristics ... K-18
K.6.6 Acts of Sabotage or Terrorism ... K-19

K.7 Risk Analysis Results ... K-19

K.8 Impact of Construction and Hazardous Material Transport ... K-26

K.9 Conclusions ... K-27

K.10 Long-Term Impacts of Transportation ... K-27
K.10.1 Uncertainty and Conservatism in Estimated Impacts ... K-28
K.10.2 Uncertainties in Material Inventory and Characterization ... K-29
K.10.3 Uncertainties in Containers, Shipment Capacities, and Number of Shipments ... K-29
K.10.4 Uncertainties in Route Determination ... K-30
K.10.5 Uncertainties in the Calculation of Radiation Doses ... K-30

K.11 References ... K-31

Appendix L
Categorical Exclusion Summary

Appendix M
Contractor Disclosure Statement

LIST OF FIGURES

Appendix D
Figure D–1 Relative Risk of Wildfire in the Los Alamos Region (1999)....D-44
Figure D–2 Relative Risk of Wildfire in the Los Alamos Region (2002)....D-44

Appendix E
Figure E–1 Location Map of the Central Pajarito Plateau....E-2
Figure E–2 Locations of Major Structural and Geologic Elements in the Vicinity of Los Alamos National Laboratory....E-4
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....E-5
Figure E–4 Pajarito Plateau Stratigraphy and Hydrogeologic Units....E-8
Figure E–5 Deep Canyon Exposures....E-9
Figure E–6 Outcrop of Totavi Lentil Along SR 304....E-11
Figure E–7 Conceptual Cross-Section Across the Pajarito Plateau Along Los Alamos Canyon....E-16
Figure E–8 Conceptual Cross-Section Across the Pajarito Plateau Along Pajarito Canyon....E-17
Figure E–9 Average Spatial Distribution (n=6) for Key Analytes in Los Alamos National Laboratory Background Wells and Springs....E-24
Figure E–10 Major Liquid Release Sources that have Potentially Affected Groundwater at Los Alamos National Laboratory. Most of these are now inactive.....E-28
Figure E–11 Outcrop of Cerros del Rio Basalt at White Rock Overlook (East of Los Alamos National Laboratory)....E-30

Appendix F
Figure F–1 Americium-241 Measured Mean Concentration Value in Groundwater....F-3
Figure F–2 Cesium-137 Measured Mean Concentration Value in Groundwater....F-3
Figure F–3 Plutonium-238 Measured Mean Concentration Value in Groundwater....F-4
Figure F–4 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value in Groundwater....F-4
Figure F–5 Strontium-90 Measured Mean Concentration Value in Groundwater....F-5
Figure F–6 Tritium Measured Mean Concentration Value in Groundwater....F-5
Figure F–7 Americium-241 Measured Mean Concentration Value in Sediment....F-6
Figure F–8 Cesium-137 Measured Mean Concentration Value in Sediment....F-7
Figure F–9 Plutonium-238 Measured Mean Concentration Value in Sediment....F-7
Figure F–10 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value in Sediment....F-8
Figure F–11 Strontium-90 Measured Mean Concentration Value in Sediment....F-8
Figure F–12 Tritium Measured Mean Concentration Value in Sediment....F-9
Figure F–13 Americium-241 Measured Mean Concentration Value for Storm Water Runoff....F-10
Figure F–14 Cesium-137 Measured Mean Concentration Value for Storm Water Runoff....F-10
Figure F–15 Plutonium-238 Measured Mean Concentration Value for Storm Water Runoff....F-11
Figure F–16 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Storm Water Runoff....F-11
Figure F–17 Strontium-90 Measured Mean Concentration Value for Storm Water Runoff....F-12
Figure F–18 Tritium Measured Mean Concentration Value for Storm Water Runoff....F-12
Figure F–19 Americium-241 Measured Mean Concentration Value for Soils....F-13
Figure F–20 Cesium-137 Measured Mean Concentration Value for Soils....F-13
Figure F–21 Plutonium-238 Measured Mean Concentration Value for Soils....F-14
Figure F–22 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Soils....F-14
Figure F–23 Tritium Measured Mean Concentration Value for Soils....F-15

Appendix G

Figure G–1 Proposed Timeframes for Construction and Operation of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities G-2
Figure G–2 Proposed Location for the Center for Weapons Physics Research G-10
Figure G–3 Replacement Office Building Complex Proposed Layout G-22
Figure G–4 Existing Radioactive Liquid Waste Treatment Facility G-61
Figure G–5 Existing Treatment Processes for Transuranic Waste G-64
Figure G–6 Proposed Project Location G-65
Figure G–7 Proposed Low-Level Radioactive Waste Treatment Process G-67
Figure G–8 Proposed Transuranic Waste Treatment Process G-68
Figure G–9 Proposed Layout under the Two Liquid Waste Treatment Buildings Option G-69
Figure G–10 Location of Los Alamos Neutron Science Center at Technical Area 53 .... G-92
Figure G–11 Location of Building 55-41 Relative to Building 55-4 at Technical Area 55 .... G-99
Figure G–12 Conceptual Layout of the Science Complex at the Northwest Technical Area 62 Site G-126
Figure G–13 Technical Area 72 Remote Warehouse and Truck Inspection Station Conceptual Layout G-146

Appendix H

Figure H–1 Proposed Timeframes for Construction and Operation of Closure and Remediation Actions H-1
Figure H–2 Technical Area 18 Pajarito Site H-7
Figure H–3 Technical Area 21 Map of DP West Buildings and Solid Waste Management Units H-23
Figure H–4 Technical Area 21 Map of DP East Buildings and Solid Waste Management Units H-24
Figure H–5 Aerial Photograph of the DP East and DP West Sites, Looking West (1995) H-25
Figure H–6 Land Transfer H-28

Appendix I

Figure I–1 Los Alamos National Laboratory Technical Area Locations I-8
Figure I–2 Technical Area 15 Firing Sites and Other Facilities I-14
Figure I–3 Material Disposal Area F I-18
Figure I–4 Material Disposal Area A I-23
Figure I–5 General's Tanks within Material Disposal Area A I-24
Figure I–6 Material Disposal Area B Base Map Showing Estimated Disposal Trench Locations I-27
Figure I–7 Material Disposal Area B Base Map Showing Estimated Disposal Trench Locations I-29
Figure I–8 Material Disposal Area T I-31
Figure I–9 Absorption Bed and Distribution Pipe Cross-Section I-32
Figure I–10 Location of Lines Discharging to Absorption Beds at Material Disposal Area T Before 1952 .... I-33
Figure I–11 Material Disposal Area U Showing Pipelines for Liquid Effluents I-39
Figure I–12 Technical Area 49 Shaft Areas and Other Solid Waste Management Units I-42
Figure I–13 Material Disposal Area C Within Technical Area 50 .... I-50
Figure I–14 Material Disposal Area Locations of Technical Area-54 .... I-56
Figure I–15 Waste Management Areas within Area G of Technical Area-54 .... I-58
Figure I–16 Material Disposal Area L Inactive Waste Unit Locations I-65
Figure I–17 Material Disposal Area L Operational Waste Management Units I-69
Figure I–18 260 Outfall Within Technical Area-16 .... I-74
Figure I–19 Closeup View of Conceptual Site Changes to Facilitate Complete Excavation and Removal Corrective Measure Option I-109
Figure I–20 Example of a Remotely Operated Dismantling System and Inspection Station I-110
Figure I–21 Conceptual Geologic Model of Operable Unit 1114 .... I-137
Figure I–22 Aerial Illustrations of Borrow Pit I-138
Figure I–23 View to the East from within the Technical Area 61 Borrow Pit I-138
Figure I–24 Material Disposal Area B Investigative Sections I-162
Figure I–25 Major Transportation Routes within Los Alamos National Laboratory I-217
Figure I–26 Major Transportation Routes Outside of Los Alamos National Laboratory I-218

Appendix J

Figure J–1 Proposed Timeframes for Construction and Operation of Projects to Add New Infrastructure or Increase Levels of Operation J-1
Figure J–2 Proposed Pajarito Corridor West Security-Driven Transportation Plan J-4
Figure J–3 Proposed Technical Area 48 Security-Driven Transportation Modifications J-8
Figure J–4 Proposed Technical Area 35 and Technical Area 63 Security-Driven Transportation Modifications J-10
Figure J–5 Photograph of Canyon to be Bridged between Technical Area 35 and Technical Area 63 .... J-11
Figure J–6 General Locations of the Auxiliary Action Bridges and Roadways to Technical Area 60 and Technical Area 61 .... J-13
Figure J–7 Photograph Looking North Across Mortandad Canyon in the Area of the Bridge for Proposed Auxiliary Action A J-14

Appendix K

Figure K–1 Transportation Risk Assessment K-7
Figure K–2 Analyzed Truck Routes K-10

LIST OF TABLES

Appendix B
Table B–1 Criteria Pollutant Standards B-2
Table B–2 Criteria Pollutant Emissions Summary B-7

Appendix C
Table C–1 Exposure Limits for Members of the Public and Radiation Workers C-6
Table C–2 Nominal Health Risk Estimators Associated with Exposure to 1 Rem of Ionizing Radiation C-8
Table C–3 Los Alamos National Laboratory Key Facilities C-12
Table C–4 Radiological Air Emissions from Technical Area 3-29 (Chemistry and Metallurgy Research Building) C-15
Table C–5 Radiological Air Emissions from Technical Area 3-66 (Sigma Complex) C-15
Table C–6 Radiological Air Emissions from Technical Area 3-102 (Machine Shops) C-15
Table C–7 Radiological Air Emissions from Technical Area 11 (High Explosives Processing) C-16
Table C–8 Radiological Air Emissions from Technical Area 15 and Technical Area 36 (High Explosives Testing) C-16
Table C–9 Radiological Air Emissions from Technical Area 16 (Tritium Facility) C-16
Table C–10 Radiological Air Emissions from Technical Area 18 (Pajarito Site) C-17
Table C–11 Radiological Air Emissions from Technical Area 48 (Radiochemistry Facility) C-17
Table C–12 Radiological Air Emissions from Technical Area 53 (Los Alamos Neutron Science Center) C-18
Table C–13 Radiological Air Emissions from Technical Area 54 (Waste Management Operations) C-19
Table C–14 Radiological Air Emissions from Technical Area 55 (Plutonium Facility Complex) C-19
Table C–15 Radiological Air Emissions from Non-Key Facilities (Technical Area 21) C-20
Table C–16 Summary of Facility-Specific Maximally Exposed Individual Dose C-22
Table C–17 Maximally Exposed Individual Dose for the No Action Alternative C-23
Table C–18 Maximally Exposed Individual Dose for the Reduced Operations Alternative C-24
Table C–19 Maximally Exposed Individual Dose for the Expanded Operations Alternative C-25
Table C–20 Collective Population Dose Summary C-26
Table C–21 Ingestion Exposure Pathway Components Evaluated for Offsite Resident, Recreational User, and Special Pathways Receptors C-29
Table C–22 Dose from the Consumption of Produce C-30
Table C–23 Dose from the Consumption of Free Range Beef C-30
Table C–24 Dose from the Consumption of Milk C-31
Table C–25 Dose from the Consumption of Fish C-31
Table C–26 Dose from the Consumption of Elk C-32
Table C–27 Dose from the Consumption of Deer C-32
Table C–28 Dose from the Consumption of Honey C-33
Table C–29 Dose from the Consumption of Piñon Nuts C-33
Table C–30 Dose from the Consumption of Groundwater C-34
Table C–31 Dose from the Consumption of Soil C-34
Table C–32 Dose from the Consumption of Sediment C-35
Table C–33 Dose to the Recreational User Receptor from the Consumption of Surface Water C-35
Table C–34 Dose to the Recreational User Receptor from the Consumption of Soil C-36
Table C–35 Dose to the Recreational User Receptor from the Consumption of Sediment C-36
Table C–36 Dose to the Special Pathways Receptor from the Consumption of Fish C-37
Table C–37 Dose to the Special Pathways Receptor from the Consumption of Elk Heart and Liver C-37
Table C–38 Dose to the Special Pathways Receptor from the Consumption of Indian Tea (Cota) C-38
Table C–39 Summary of Ingestion Pathway Doses for Offsite Resident, Recreational User, and Special Pathways Receptors C-38
Table C–40 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Groundwater C-44

Table C–41 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Surface Water C-48
Table C–42 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Sediment C-49
Table C–43 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Sediment C-51
Table C–44 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Soil C-52
Table C–45 Hazard Index and Cancer Risk to the Recreational User Receptor from the Ingestion of Nonradioactive Contaminants in Soil C-52
Table C–46 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Produce C-55
Table C–47 Hazard Index and Cancer Risk to the Offsite Resident Receptor from the Ingestion of Nonradioactive Contaminants in Fish C-55
Table C–48 Hazard Index and Cancer Risk to the Special Pathways Receptor from the Ingestion of Nonradioactive Contaminants in Fish C-56
Table C–49 Containment Design Practices and Levels of Biological Agents for Each Biosafety Level Facility C-61

Appendix D

Table D–1 Evaluation of Accident Data from the *1999 SWEIS* D-3
Table D–2 General Analysis Assumptions Independent of Scenario D-6
Table D–3 Facility Accident Source Term Data D-11
Table D–4 Radiological Accident Offsite Population Consequences for the No Action Alternative D-17
Table D–5 Radiological Accident Onsite Worker Consequences for the No Action Alternative D-18
Table D–6 Radiological Accident Offsite Population and Worker Risks for the No Action Alternative D-19
Table D–7 Radiological Accident Offsite Population Consequences for the Expanded Operations Alternative D-20
Table D–8 Radiological Accident Onsite Worker Consequences for the Expanded Operations Alternative D-21
Table D–9 Radiological Accident Offsite Population and Worker Risks for the Expanded Operations Alternative D-22
Table D–10 Chemical Accident Impacts D-24
Table D–11 Chemical Accident Impacts for the Expanded Operations Alternative D-26
Table D–12 Site-wide Earthquake Source Term Data D-28
Table D–13 Site-wide Seismic 1 Radiological Accident Offsite Population Consequences for the No Action Alternative D-31
Table D–14 Site-wide Seismic 1 Radiological Accident Onsite Worker Consequences for the No Action Alternative D-31
Table D–15 Site-wide Seismic 1 Radiological Accident Offsite Population and Worker Risks for the No Action Alternative D-32
Table D–16 Site-wide Seismic 2 Radiological Accident Offsite Population Consequences for the No Action Alternative D-33
Table D–17 Site-wide Seismic 2 Radiological Accident Onsite Worker Consequences for the No Action Alternative D-34
Table D–18 Site-wide Seismic 2 Radiological Accident Offsite Population and Worker Risks for the No Action Alternative D-35
Table D–19 Chemical Accident Impacts Under Seismic 1 Conditions D-35
Table D–20 Chemical Accident Impacts Under Seismic 2 Conditions D-36
Table D–21 Evaluation of Vulnerability of Los Alamos National Laboratory Buildings to Wildfire D-55
Table D–22 Wildfire Accident Source Term Data D-58
Table D–23 Radiological Accident Offsite Population Consequences for a Wildfire Accident D-60
Table D–24 Radiological Accident Onsite Worker Consequences for a Wildfire Accident D-60
Table D–25 Radiological Accident Offsite Population and Worker Risks for a Wildfire Accident D-61
Table D–26 Chemical Accident Impacts under Wildfire Conditions D-62
Table D–27 Maximally Exposed Individual-Type Doses versus Downwind Distance by Accident Scenario D-69

Appendix E

Table E–1 Summary of Jemez Mountain Volcanic Field Names, Rock Types, and Rock Ages E-7

Appendix F

Table F–1 Groundwater Data Set Comparison F-2
Table F–2 Sediment Data Set Comparison F-6
Table F–3 Storm Water Data Set Comparison F-9
Table F–4 Comparison of Measured 2001 through 2004 Radioisotope Groundwater Data to 1991 through 1996 Data....................F-16
Table F–5 Comparison of Measured 2001 through 2004 Radioisotope Sediment Data to 1991 through 1996 Data....................F-16
Table F–6 Comparison of Measured 2001 through 2004 Radioisotope Storm Water Runoff or Surface Water Data to 1991 through 1996 Data F-17
Table F–7 Comparison of Measured 2001 through 2004 Radioisotope Soil Data to 1991 through 1996 Data....................F-18
Table F–8 Key Parameters of Radioisotopes Measured at the Los Alamos National Laboratory Environment....................F-18
Table F–9 Number of Detectable Radiological Data Samples at Los Alamos National Laboratory F-21
Table F–10 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Groundwater Systems F-21
Table F–11 Radiochemical Statistical Analysis of Groundwater – Pueblo/Los Alamos/Sandia Canyon Area Perched System In Conglomerates and Basalt F-24
Table F–12 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Springs F-25
Table F–13 Radiochemical Statistical Analysis of Groundwater – Test Wells....................F-28
Table F–14 Radiochemical Statistical Analysis of Groundwater – Other Springs....................F-30
Table F–15 Radiochemical Statistical Analysis of Groundwater – Perched Groundwater System in Volcanics F-32
Table F–16 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Groundwater Systems Pueblo/Los Alamos/Sandia Canyon Area Perched Systems in Conglomerates and Basalt F-33
Table F–17 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Wells Hydrogeologic Characterization Wells....................F-34
Table F–18 Radiochemical Statistical Analysis of Groundwater – Water Supply Wells....................F-37
Table F–19 Radiochemical Statistical Analysis of Groundwater – Santa Fe Water Supply Wells....................F-40
Table F–20 Radiochemical Statistical Analysis of Sediment from 2001 through 2004....................F-41
Table F–21 Radiochemical Statistical Analysis of Surface Water or Storm Water Runoff....................F-49
Table F–22 Radiochemical Statistical Analysis of Soil Composite from 2001 through 2003 ....F-55
Table F–23 Benchmark Concentrations for Analyzed Radionuclides for Groundwater, Surface Water or Storm Water Runoff....................F-56
Table F–24 Perchlorate Statistical Analysis of Groundwater from 2002 through 2004....................F-57

Appendix G

Table G–1 Estimated Waste Volumes from Center for Weapons Physics Research Decontamination, Decommissioning, and Demolition Activities G-18
Table G–2 Incident-Free Transportation Impacts – Center for Weapons Physics Research G-19
Table G–3 Transportation Accident Impacts – Center for Weapons Physics Research G-20
Table G–4 Summary of Los Alamos National Laboratory Radiological Buildings Proposed for Decontamination, Decommissioning, and Demolition Radiological Sciences Institute Project........G-31
Table G–5 Name, Function, and Number of Employees of Permanent Buildings Proposed for Decontamination, Decommissioning, and Demolition by the Radiological Sciences Institute Project....................G-32
Table G–6 Annual Radiological Impacts on the Public from Operations under the Radiological Sciences Institute Project No Action Option G-36
Table G–7 Bounding Radiological Accident Scenarios under the Radiological Sciences Institute Project No Action Option....................G-38

Table G–8 Radiological Accident Offsite Population Consequences under the Radiological Sciences Institute Project No Action Option G-38
Table G–9 Radiological Incident Onsite Worker Consequences under the Radiological Sciences Institute Project No Action Option G-39
Table G–10 Radiological Accident Offsite Population and Worker Risks under the Radiological Sciences Institute Project No Action Option G-39
Table G–11 Nonradiological Air Pollutant Emissions at Technical Area 48 – 2002 .... G-44
Table G–12 Nonradiological Air Pollutant Emissions at Technical Area 3 Machine Shops and Technical Area 18 – 2002 .... G-44
Table G–13 Radiological Air Emissions from the Radiological Sciences Institute G-46
Table G–14 Annual Radiological Impacts on the Public from Radiological Sciences Institute Operations G-50
Table G–15 Affected Cultural Resource Sites – Radiological Sciences Institute G-52
Table G–16 Waste Generation for the Radiochemistry Facility, Pajarito Site, Sigma Complex, and Machine Shops at Technical Area 3 (1998 to 2003) G-55
Table G–17 Decontamination, Decommissioning, and Demolition of Waste Volumes for Buildings to be Replaced by the Radiological Sciences Institute G-56
Table G–18 Incident-Free Transportation Impacts – Radiological Sciences Institute G-57
Table G–19 Transportation Accident Impacts – Radiological Sciences Institute G-57
Table G–20 Bounding Radiological Accident Scenarios – Radiological Sciences Institute G-58
Table G–21 Radiological Accident Offsite Consequences – Radiological Sciences Institute G-59
Table G–22 Radiological Accident Onsite Worker Consequences – Radiological Sciences Institute G-59
Table G–23 Radiological Accident Offsite Population and Worker Risks – Radiological Sciences Institute G-60
Table G–24 Design Basis Influent Volumes – Radioactive Liquid Waste Treatment Facility Upgrade G-62
Table G–25 Incident-Free Transportation – for Single Liquid Waste Treatment Building Option Impacts G-80
Table G–26 Transportation Accident Impacts – for Single Liquid Waste Treatment Building Option G-81
Table G–27 Decontamination, Decommissioning, and Demolition Contaminated Construction Waste Volumes – Two Liquid Waste Treatment Buildings Option G-84
Table G–28 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings Option G-85
Table G–29 Transportation Incident Impacts – Two Liquid Waste Treatment Building Option G-85
Table G–30 Decontamination, Decommissioning, and Demolition Contaminated Construction Waste Volumes – Two Liquid Waste Treatment Buildings and Renovation Option G-87
Table G–31 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings and Renovation Option G-88
Table G–32 Transportation Incident Impacts – Two Liquid Waste Treatment Building and Renovation Option G-88
Table G–33 Waste Generation from Existing Los Alamos Neutron Science Center Operations at Technical Area 53 .... G-96
Table G–34 Toxic and Hazardous Pollutant Air Emissions from Existing Operations at Technical Area 55 .... G-119
Table G–35 Waste Generation from Existing Operations at Technical Area 55 .... G-121
Table G–36 Total Waste Generation from Implementation of the Plutonium Facility Complex Refurbishment Project at Technical Area 55 .... G-122
Table G–37 Incident-Free Transportation Impacts – Plutonium Facility Complex Refurbishment G-123
Table G–38 Transportation Incident Impacts – Plutonium Facility Complex Refurbishment G-124

Appendix H

Table H–1 Estimated Waste Volumes H-20
Table H–2 Incident-Free Transportation Impacts – Technical Area 18 Decontamination, Decommissioning, and Demolition H-21
Table H–3 Transportation Accident Impacts – Technical Area 18 Decontamination, Decommissioning, and Demolition H-22
Table H–4 Technical Area 21 Buildings to Undergo Decontamination, Decommissioning, and Demolition for the Compliance Support Option H-33
Table H–5 Volume of Technical Area 21 National Pollutant Discharge Elimination System Outfalls H-37
Table H–6 Calculated Actual Emissions for Regulated Pollutants Reported to the New Mexico Environment Department for 2004 .... H-39
Table H–7 Technical Area 21 Radiological Point Source Emissions H-40

Table H–8 Technical Area 21 Ambient Air Monitoring H-41
Table H–9 Maximally Exposed Individual Average Radiological Doses from Technical Area 21 Point Source Emissions H-44
Table H–10 Radiological Doses (above background) Measured at Technical Area 21 and the East Gate Locations, Based on Ambient Air Monitoring H-44
Table H–11 Waste Generation Ranges and Annual Average Generation Rates from Technical Area 21 Facilities H-51
Table H–12 Waste Generation under the Proposed Action and Compliance Response Alternatives H-52
Table H–13 Incident-Free Transportation Impacts – Technical Area 21 Decontamination, Decommissioning, and Demolition H-54
Table H–14 Transportation Accident Impacts – Technical Area 21 Decontamination, Decommissioning, and Demolition H-55
Table H–15 Area L Container Storage Units and Associated Storage Volumes H-72
Table H–16 Nonradiological Air Pollutant Emissions at Solid Radioactive and Chemical Waste Management Key Facility – 2004 .... H-82
Table H–17 Radiological Air Emissions from Each Waste Management Facility H-83
Table H–18 Potential Radiation Dose from Current Technical Area 54 Operations H-87
Table H–19 Waste Generation Ranges and Annual Average Generation Rates for the Solid Radioactive and Chemical Waste Facilities H-91
Table H–20 Estimated Waste Volumes from Decontamination, Decommissioning and Demolition Activities H-92
Table H–21 2004 Traffic Counts Along Pajarito Road Immediately East of Technical Area 63 .... H-93
Table H–22 Incident-Free Transportation Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities H-94
Table H–23 Transportation Accident Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities H-94
Table H–24 Alternative Site Seismic Source Terms H-97
Table H–25 Alternative Site Seismic Radiological Accident Consequences H-101
Table H–26 Alternative Site Seismic Radiological Accident Onsite Worker Consequences H-101
Table H–27 Alternative Site Radiological Accident Offsite Population and Worker Risks H-102

Appendix I

Table I–1 Large Material Disposal Areas Considered in This Project-Specific Analysis I-4
Table I–2 Updated Corrective Measure Report Schedules for Large Material Disposal Areas I-4
Table I–3 Additional Material Disposal Areas Considered in This Project-Specific Analysis I-5
Table I–4 Examples of Potential Release Sites Being Addressed Under the Consent Order I-5
Table I–5 Non-Deferred Sites Within Testing Hazard Zones I-12
Table I–6 Deferred Sites in Testing Hazard Zones I-13
Table I–7 Material Disposal Area T Waste Disposal Shaft Depths and Diameters I-34
Table I–8 Plutonium-239 Disposed of in Material Disposal Area T Shaft Bathyspheres I-36
Table I–9 Radionuclide Inventories and Cement Paste Volume by Shaft I-36
Table I–10 Material Disposal Area AB Principal Radionuclides Inventories I-46
Table I–11 Material Disposal Area AB Test and Support Shaft Depths I-48
Table I–12 Approximate Dimensions of Material Disposal Area C Disposal Units I-51
Table I–13 Los Alamos Scientific Laboratory Logbook Citations of Wastes Placed in Pits and Shafts I-53
Table I–14 Material Disposal Area C Estimated Radionuclide Inventories as of January 1989 .... I-54
Table I–15 Material Disposal Area G Pits I-59
Table I–16 Material Disposal Area G Trench Information I-61
Table I–17 Material Disposal Area G Summary Shaft Information I-61
Table I–18 Material Disposal Area G Solid Waste Management Unit Groupings I-61
Table I–19 Material Disposal Area G Hazardous Chemical Inventories I-63
Table I–20 Material Disposal Area L Pit and Impoundment Dimensions and Operation Dates I-66
Table I–21 Material Disposal Area L Shaft Dimensions and Operation Dates I-66
Table I–22 Aggregate Areas and Watersheds I-71
Table I–23 Solid Waste Management Units Requiring Continuing Investigation I-71

Table I–24 Potential Release Sites Considered in the Middle Mortandad–Ten Site Aggregate Sampling and Analysis Plan I-77
Table I–25 Projections of Environmental Restoration Project Wastes from Fiscal Year 2006 through Fiscal Year 2012 ..... I-86
Table I–26 Waste Types Considered I-87
Table I–27 Hazard Categories and Descriptions of Nuclear Environmental Sites I-91
Table I–28 Possible Technologies for Containment and in Situ Treatment I-94
Table I–29 Typical Removal Activities I-100
Table I–30 Equipment Commonly Used for Standard Removals I-101
Table I–31 Examples of Specialized Excavators and Other Equipment I-101
Table I–32 Example Contamination Control Options I-102
Table I–33 Hazardous Waste Operations Near Los Alamos National Laboratory I-105
Table I–34 Belowground Storage and Disposal Units at Area G I-115
Table I–35 Closure Phases for Area G I-116
Table I–36 Inadvertent Future Intruder Impact Summary I-119
Table I–37 Maximum Lifetime Maximally Exposed Individual and Population Impacts after Assumed Loss of Institutional Control I-119
Table I–38 Estimated Cover Materials for Material Disposal Area G I-120
Table I–39 Summary of Waste Management Units at Area L I-121
Table I–40 Bulk Materials for Material Disposal Area L Final Cover I-122
Table I–41 Solid Waste Generation during Capping of Large Material Disposal Areas I-124
Table I–42 Asphalt or Concrete Removal from Material Disposal Areas I-125
Table I–43 Bulk Materials for Material Disposal Area C Final Cover I-125
Table I–44 Summary of Material Disposal Area C Retaining Wall Quantities I-126
Table I–45 Cover Materials for Selected Material Disposal Areas I-127
Table I–46 One-Way Shipments for Delivery of Cover Materials for Selected Material Disposal Areas I-127
Table I–47 Cover Assumptions for Remaining Material Disposal Areas I-128
Table I–48 One-Way Shipments of Cover Materials for Remaining Material Disposal Areas I-128
Table I–49 Waste Generation through Fiscal Year 2016 from Capping Additional Material Disposal Areas I-129
Table I–50 Cover Assumptions for Technical Area 49 Contaminated Areas I-129
Table I–51 One-Way Shipments for Technical Area 49 Contaminated Areas I-129
Table I–52 Temporal Assumptions for Capping Large Material Disposal Areas I-135
Table I–53 Volumes of Transuranic-Contaminated Materials Estimated to Be within Los Alamos National Laboratory Material Disposal Areas I-143
Table I–54 Waste Volumes and Shipments for Removal of Material Disposal Areas A, B, C, G, L, T, U, and AB I-144
Table I–55 Volumes and Shipments of Bulk Materials for Removal of Material Disposal Areas A, B, C, G, L, T, U, and AB I-145
Table I–56 Liquid Waste Volumes and Shipments from Large-Material-Disposal-Area Exhumation I-145
Table I–57 Waste Projections for Removing Remaining Material Disposal Areas I-157
Table I–58 One-Way Shipments from Exhuming Remaining Material Disposal Areas I-158
Table I–59 Soil and Similar Materials for Removal of Remaining Material Disposal Areas I-158
Table I–60 One-Way Shipments of Soil and Similar Materials for Removal of Remaining Material Disposal Areas I-159
Table I–61 Temporal Assumptions for Removing Large Material Disposal Areas I-160
Table I–62 Estimated Waste Volume by Section at Material Disposal Area B I-161
Table I–63 Treatment Group Examples I-169
Table I–64 Alternative Corrective Measures for the 260 Outfall I-170
Table I–65 Annual Waste Generation from Remediating Additional Potential Release Sites I-171
Table I–66 Container and Shipment Assumptions I-173
Table I–67 Transportation Dose and Risk Assessment Results I-175
Table I–68 Annual Waste Generation Rates for No Action Option I-175
Table I–69 Capping Option Annual Waste Generation Rates I-177
Table I–70 Removal Option Annual Waste Generation Rates I-178
Table I–71 No Action Option Annual Waste Shipments I-179

Table I–72 Capping Option Annual Waste Shipments ... I-180
Table I–73 Removal Option Annual Waste Shipments ... I-181
Table I–74 Materials and Shipments for Capping All Material Disposal Areas ... I-182
Table I–75 Materials and Shipments for Removing All Material Disposal Areas ... I-183
Table I–76 Summary of Labor, Equipment Hours, and Fuel Use for Remediation Case Studies ... I-185
Table I–77 Remediation Case Study Total Equipment and Fuel Use and Pollutant Emissions ... I-186
Table I–78 Remediation Case Study Total Industrial Risks ... I-187
Table I–79 Case Studies Applied to Material Disposal Area Removal ... I-190
Table I–80 Approximate Sizes of Material Disposal Areas and Selected Potential Release Sites ... I-194
Table I–81 Watersheds and Depth to Regional Water by Material Disposal Area ... I-202
Table I–82 Comparative Summaries for Los Alamos National Laboratory Meteorological Stations with Nearby Material Disposal Areas ... I-204
Table I–83 Summary of Material Disposal Area and Potential Release Sites Vegetation Zones ... I-205
Table I–84 Principal Access Routes to Material Disposal Areas and Selected Solid Waste Management Units ... I-216
Table I–85 Material Disposal Area G Performance Assessment and Composite Analysis Summary Results ... I-228
Table I–86 No Action Option Projected Pollutant Releases to Air from Heavy Machinery Operation ... I-235
Table I–87 Capping Option Projected Pollutant Releases to Air from Heavy Machinery Operation ... I-236
Table I–88 Projected Pollutant Releases to Air from Heavy Machinery Operation from Capping Material Disposal Area G and Combined Material Disposal Areas A, B, T, and U ... I-237
Table I–89 Capping Option Projected Pollutant Releases to Air from Technical Area 61 Borrow Pit Heavy-Machinery Operation ... I-238
Table I–90 Removal Option Projected Pollutant Releases to Air from Heavy-Machinery Operation ... I-241
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 ... I-241
Table I–92 Removal Option Projected Pollutant Releases to Air from Technical Area 61 Borrow Pit Heavy-Machinery Operation ... I-242
Table I–93 Screened Inventories of Radionuclides Within Large Material Disposal Areas and the Combined Potential Release Site Area ... I-250
Table I–94 Annual Dose Estimates from Complete Removal of Large Material Disposal Areas ... I-253
Table I–95 No Action Option Transportation Impacts Summary ... I-259
Table I–96 No Action Option Comparison of On- and Offsite Radioactive Waste Disposal Transportation Impacts (Fiscal Year 2007 through Fiscal Year 2016) ... I-260
Table I–97 Capping Option Shipments of Waste and Bulk Materials into and out of Technical Area 21 ... I-261
Table I–98 Capping Option Transportation Impacts Summary ... I-262
Table I–99 Capping Option Comparison of On- and Offsite Radioactive Waste Disposal Transportation Impacts (Fiscal Year 2007 through Fiscal Year 2016) ... I-263
Table I–100 Removal Option Shipments of Waste and Bulk Materials into and out of Technical Area 21 ... I-264
Table I–101 Removal Option Transportation Impacts Summary ... I-265
Table I–102 Removal Option Comparison of On- and Offsite Radioactive Waste Disposal Transportation Impacts (Fiscal Year 2007 through Fiscal Year 2016) ... I-266
Table I–103 Analytical Parameters for Assumed Accidents at Material Disposal Area G and Material Disposal Area B ... I-271
Table I–104 Material Disposal Area Explosion or Fire: Radiological Accident Consequences ... I-273
Table I–105 Material Disposal Area Explosion or Fire: Radiological Accident Risks ... I-273
Table I–106 Material Disposal Area B Waste Retrieval Chemical Accident Consequences ... I-275
Table I–107 Industrial Accident Risks for Project-Specific Analysis Options ... I-276
Table I–108 Industrial Accident Risks for Technical Area 61 Borrow Pit Operations ... I-277
Table I–109 Industrial Accident Risks for Removal of Material Disposal Area G and Combined Material Disposal Areas A, B, T, and U ... I-277

Appendix J

Table J–1 Land Use Designations and Development Areas for Technical Areas that Comprise the Pajarito Corridor West J-16
Table J–2 2004 Traffic Counts Along Pajarito Road at Technical Area 48 and Technical Area 64 .... J-29
Table J–3 2004 Traffic Counts Along Pajarito Road Immediately East of Technical Area 63 .... J-29
Table J–4 Metropolis Center Operating Requirements J-41
Table J–5 Projected Annual Volumes of Waste with No Disposal Path for Duration of the Off-Site Source Recovery Project J-48
Table J–6 Additional Sources Registered with the Off-Site Source Recovery Project – Newly Eligible Materials J-48
Table J–7 Anticipated Volume of Greater-Than-Class C Actinide Waste with No Disposal Path over the Life of the Project J-51
Table J–8 Currently Stored Material with No Disposal Path J-51
Table J–9 Maximum Allowable Sealed Source Radioisotope Inventory at Technical Area 54 Area G........ J-53
Table J–10 Maximum Allowable Sealed Source Radioisotope Inventory at Chemistry and Metallurgy Research Building Wing 9 .... J-53
Table J–11 Sealed Source Aircraft Impact Crash Accident at Technical Area 54 Area G Dome Airborne Release Source Term for MACCS2 Calculation........ J-54
Table J–12 Sealed Source Aircraft Impact Crash Accident at Technical Area 54 Area G Dome Air Release and Direct Radiation Source Terms........ J-54
Table J–13 Dose and Risk Consequences of Sealed Source Aircraft Impact Crash Accident at Technical Area 54 Area G Dome J-55
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........ J-56
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........ J-56
Table J–16 Sealed Source Severe Earthquake Collapse and Fire Accident Dose and Risk Consequences at Technical Area 48 Location........ J-56
Table J–17 Total Accident Doses and Risks From Sealed Sources at Technical Area 3, Technical Area 48, and Technical Area 54........ J-57

Appendix K

Table K–1 Offsite Transport Truck Route Characteristics K-9
Table K–2 Radioactive Material Type and Container Characteristics........ K-11
Table K–3 Risk Factors per Truck Shipment of Radioactive Material........ K-20
Table K–4 Risk Factors per Truck-Shipment of Radioactive Material at Nearby Routes........ K-21
Table K–5 Estimates of the Number of Radioactive Shipments Under Each Alternative........ K-23
Table K–6 Risks of Transporting Radioactive Materials Under Each Alternative K-24
Table K–7 Estimated Dose to Maximally Exposed Individuals During Incident-Free Transportation Conditions........ K-25
Table K–8 Estimated Dose to the Population and to Maximally Exposed Individuals during Most Severe Accident Conditions........ K-26
Table K–9 Estimated Impacts of Construction and Operational Material Transport........ K-27
Table K–10 Cumulative Transportation-related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2047)........ K-28

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*
CME	corrective measure evaluation
CMR	Chemistry and Metallurgy Research (Building)
CMRR	Chemistry and Metallurgy Research Building Replacement Project
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
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 Guidelines
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FY	fiscal year
GIS	geographical information system
HDPE	high-density polyethylene
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
LASL	Los Alamos Scientific Laboratory (now LANL)
LCF	latent cancer fatality
LEED	Leadership in Energy and Environmental Design

LLW	low-level radioactive waste
LOC	level-of-concern
MAR	material at risk
MDA	material disposal area
MEI	maximally exposed individual
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
NOEL	No Observed Effect Level
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
PC	performance category
PCB	polychlorinated biphenyl
PEL	permissible exposure limit
PHERMEX	Pulsed High Energy Radiographic Machine Emitting X Rays
PM_n	particulate matter less than or equal to *n* microns in aerodynamic diameter
PRS	potential release site
PSVE	passive soil vapor extraction
RCRA	Resource Conservation and Recovery Act
rad	radiation absorbed dose
RANT	Radioactive Assay and Nondestructive Test
rem	roentgen equivalent man
RFI	RCRA facility investigation
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
SST	safe secure transport
SVE	soil vapor extraction
SWEIS	Site-Wide Environmental Impact Statement
SWMU	solid waste management unit
TA	technical area
TEDE	total effective dose equivalent
TEELs	Temporary Emergency Exposure Limits
teraops	a trillion floating point operations per second

TRAGIS	Transportation Routing Analysis Geographic Information System
TSFF	Tritium Science and Fabrication Facility
TSCA	Toxic Substances Control Act
TSTA	Tritium Systems Test Assembly
TWCF	Transuranic Waste Consolidation Facility
UCL	upper confidence limit
USGS	U.S. Geologic Survey
VOC	volatile organic compound
WCRR	Waste Characterization, Reduction, and Repackaging Facility
WETF	Weapons Engineering Tritium Facility
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}

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

APPENDIX B
NONRADIOLOGICAL AIR QUALITY

APPENDIX B
NONRADIOLOGICAL AIR QUALITY

B.1 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 toxic chemical emissions.

B.1.1 Assumptions, Data Sources, Standards, and Models

B.1.1.1 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.

Toxic Air Pollutants

Chemicals are currently used at LANL in separately located groups of operations or laboratory complexes called "technical areas" (TAs) that each comprise large geographic areas. Toxic 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)*, 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	50 [c] 150 [c]
$PM_{2.5}$	Annual 24 hours	15 [c] 65 [c]
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.
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 (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 and annual arithmetic PM_{10} mean standards are 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 50 (National Ambient Air Quality Standards).

For the purpose of this SWEIS, the estimated toxic 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 or 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. LANL has not been required to obtain any permits specifically for toxic air pollutant emissions, and therefore there is no requirement to monitor for toxic air pollutants. Additionally, in the Title V operating permit application, LANL requested voluntary facility-wide limits on hazardous air pollutants to keep LANL below the major source threshold for hazardous air pollutants. 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 2004 (LANL 2005). 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 one 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.

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.

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.1.1.2 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 toxic 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 toxic 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.

Toxic 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 toxic 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.1.1.3 Air Quality Dispersion

Models

The EPA's Industrial Source Complex Air Quality Dispersion Model (ISCST3) was used for both the criteria and toxic 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.1.2 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,

[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.*

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.1.2.1 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–2**. 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.1.2.2 Results of Criteria Pollutant Analysis

The results of the analysis of criteria pollutants from LANL's combustion sources are presented in Chapter 5, Table 5–5 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.

B.1.3 Toxic Air Pollutants – General Approach

Unlike a production facility with well-defined operational processes and schedules, LANL is a research and development facility that has great fluctuations in both the types of chemicals emitted and their emission rates. Because LANL's toxic air pollutant emission rates are relatively low (compared to releases from production facilities), vary greatly, are released from hundreds of sources spread over a large geographic area, and are well below the state's permitting threshold limits, toxic air pollutant emissions are not monitored.

Table B–2 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.

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 toxic 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 toxic 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 toxic 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 toxic 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.1.3.1 Toxic Pollutants – Methodology for Individual Pollutants

Screening Level Analysis

The following sections provide more detail on the methodology used for screening and detailed analysis for toxic air pollutants in the *1999 SWEIS* (DOE 1999).

Once screening level emission values (both short-term and long-term) were established for each of the toxic 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.1.3.2 Toxic 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 toxic air pollutants, 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 excess latent cancer fatalities for beryllium under the Expanded Operations Alternative in the *1999 SWEIS* was estimated to be one chance in 2.7 million (3.6×10^{-7}) per year (DOE 1999).

B.1.3.3 Toxic 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 in comparison 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.1.3.4 Toxic 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 were 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.2 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 National Laboratory, 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 to 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), 2005, *SWEIS Yearbook – 2004, Comparison of 2004 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, DOE/EIS-0238, LA-UR-05-6627, Ecology Group, Los Alamos, New Mexico, August.

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 on radiation and its effects on human health. It also describes 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 (for example, ground and surface water, game animals) in and around the LANL environs. It also presents background information on effects from exposure to radiation, biological agents, and hazardous chemicals on human health. The methods used to assess impacts and the impacts themselves from other projects that may be implemented at LANL are addressed elsewhere in this SWEIS (see Appendices G, H and I and Chapter 5).

Releases to ambient air is the focus in these analyses because they are projected to dominate possible exposures to the public associated with 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 National Emission Standards for Hazardous Air Pollutants. However, past releases have resulted in some radiological and chemical contamination in several environmental media, and impacts from this contamination are addressed herein. 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 topics of interest to the general public. For this reason, this appendix places emphasis on the consequences of exposure to radiation, provides the reader with information on the nature of radiation, and explains the basic concepts used in the evaluation of 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), with 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. The term "ionizing radiation" refers to the fact that the charged particle or gamma ray can strip or displace electrons 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 is one 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 the room's 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.

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

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 skin's surface.

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 measure. Therefore, a variety of units were used to measure radiation. These units were used to determine 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.

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

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 of 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.

Rad—The rad is the unit of measurement for 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 an amount of 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 in measuring the effects of radiation on the body as degrees centigrade are used in measuring 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 measure in the International System of Units are: becquerel (a measure of source intensity [activity]), gray (a measure of absorbed dose), and sievert (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 350 and 500 millirem, depending on where they live (LANL 2004c). 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. These particles and the secondary particles and photons they create comprise cosmic radiation. 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 2004c).

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 2004c).

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.

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 +

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.

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 several different pathways, all having in common the fact that the radiation causing 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 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 quantity that takes these different susceptibilities into account is called the committed effective dose equivalent, and it provides a broad indicator of the 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 and sets 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 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 61 (EPA)	10 millirem per year (all air pathways)	Not applicable
40 CFR 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 is a limit (or level) that is enforced by DOE, worker doses must be managed in accordance with as low as reasonably achievable 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 as low as reasonably achievable levels. (DOE 1999b)

[b] Derived from 40 CFR 61, 40 CFR 141, and 10 CFR 20.

C.1.2 Health Effects

Radiation exposure and its consequences are topics of interest to the general public. To provide the background for discussions of impacts, this section explains the basic concepts used in the evaluation of 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 UNSCEAR and International Commission on Radiological Protection reports. However, the report 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 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.

[1] *Low dose is defined as the dose level where 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).*

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 2003.
[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 2003.

The 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 of 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* (ISCORS 2002). 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. However, for situations in which a radiation risk assessment is required for making risk management decisions, the radionuclide-specific risk coefficients in Federal Guidance Report No. 13 should be used.

However, 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. The 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] (ISCORS 2002).

The ISCORS report notes that the recommended risk coefficients used with TEDE dose estimates generally produce conservative radiation risk estimates (they overestimate risk). For the ingestion pathway of 11 radionuclides compared, risks would be overestimated compared to

[2] *Such estimates should not be stated with more than 1 significant digit.*

the Federal Radiation Guidance Report No. 13 values 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 multiplying the conversion factor approach to Federal Radiation Guidance Report No. 13 for the inhalation pathway and found a bias toward overestimation of 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 uptake portions of dose or risk modeling and, therefore, the approach recommended is fully acceptable for comparative assessments. That notwithstanding, it is recommended that, wherever possible, the more rigorous approach with Federal Radiation Guidance Report No. 13 cancer risk coefficients be used (DOE 2003).

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 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 (time between exposure to carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers 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 six additional cancer fatalities from the radiation (10,000 person-rem times 0.0006 lifetime probability of cancer fatalities per person-rem = six 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 one, 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). The 0.06 means that there is 1 chance in 16.6 that the exposed population would experience one fatal cancer. In other words, the 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, one cancer fatality would result; in exceptionally few groups, two 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 has a large involvement in nuclear science and its applications. Therefore, there are many types of radioactive materials and radiation sources in use at LANL. However, many of the uses require only very small amounts of material. Note that all radioactive materials are considered in this new SWEIS; but, there are three radionuclides that tend to dominate the human health effects at LANL. This is 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 with radioactive half-lives ranging from tens to thousands of years. Due to its long half-life, once an isotope of plutonium is absorbed into the body, it tends to stay for a very long time and deposits a lot of localized energy.

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-235 and -234. 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 has been 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, and as a result, uranium is generally of lower radiological concern than plutonium. However, its actual radiological concern varies with its enrichment. As a heavy metal, uranium also can be chemically toxic to the kidneys. Depending upon 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 where 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 the water molecule, forming tritiated water. In the environment, tritium is most often found either 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, being easily displaced with regular water and with 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 were performed at LANL for members of the general public 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 that is modeled as having the greatest dose to a hypothetical public individual from all modeled emissions.

- *LANL Site-Wide MEI*—The LANL MEI represents the location of the single highest modeled dose to 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:

- Pajarito Site (TA-18) was removed from the LANL Key Facility list in both the Reduced and Expanded Operations Alternatives of this SWEIS (see Section 3.1.3.9). Because the normal operational releases will still be applicable for the No Action Alternative at Pajarito Site, a dose assessment was performed for this SWEIS.

- TA-21 (Tritium Facility) was removed from the LANL Key Facility 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 TA-21 in this SWEIS.

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 not modeled. It was anticipated that the replacement Radioactive Liquid Waste Treatment Facility would also have minimal radiological air emissions and therefore would not be modeled in this SWEIS (Appendix G).

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
TA-15 and TA-36	High Explosives Testing (Firing Sites)
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)	Tritium Facility [a]

[a] These facilities include the Weapons Engineering Tritium Facility (TA-16). The Tritium Science and Fabrication Facility and the Tritium Systems Test Assembly (TA-21) continue to produce emissions while awaiting decommissioning and decontamination 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.

C.1.3.2 CAP-88 Model

The Clean Air Act Assessment Package – 1988 (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 (CAP88-PC) DOS Version 1.0 used in the *1999 SWEIS* and Version 3.0 used here. These included:

- The incorporation of the new Federal Guidance Report No. 13 dose and risk factors;
- The incorporation of options to choose different chemical forms for each radionuclide;

- The addition of pathways, such as drinking water ingestion and external exposure from multiple depths of soil contamination;
- The ability to account for the effect of humidity; and
- The addition of more than 800 isotopes, consistent with those in Federal Guidance Report No. 13.

C.1.3.3 Model Input Parameters

The CAP-88 model requires many input parameters in order 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

Potential doses to the local population from airborne radioactive emissions at each Key Facility at LANL were estimated using a 50-mile (80-kilometer) radius centered on the facility whose emissions were being analyzed. This methodology allowed for consistency with the accident analysis results.

The Sector Population, Land Fraction, and Economic Estimation Program (SECPOP 2002, NRC 2003) was used to create population distribution files that were then configured to work as data input files for CAP-88. 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.

In its population files, CAP-88 uses edgepoints for each sector, entered in the population file in kilometers. The edgepoints used for CAP-88 were consistent with those used for the accident analyses (1, 2, 3, 4, 5, 10, 20, 30, 40, 50 miles). Each CAP-88 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 Section 5.6, Human Health). 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 parcels near White Rock (LANL 2006). 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. TA-3-29 (Chemistry and Metallurgy Research [CMR] Building) and TA-3-66 (Sigma Complex) share the same MEI location, as do TA-48 (Radiochemistry Facility) and TA-55 (Plutonium Facility Complex).

Meteorological Data

There are six towers and that gather meteorological data. Four of the towers are located on mesa tops and are used with the CAP-88 model to estimate air dispersion of emitted nuclides. The data used for each tower was the 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 Facilities***
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 CAP-88 is listed below. Previous versions of CAP-88 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 CAP-88)

Stack Parameters

The height and diameter measurements of monitored stacks were taken from the 2003 LANL Radionuclide Air Emissions Report (LANL 2004b). The same exit velocities for those stacks were used as in the *1999 SWEIS*. The parameters used for unmonitored stacks were obtained from LANL (LANL 2006). Stack parameters are listed in **Tables C–4** through **C–15.**

Agricultural Data

Radionuclides emitted to the air and subsequently ingested through food crops is one pathway of exposure used by CAP-88. CAP-88 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 CAP-88 was the rural setting.

Table C–4 Radiological Air Emissions (curies per year) from Technical Area 3-29 (Chemistry and Metallurgy Research Building) [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	Same as No Action	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] Due to the start of the CMR Replacement project there will be no emissions from the CMR Building after approximately 2014. The actinide processes and resulting emissions will 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 remained 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 Technical Area 3-66 (Sigma Complex)

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 Technical Area 3-102 (Machine Shops)

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 Technical Area 11 (High Explosives Processing)

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 Technical Area 15 and Technical Area 36 (High Explosives Testing) [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 Technical Area 16 (Tritium Facility)

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 Technical Area 18 (Pajarito Site)

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 move to another DOE site and all nuclear materials would be removed from TA-18 in 2009 resulting in 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 Technical Area 48 (Radiochemistry Facility)

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] The 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] The 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 Technical Area 53 (Los Alamos Neutron Science Center) [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)	4060	0	4,060
Nitrogen-13	200	0	200
Oxygen-15	50	0	50
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 Technical Area 54 (Waste Management Operations)

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 Technical Area 55 (Plutonium Facility Complex)

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*	*Reduced Operations*	*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] Under expanded operations, the decontamination and demolition of TA-21 would be completed by 2009 resulting in no radiological air emissions from that point forward.

[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.

Emissions Data

For this SWEIS, all actual emissions from 1999 through 2004 (LANL 2000, 2001, 2002a, 2003a, 2004b, 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 CAP-88 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, the Los Alamos Neutron Science Center (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 comprised the majority of the particulate and vapor form emissions (LANL 2004b). Tritium can be released in different forms at each facility where present, either as tritium oxide (vapor), or as elemental tritium (gas). Area G at TA-54, for instance, is a known source of diffuse emissions of tritium vapor (LANL 2004b). 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 CMR 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 are higher than what 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 CAP-88 Version 3.0. Impacts from these radionuclides would be minimal due to their extremely short half-lives and small inventory amounts. All of those radionuclides omitted from the dose assessment have half-lives of less than 2 minutes. Chlorine-39, whose portion of the LANSCE air emissions was negligible (less than 0.01 percent per year), was also omitted from the dose assessment.

C.1.3.4 Results of Analyses

The sequence of analyses performed to generate the radiological impact estimates from normal operations include 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).

This analysis is designed to ensure—through judicious selection of release scenarios, models, and parameters—that the results represent the potential risks. This is accomplished by making conservative assumptions in the calculations at each step. The models, parameters, and release scenarios used in the calculations are selected in such a way that most intermediate results and, consequently, the final estimates of impacts, are 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 results that are conservative in order to capture any uncertainties in normal operations.

Maximally Exposed Individual

The facility-specific MEI represents a location near a facility that is 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 and the type and amount of radiological air emissions from the Key Facility. For the purposes of this analysis, the very conservative assumption was made 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 the 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.

LANL site-wide MEI dose impacts (see Tables C-17 through C-19) include the change in location of the actinide processes at CMR Building to the new CMR 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 CMR Building and the addition of the dose from operations at CMR Replacement Facility). These impacts to the MEI were minimal. 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 for the Expanded Operations Alternative. The regulatory limit of 10 millirem per year (40 *Code of Federal Regulations* [CFR] 61.92) to a member of the public would therefore 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 (see Section 5.6, Human Health Impacts)

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	0.18	0.46
Machine Shops	0.37	0.12	0.37
High Explosives Processing	0.38	0.12	0.38
High Explosives Testing	2.9	0.79	2.9
Tritium Facility	0.32	0.10	0.32
Pajarito Site [d]	2.9	0.79	2.9
Radiochemistry Facility and Plutonium Facility Complex [e]	0.78	0.24	0.78
Los Alamos Neutron Science Center [f]	14	0.25	14
Waste Management Operations	1.2	0.34	1.2
Non-Key Facility (TA-21) [g]	1.9	0.30	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] CMR Building and Sigma Complex had the same MEI location.
[d] Under the Reduced and Expanded Operations Alternatives, Pajarito Site would not be operational after 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] Tritium Facility (TA-21) would not be contributing to the dose after 2009 due to decontamination and demolition.

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	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	0.00000118	0.00000127	0.0000212	0.00000230	0.00000736	0.00000212	0.00000281	0.00000134	0.00000109	0.00000142
High Explosives Testing	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	0.268	0.240	0.241	1.88	0.209	1.97	0.515	13.3 [a]	0.809	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
Non-Key (TA-21)	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**	**13.55 [b]**	**1.21**	**1.93**

CMR = Chemistry and Metallurgy Research Building, 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 resulting in a LANL Site-Wide MEI dose of 7.8 millirem.

[b] After approximately 2014, actinide emissions will move from CMR to the CMR Replacement Facility near TA-55. The resulting dose will have minimal impact (an additional 0.0023 millirem) 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	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	0.000000947	0.00000102	0.0000169	0.00000184	0.00000589	0.00000169	0.00000225	0.00000107	0.000000872	0.00000114
High Explosives Testing	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
Non-Key (TA-21)	0.00266	0.00252	0.00242	0.00705	0.00209	0.00478	0.00374	0.0115	0.00277	0.0223
Total (millirem per year)	**0.18**	**0.12**	**0.12**	**0.787** [b]	**0.10**	**0.786**	**0.24**	**0.25**	**0.34**	**0.30**

CMR = Chemistry and Metallurgy Research Building, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.
[a] Pajarito Site would not be operational after 2009 under this alternative and will not be producing emissions. These values are applicable for the first few years.
[b] After approximately 2014, actinide emissions will move from CMR to the CMR Replacement Facility near TA-55. The resulting dose will have minimal impact (an additional 0.018 millirem) on the LANL MEI dose at TA-36.

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	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	0.00000118	0.00000127	0.0000212	0.00000230	0.00000736	0.00000212	0.00000281	0.00000134	0.00000109	0.00000142
High Explosives Testing	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	0.268	0.240	0.241	1.88	0.209	1.97	0.515	13.3 [b]	0.809	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
Non-Key (TA-21) [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**	**13.55** [c]	**1.21**	**1.93**

CMR = Chemistry and Metallurgy Research Building, MEI = maximally exposed individual, TA = technical area, LANSCE = Los Alamos Neutron Science Center.

[a] TA-18 and TA-21 are expected to be decommissioned, decontaminated and demolished by 2009 under this alternative and will not be producing emissions at 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 resulting in a LANL Site-Wide MEI dose of 7.8 millirem.

[c] After approximately 2014, actinide emissions will move from CMR to the CMR Replacement Facility near TA-55. The resulting dose will have minimal impact (an additional 0.0023 millirem) 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 Firing Sites and the LANSCE in both the No Action and the Expanded Operations alternatives. Under the Reduced Operations Alternative, the LANSCE would not be operating and therefore 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	0.43	0.43
Sigma Complex	0.16	0.16	0.16
Machine Shops	0.01	0.01	0.01
High Explosives Processing	0.00005	0.00004	0.00005
High Explosives Testing	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 Facility Complex	0.19	0.19	0.20
Non-Key Facility (TA-21)	0.09	0.09	0.09 [b]
Total Dose (person-rem per year)	**30**	**6.4**	**30**

TA = technical area.

[a] Due to the start of the CMR Replacement project there will be no emissions from the CMR Building after approximately 2014. The actinide processes and resulting emissions will move to a new facility near TA-55 and the wing 9 processes would move to the Radiological Sciences Institute. There is a no population dose impact from this move.

[b] TA-18 and TA-21 are expected to be decommissioned, decontaminated and demolished by 2009 under these alternatives and would not be producing emissions at that time. These values are applicable for the first few years.

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 not found to be significant contributors to risk. Recent environmental surveillance results and other reports on conditions following the 2000 Cerro Grande fire indicate that diet, land use and cultural practices remain largely unchanged from conditions noted in the 1999 SWEIS analysis, and that ingestion continues to be the only significant pathway, besides inhalation, 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 were therefore evaluated for three receptors and ingestion exposure scenarios. 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 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 was also 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 the groundwater and the above-listed foods, plus inadvertent ingestion of sediments and soil. 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 the 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 [8.8 kilograms] of fruits and vegetables, 1.2 pounds [2.6 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 "Special Pathways".

- **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, soils and sediments at concentrations typical of the canyons. 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 *in addition to* those depicted by the Offsite Resident and Special Pathways.

- **Special Pathways – 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." 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 herbal teas. In general, these intakes can be assumed to be *in addition to* the meat, milk, produce, water and sediment consumption reflected in the "offsite resident" pathway assumption. Consumption of all components of the Offsite Resident diet at the high intake rates, plus three additional components (bottom feeder fish, herbal teas, organ meats), will approximate a complete subsistence diet for someone living in vicinity of LANL.

Concentrations of radionuclides and chemicals in environmental media reported in LANL Environmental Surveillance reports for 2001 through 2004 (LANL 2002b, 2004d, 2004c, 2005b) were used in the dose and risk analysis except where noted in the table (see Tables C–22 through C–38). For each environmental medium, the mean and 95 percent upper confidence limit 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 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 Navajo 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^{th} percentile 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 in developing 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, 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 format 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 being below the detection limit.

Based on 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 will account for essentially all of ingestion exposure to nonradioactive contaminants. Accordingly, only those five pathway components were analyzed for contribution to nonradiological risk. **Table C–21** summarizes the ingestion exposure pathway components that were evaluated for each receptor.

Table C–21 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 have intake of various foodstuffs, water, soil and sediments with concentrations of contaminants at the 95 percentile 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 on-site locations.

The consumption rate of each component of the ingestion pathway was assumed to equal the average adult daily intake published in the EPA *Exposure Factors Handbook* (EPA 1997) except where noted in the table (see Tables C–22 through C–38). If the handbook did not provide consumption rates applicable to the foodstuffs in question, estimates used in the *1999 SWEIS* ingestion pathway analyses were used. The average adult daily intake of each foodstuff is defined as the 50th percentile. The "high" daily consumer is defined as the 95th 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 doses for both intake rates are reported in the notes following the dose calculation tables for the various components of the ingestions pathway. For chemicals, the health hazard index and cancer risk were calculated using the most current Reference Doses and Slope Factors published by the Environmental Protection Agency Region 6 (EPA 2004).

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–22** through **C–38**. Except where noted, all intake rates are in grams dry weight per year. The total dose from all pathway components is presented in **Table C–39**.

Table C–22 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 (8.2 grams per kilogram-day) a dry to wet weight ratio of 0.15. 71.8-kilogram adult (365 days per year) = 32,200 grams dry weight per year. 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 (DOE 1999a). 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.

Table C–23 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 (LANL data used in *1999 SWEIS*) × 71.8 kilogram adult × 365 days per year = 14,900 grams dry weight per year. Concentration values are from 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 (DOE 1999a). Thus, dose at high intake is (5.1/2.1) × 0.000256 or 0.000622 rem per year.

Table C–24 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 x 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. Worst case intake is 0.8 liters per day (DOE 1999a). Thus, dose at high intake is (0.8/0.3) × 0.000284 or 0.000757 rem per year. To convert liters to gallons, multiply by 0.26418.

Table C–25 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

Note: Average annual intake is 20.1 grams per day (5.15 grams per day dry weight × 365 days = 1,880 grams per year). Worst case 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. 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–26 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 (from *1999 SWEIS* Table D.3.3-29) times 0.255 dry to wet ratio (LANL data used in *1999 SWEIS*) times 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. Worst case intake is 63 grams per day (DOE 1999a). Thus, dose at high intake is 63/26 × 0.0000212 or 0.0000514 rem per year. To convert grams to ounces, multiply by 0.035274.

Table C–27 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 (LANL data used in *1999 SWEIS*) times 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–28 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		–	–	6.44×10^{-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. Worst case intake is 13.7 grams per day or 3,528 milliliters per year. Thus, dose at high intake is $13.7/3.84 \times 6.44 \times 10^{-6}$ 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* (DOE 1999a) 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. To convert grams to ounces, multiply by 0.035274.

Table C–29 Dose from the Consumption of Piñon 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 (from *Nutrition Facts*, accessed at http://www.nutritiondata.com/facts-001-02s02f2.html). 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–30 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 worst case 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). (*1999 SWEIS* [DOE 1999a] reported 0.00234 rem per year for off-site Los Alamos County resident from this source and pathway). To convert grams to ounces, multiply by 0.035274.

Table C–31 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. Worst case intake is 146 grams per year. Thus, dose at worst case 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). (*1999 SWEIS* [DOE 1999a] reported 0.000313 rem per year for off-site resident from this source and pathway). To convert grams to ounces, multiply by 0.035274.

Table C–32 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. Worst case intake is 146 grams per year. Thus, dose at worst case 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). (*1999 SWEIS* [DOE 1999a] reported 0.00262 rem per year for off-site resident from this source and pathway). To convert grams to ounces, multiply by 0.035274.

Table C–33 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). (*1999 SWEIS* [DOE 1999a] reported 0.000740 rem per year for "resident recreational user" from this source and pathway). To convert grams to ounces, multiply by 0.035274.

Table C–34 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		–	–	1.09×10^{-6}

Notes: Average intake is 1.07 grams per year. High intake is 4.27 grams per year. Thus, dose at high intake is $(4.27/1.07) \times 1.09 \times 10^{-6}$ 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). (*1999 SWEIS* [DOE 1999a] reported 0.0000125 rem per year "resident recreational user" from this source and pathway).

Table C–35 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		–	–	8.91×10^{-6}

Notes: Average intake is 1.07 grams per year. High intake is 4.27 grams per year. Thus, dose at high intake is $(4.27/1.07) \times 8.91 \times 10^{-6}$ or 0.0000356 rem per year. Calculated using 2001-2004 composite data (95 percent upper confidence limit) for onsite stations (see Appendix F). (*1999 SWEIS* [DOE 1999a] reported 0.000176 rem per year for "resident recreational user" from this source and pathway).

Table C–36 Dose to the Special Pathways Receptor from the Consumption of Fish

Exposure Pathway: Fish Ingestion (Subsistence Consumption)				
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). Worst case 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.
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 x 0.40 picocuries per milliliter × 1 milliliter per gram water = 1.163 picocuries per gram dry weight.

Table C–37 Dose to the Special Pathways Receptor from the Consumption of Elk Heart and Liver

Exposure Pathway: Elk Ingestion (Native American/Traditional)				
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		–	–	7.01×10^{-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 – LANL data used in *1999 SWEIS*). Average liver intake is based on 5.6 pounds per year for an individual × 454 grams per pound × 0.30 (wet to dry ratio – LANL data used in *1999 SWEIS*). The *1999 SWEIS* (DOE 1999a) reported 0.0000343 rem per year from this source and pathway (no new data was found – same data and consumption rates were used here as for *1999 SWEIS*).

Table C–38 Dose to the Special Pathways Receptor from the Consumption of Indian Tea (Cota)

Exposure Pathway: Indian Tea (Cota) Ingestion (Subsistence Consumption)				
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* (DOE 1999a) reported 0.000749 rem per year (average intake) from this source and pathway.

Table C–39 Summary of Ingestion Pathway Doses for Offsite Resident, Recreational User, and Special Pathways Receptors

Exposure Pathway	*Dose to Receptor (rem per year)*		
	Offsite Resident	***Recreational User***	***Special Pathways***
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}
Piñon 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	–	1.09×10^{-6}	1.09×10^{-6}
Sediment	–	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

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 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 3 in one 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–22 through C–38). The total doses to each receptor as a result of the 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 receptors should be viewed against the dose of about 425 millirem (dose ranges from 350 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 pathway, the 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, Human Health).

As shown in Table C–39, the highest estimated ingestion pathway dose to any offsite resident 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 this particular offsite resident were also to receive the maximum impact from projected future radionuclide LANL emissions to the atmosphere (see Tables C-18 and C-19), that particular resident 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 Expanded Operations Alternative. The fatal cancer risk associated with these doses ranges from about 3 in one million to 7 in one million. To place these doses in perspective, that same individual would be expected to receive an annual dose from background sources of about 360 millirem and another 50 millirem as a result of medical and dental procedures. In addition, these are conservatively calculated doses, since no one person would actually consume at such a large concentration from each pathway component. These large concentrations are found at scattered locations around 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 as compared to the 1991 through 1996 data used in the *1999 SWEIS* calculations.

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 amount or rate at which the substance 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. However, substances that accumulate in the body over time 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 route, 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 and following a short, severe course of symptoms) are seldom observed. However, elevated levels of some contaminants in air, water, soil and other environmental media 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’s Integrated Risk Information System database (EPA 2005). 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 2005). If the hazard index thus calculated 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, soil and sediment are used here to calculate the health risk 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 in 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

For purposes of estimating human health impacts to the public, only contaminants that could be ingested by the postulated receptors are 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, the 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 felt 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 U.S. is in 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. The LANL Environmental Surveillance program results (LANL 2005b) indicate that a possible source for these contaminants is effluent from a local sewage treatment plant. Also some past effluent discharges from the Radioactive Liquid Waste Treatment Facility contained high levels of nitrates (LANL 2004d).

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, semi-volatile 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 and were therefore not included in the group of compounds contributing to risk from groundwater consumption.

High-explosive compounds were also not found in statistically significant quantities in the water supply wells. However, they have been found in other regional aquifer wells and are a known contaminant in surface waters and sediments. As a result any sample results containing high-explosive compounds reported for supply wells 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 supported by neither previous data nor process knowledge at the sample locations. Subsequent examination of the data revealed that some glassware used in the process was only rinsed, with no 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–40 shows the contribution to health risk to the Offsite Resident receptor from ingestion of trace metals, nitrates, perchlorate and organic compounds in groundwater. 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 for 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 in response only 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.

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. However, nearly every major watershed shows indications of some effect from LANL operations, often for just a few analytes.

Table C–40 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	0.07		0.0547	0.0886		
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	0.0001		0.604	0.978		
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(2ethylehexyl)pathallate	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}
Heptaclor 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) × 1/71.8 kg (Body Weight). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

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 environmental surveillance program 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 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 two-mile 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. Review of sediment data from the drainage does 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–41 and **C–42** 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–43** 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 (occur at less than 1,000 micrograms per gram in soil) and 3 light and heavy abundant elements (occur at 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 on-site areas had barium, beryllium, mercury, or lead concentrations above the regional statistical reporting limits and these concentrations were far below the screening action levels.

Comparing the means of these elements in soils collected from perimeter and on-site areas with those from regional areas, shows that the concentrations of beryllium, mercury, and lead in soils collected from on-site areas were significantly higher than concentrations from regional soils. Although beryllium, mercury, and lead concentrations in soils from on-site areas were statistically higher than regional soils, the differences were very small.

Tables C–44 and **C–45** shows the contribution to health risk to the Offsite Resident and the Recreational User receptors from the ingestion of trace metals in surface soil.

Table C–41 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	0.07		0.00952	0.0154		
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}	0.0001		0.0342	0.0553		
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		
Zinc	862	0.000176	0.000284	0.3		0.00586	0.000948		

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	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(2ethylehexyl)pathallate	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) × 1/71.8 kg (Body Weight). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–42 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	0.07		0.000142	0.000568		
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)fluroanthene	982	0.0000401	0.000160		0.73			0.0000293	0.000117
Bis(2-ethyhexyl)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) × 1/71.8 kg (Body Weight). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–43 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	0.07		0.00737	0.0295		
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-ethyhexyl)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) × 1/71.8 kg (Body Weight). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–44 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	0.07		0.00327	0.0131		
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) × 1/71.8 kg (Body Weight). 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 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	0.07		0.000107	0.000429		
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) × 1/71.8 kg (Body Weight). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

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, piñon 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, have a history of use at LANL, and have been detected in significantly higher concentrations in soils. Of the five metals analyzed in produce collected from perimeter and on-site areas, only three (barium, lead, and selenium) were found above their limits of detection; beryllium and mercury were below the limits of detection. Of the three elements that were above the limit of detection, all were within regional statistical reporting limits. As a group, the levels of all the metal elements analyzed in produce from all perimeter and on-site areas were not significantly higher than in produce collected from regional areas. Of special note is that beryllium and lead, which were significantly higher in soils collected in perimeter and on-site areas, were not significantly higher in produce collected from perimeter or on-site areas than in produce collected from around the region.

Monitoring results reported in 2002 (LANL 2004d) 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 in soil samples collected from these same sites in 2000 and 2002 were not significantly higher than selenium concentrations 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 2004c). Perchlorates are use 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 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 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. Also it was 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 between the two stations above LANL and the station immediately below LANL. This same conclusion has been 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 the 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 statistically similar to 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–46 and **C–47** show the contributions to health risk to the Offsite Resident from the ingestion of trace metals in produce and predator fish. **Table C–48** shows the contribution to health risk to the Special Pathways receptor from ingestion of trace metals in non-predator (bottom feeding) fish.

Table C–46 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 Wt*	*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	0.07		0.525	1.63		
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) × 1/71.8 kg (Body Weight). Shaded cells in Slope Factor and Cancer Risk columns indicate no known human chemical cancer risk.

Table C–47 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	0.07		0.00215	0.00565		
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) × 1/71.8 kg (Body Weight). 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 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	0.07		0.0168	0.0407		
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) × 1/71.8 kg (Body Weight). 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 that are focused on advancing environmental and biomedical knowledge, and supporting not only the DOE mission but also the national bio-defense mission. The current biological research shows a range of topics to include, but are not limited to, genomic (or genetic) and proteomic (that is, the study of the 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 via the technology found in 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; these include bacteria, viruses, and fungi. Bacteria are single celled organisms that can multiply rapidly and can 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 are dependent 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, with a small number of these organisms capable of causing disease in humans.

C.3.2 Principles of Biosafety

All laboratories within the U.S., including LANL, follow a specific set of guidelines for all laboratory practices 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 in describing safe methods for 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 (Richmond and McKinney 1999).

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 (Richmond and McKinney 1999).

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, 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 to 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 (Richmond and McKinney 1999).

C.3.2.2 Facility Design and Construction (Secondary Barriers)

The design and construction of the facility contributes to the 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 become 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 as laboratory entrances, or separate buildings or modules to isolate the laboratory. Design engineers for laboratories may refer to specific ventilation recommendations as found in the Applications Handbook for Heating, Ventilation, and Air-Conditioning published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (Richmond and McKinney 1999).

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 (Richmond and

McKinney 1999). 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 discussion of Biosafety Levels in Section C.3.3) facilities as discussed in Section 3.1.3.11 of this SWEIS. 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. Biosafety Level 1 material at LANL, if released into the environment, 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. Laboratory personnel are still subject to non-biological hazards that are associated with all workplaces and subject to Occupational Safety and Health Administration regulations.

C.3.3 Biosafety Levels

There are four biosafety levels that consist of 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 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, antibiotic resistance patterns, vaccine and treatment availability, or other factors are significantly altered, more (or less) stringent practices may be specified (Richmond and McKinney 1999).

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, and for other laboratories in which work is performed with defined and characterized strains of viable microorganisms 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 are representative of microorganisms meeting 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 (Richmond and McKinney 1999).

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, the 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 or 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 (Richmond and McKinney 1999).

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 which 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 (Richmond and McKinney 1999). The Biosafety Level 3 work being proposed for LANL is being addressed in a separate environmental impact statement and 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 for work with dangerous and exotic agents that pose a high individual risk of life-threatening disease, which may be transmitted via the aerosol route and for which there is 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 (Richmond and McKinney 1999). No Biosafety Level 4 work is currently performed or proposed to be performed at LANL. **Table C–49** delineates containment design practices and levels of biological agents for each Biosafety Level Facility.

Table C–49 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, mucous membrane exposure	Biosafety Level 1 practices plus: - Limited access - Biohazard warning signs - "Sharps" precautions - 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; 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 - 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; respiratory protection as needed	Biosafety Level 2 plus: - Physical separation from access corridors - Self-closing, double-door access - Exhausted air not recirculated - 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 - 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 - Other requirements outlined in Section C.3.3.3

Source: HHS Publication 1999.

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 for the 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, with the more specific assays taking 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 be able to protect the public from a biological attack.

C.3.5 Select Biological Agents

Select agents are specifically regulated pathogens and toxins as defined in Title 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 U.S. in the form of biological warfare; therefore they are a risk to national security.   These select agents are of 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
- 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 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 can also be described by whether or not they just cause infection in the person that had contact with that organism (infectious) or if it the infection can be 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, which are delineated 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 is 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, Life Time 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.

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 Reduction 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 Reduction and Indoor Air, Washington, DC, August.

EPA (U.S. Environmental Protection Agency), 2004, *Region 6 Human Health Medium-Specific Screening Levels 2004-2005*, EPA Region 6, Dallas, TX, Accessed at *http://www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm*, November.

EPA (U.S. Environmental Protection Agency), 2005, *Integrated Risk Information System, List of IRIS Substances,* Available at http://www.epa.gov/IRIS.

HHS (U.S. Department of Health and Human Services), 1999, *Biosafety in Microbiological and Biomedical Laboratories*, Centers for Disease Control and Prevention and National Institutes of Health, HHS Publication No. CDC 99-0292M, Fourth Edition, May.

ICRP (International Commission on Radiological Protection), 1991, *1990 Recommendations of the International Committee on Radiological Protection*, Annals of the ICRP, ICRP Publication 60, Vol. 21, No. 1-3, Pergamon Press, New York, New York, November.

ISCORS, 2002, *ISCORS Technical Report, No. 1, A Method for Estimating Radiation Risk from TEDE*, Interagency Steering Committee on Radiation Standards, July.

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 Report*, 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, August.

LANL (Los Alamos National Laboratory), 2004a, *Air-Sampling Data from Area G: A Radioactive-Waste Management Site*, LA-14090, Los Alamos National Laboratory Report, January.

LANL (Los Alamos National Laboratory), 2004b, *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), 2004c, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004d, *Environmental Surveillance at Los Alamos during 2002*, LA-14085-ENV, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2005a, *LANL Radionuclide Air Emissions Report,* LA-14233, 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), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

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*, retrieved February 28, 2006 from http://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, Pergamon Press, Elmsford, New York, 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.

Nutrition Data, 2006, Nutritional Summary for Nuts, pine nuts piñon, and dried, accessed through http:/www.nutritiondata.com/facts-001-02s02f2.html.

Olsen, Christopher, University of Wisconsin, School of Veterinary Medicine, 2000, retrieved February 28, 2006 from http://www.vetmed.wisc.edu/pbs/zoonoses.

Richmond, Jonathan Y, Ph.D. and McKinney, Robert, Ph.D, Editors, 1999, *Biosafety in Microbiological and Biomedical Laboratories*, HHS Publication No. (CDC) (99-8395), 4th Edition, Washington, DC, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention and National Institutes of Health, Available at http://www.cdc.gov/od/ohs/biosfty/bmbl4/bmbl4toc.htm, (Accessed on November 15, 2005), May.

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 facility accident impacts presented in Chapter 5. It includes, in Section D.2, an evaluation of the present applicability of the methodology and accident data that was reported in the *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* (DOE 1999a) for the purpose of informing the reader of differences in analysis 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 is 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 through Section D.5 center on the general population and specific bounding individuals (the noninvolved worker and the maximally exposed individual). Section D.6 discusses the impacts to the worker directly involved in the operation being analyzed, that is, the involved worker. Section D.7 considers impacts on individuals at arbitrary 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.

It is not possible to predict whether intentional attacks would occur at LANL or at other critical facilities, or the nature of the types of attacks that might be made. Nevertheless, the National Nuclear Security Administration (NNSA) reevaluated scenarios involving malevolent, terrorist, or intentionally destructive acts at LANL in an effort to assess potential vulnerabilities and identify improvements to security procedures and response measures in the aftermath of the attacks of September 11, 2001. Security at NNSA and the U.S. Department of Energy (DOE) facilities is a critical priority for the Department, and it continues to identify and implement measures designed to defend against and deter attacks at its facilities. Substantive details of terrorist attack scenarios and security countermeasures are not released to the public, since disclosure of this information could be exploited by terrorists to plan attacks.

D.2 Data and Analysis Changes from the *1999 SWEIS*

Accident scenarios are generally chosen for analysis in an environmental impact statement to demonstrate 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, or the availability of new information that could change the scenarios in the *1999 SWEIS* were incorporated. Then, new operations that have been initiated since 1999 (or that are planned to be initiated) were considered. Scenarios for these changed or new operations were chosen to demonstrate the range of possible accidents, as well as to describe bounding risks.

The differences between the *1999 SWEIS* and this SWEIS are provided in **Table D–1**. Most of the differences are the result of updated environmental (such as population and meteorology) and facility operations (facilities added, deleted or material at risk [MAR] changes) information. Additional aspects of the overall study that pertain to other environmental resource areas are addressed elsewhere in this SWEIS to the extent that they are relevant.

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 the change, if any, 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 had a dominant role in directing the course of the facility accident analyses performed for this SWEIS.

DOE identifies LANL as the highest Priority I site, which is subject to 24-month internal emergency management appraisals. DOE maintains a system of Orders, programs, guidance, and training that form the basis for maintaining, updating, and testing LANL site security to preclude and mitigate any postulated terrorist actions.

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 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. External events, earthquakes or wildfires, which could impact multiple facilities, are considered in Sections D.4 and D.5, respectively.

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 is available through 2003. Sensitivity analysis using more recent data shows 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 BIO. Now noted as RANT Outdoor Container Storage Area 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 as 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 Fire at WETF. 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	MAR decreased	Now called WCRR Outdoor Storage Area Fire. New MAR from 2003 BIO, as related in 2004 Information Document (LANL 2004).
RAD-08 TA-54, TWISP	New transuranic waste storage scenario	Replaced with Waste Storage Dome Fire. Major risk accident from DOE 2003b.
RAD-09 TA-54, TWISP	New waste storage domes scenario	Replaced with Onsite Transuranic Waste Fire Accident. Major risk accident from DOE 2003b.
RAD-10 TA-55-4, Plutonium Facility	No change	Now called Plutonium Facility Storage Container Release.
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 as part of the site-wide seismic scenarios.
RAD-14 TA-55-4, Plutonium Facility	No change	Now called Plutonium Facility Ion Column Rupture.
RAD-15 TA-3-29 CMR	New CMR scenario	See RAD02. Wing Fire now considered as part of Radiological Sciences Institute.

Topic/Issue	Scenario Notes	Evaluation
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 DOE 2003a. TA-18 source term changed based on 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 per 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.
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 since 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. All else (TA-55 sources) unchanged from *1999 SWEIS*.
SITE-03 (Chem) Site-wide Earthquake		Same scenario as Seismic 2. SITE-03 was combined with SITE-02 to create Seismic 2.
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).

Topic/Issue	***Scenario Notes***	***Evaluation***
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 either MAR moved (see RAD-05), not operating (see RAD-06), or more bounding, non-aircraft crash scenario 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 replacement facility, CMRR (preferred action). The 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 thru -05 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 DOE 2002a and risks to the public and non-involved worker shown (Table C–5 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 = Radioactive Assay and Nondestructive Test, BIO = basis of interim operation, CMR = Chemistry and Metallurgy Research Building, 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.

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).
Washout coefficient	0.000095, 0.8	0.000095, 0.8	Chanin and Young 1997. Not applicable to workers and MEI.

Parameter	***General Population***	***MEI, Workers***	***Comments***
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 MET 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 MET Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-49 MET Tower data are used	11, [15], 33, 36, 39, 49	11, [15], 33, 36, 39, 49	Closest MET Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-53 MET Tower data are used	0, [21], 46, 51, 53	0, [21], 46, 51, 53	Closest MET Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
TA releases for which TA-54 MET Tower data are used	[18], [54]	[18], [54]	Closest MET Tower to TAs. All TAs with workers listed; TAs with accident releases in *1999 SWEIS* indicated with brackets [ ].
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 MET 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	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.

Parameter	***General Population***	***MEI, Workers***	***Comments***
metcod	5	5	Stratified random samples for each day of the year (see nsmpls).
nsmpls	24	24	24 MET 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 MET 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 MET conditions below). Not applicable to workers.
Model boundary rain fall rate	23 millimeters per hour	0 millimeters per hour	Maximum hourly rate from all 2003 MET files (noted at TA-53 and 54), conservative. 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 will default 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, 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

Parameter	***General Population***	***MEI, Workers***	***Comments***
			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, 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 3.28; from miles to kilometers, multiply by 1.609.

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 due to building fire scenario is included because it represents high consequence and high risk (relative to other DVRS scenarios) impacts to the general public and workers.

Storage of sealed sources represents a potential source of radionuclides not included in the earlier *1999 SWEIS*. These radionuclides (for example cobalt-60 and cesium-137) represent external gamma radiation dose risks, 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 Chemistry and Metallurgy Research Building (CMR) impacting sealed sources, is included. The doses to individuals very close to the source (for example the noninvolved worker) include a component from direct (external) exposure to exposed source material. Appendix J further 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 an action considered in the *1999 SWEIS*. Appendix I of the current SWEIS describes proposed actions for 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 Expanded Operations Alternative in this section.

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 and, 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 the accident's consequences. Dose consequences are estimated for the maximally exposed individual (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). Impacts at locations of public access closer than the nearest site boundary are also discussed.

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: RAD01. **Scenario:** RANT Outdoor Container Storage Area Fire (TA-54-38).													
Combustible													
Spilled and expelled	Plutonium [a] Equivalent	grams	9,700	1	0.001	0.3	–	1	2.91	–	–	0	No
Burning			9,690	1	0.01	1	–	1	96.9	–	–	0	No
Contained in drum (burning)			10,600	1	0.0005	1	–	1	5.29	–	–	0	No
Noncombustible													
Spilled and expelled	Plutonium Equivalent	grams	17,500	1	0.001	0.1	–	1	1.75	–	–	0	No
Burning			17,500	1	0.006	0.01	–	1	1.05	–	–	0	No
Contained in drum (burning)			19,100	1	0	0	–	1	0	–	–	0	No
Total													
Spilled and expelled	Plutonium Equivalent	grams	–	–	–	–	–	–	4.66	1	0	0	No
Burning (high heat)			–	–	–	–	–	–	51.6	60	12	0	No
Burning (smoldering)			–	–	–	–	–	–	51.6	60	0.1	0	No
Resuspension			27,000	1	–	1	0.00004	1	25.9	1,440	0	0	No
Identifier: WETF. **Scenario:** WETF 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: RAD07. **Scenario:** WCRR Outdoor Storage Area Fire (TA-50-69).													
Fire (high heat)	Plutonium Equivalent	curies	500	0.35	0.0005	1	–	1	0.0875	60	1	0	No
Fire (smoldering)			500	0.35	0.0005	1	–	1	0.0875	60	0.1	0	No
Resuspension			1,000	0.35	–	1	0.00004	1	0.336	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 (units of MAR)*	*Release Duration (minutes)*	*Plume Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
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 Accident (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
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: RAD10. **Scenario:** Plutonium Facility Storage Container Release (TA-55-4).													
Container drop	Weapons Grade Plutonium [b]	grams	4,500	1	0.002	0.3	–	1	2.70	30	0	0	Yes
Resuspension			4,500	1	–	1	0.00004	1	4.32	1,440	0	0	Yes
Identifier: RAD14. **Scenario:** Plutonium Facility Ion Column Rupture (TA-55-4).													
Solution flashing (nitrate)	Weapons Grade Plutonium	grams	246	1	0.01	0.6	–	1	1.48	10	0	9.14	Yes
Resin bed burning (oxide)			1,000	0.1	0.01	0.9	–	1	0.9	10	0	9.14	Yes
Suspension of nitrate			244	1	–	1	0.0000004	1	0.00234	1,440	0	9.14	Yes
Suspension of oxide			999	0.1	–	0.9	0.00004	1	0.0863	1,440	0	9.14	Yes
Total													
Initial release	Weapons Grade Plutonium	grams	–	–	–	–	–	–	2.38	10	0	9.14	Yes
Suspension			–	–	–	–	–	–	0.0887	1,440	0	9.14	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: DVRS01. **Scenario:** DVRS Operational Spill (TA-54).													
	Plutonium Equivalent	curies	1,100	1	0.001	0.3	–	1	0.33	10	0	0	Yes
Identifier: DVRS05. **Scenario:** DVRS Building Fire and Spill Due to Forklift Collision (TA-54).													
	Plutonium Equivalent	curies	1,100	1	0.01	1	–	1	11.0	120	0.1	0	Yes
Identifier: SHEBA. **Scenario:** SHEBA Hydrogen Detonation (TA-18-168) No Action 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	1.00	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:** CMR 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:** Fire Impacting Sealed Source, Wing 9 at CMR Building. 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

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?
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
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

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: MDAGEXP. **Scenario:** Explosion at a Pit at MDA G Expanded Operations Only													
Explosion	Americium-241	curies	352	0.02 [c]	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 [c]	0.005	0.3	–	1	0.780	1	0	0	No
	Plutonium-239	curies	319	0.96 [c]	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
Suspension	Americium-241	curies	352	0.02 [c]	–	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 [c]	–	1	0.000004	1	0.0497	1,440	0	0	No
	Plutonium-239	curies	318	0.96 [c]	–	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 [c]	–	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, RANT = radioassay and nondestructive testing, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, 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.

[a] Plutonium Equivalent means the activity of plutonium-239 with the same radiological consequences.

[b] Weapons Grade Plutonium means a mix of plutonium isotopes representative of plutonium used in a nuclear weapon.

[c] 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.

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 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.

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 TA-54 operations (Radioactive Assay and Nondestructive Test [RANT], waste storage domes, DVRS).

The nearest public access to the CMR Building, 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 CMR. The same assumptions used to calculate dose to the MEI were applied to this individual. The dose 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 boundary location would also be 10 times the value indicated in Tables D–5 and D–6 for this scenario.

D.3.2.2 Reduced Operations Alternative

Accident impacts from the Reduced Operations Alternative are similar to those from the No Action Alternative, as given in Tables D–4 through D–6. Solution High-Energy Burst Assembly (SHEBA) operations at LANL would cease. 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 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 from the Expanded Operations Alternative, shown in **Tables D–7** through **D–9**, would be generally greater than those from the No Action Alternative. SHEBA operations at LANL would cease under the Expanded Operations Alternative; 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 management at DVRS and the waste storage domes would be moved offsite or to a new facility, the Transuranic Waste Consolidation Facility, located in TA-50 or TA-63. The impacts to the public from this new facility would be less than those of the existing facilities because of the new location and because less material would be stored, the rest being 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 facility. Accident impacts for the new facility are described in Appendix H.

Table D–4 Radiological Accident Offsite Population Consequences for the No Action Alternative

Accident Scenario	MEI		Population to 50 Miles (80 kilometers)	
	Dose (rem)	Latent Cancer Fatality [a]	Dose (person-rem)	Latent Cancer Fatalities [b, c]
RANT Outdoor Container Storage Area Fire (TA-54-38)	71.5	0.0858	3,970	2 (2.38)
WETF Fire (TA-16-205)	5.91	0.00355	187	0 (0.112)
WCRR Outdoor Storage Area Fire (TA-50-69)	1.10	0.000660	265	0 (0.159)
Waste Storage Dome Fire (TA-54)	419	0.503	4,230	3 (2.54)
Onsite Transuranic Waste Fire Accident (TA-54)	186	0.223	5,720	3 (3.43)
Plutonium Facility Storage Container Release (TA-55-4)	2.50	0.00150	372	0 (0.223)
Plutonium Facility Ion Column Rupture (TA-55-4)	1.28	0.000768	131	0 (0.0786)
DVRS Operational Spill (TA-54)	19.6	0.0118	185	0 (0.111)
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	321	0.385	6,140	4 (3.68)
SHEBA Hydrogen Detonation (TA-18-168)	0.877	0.000526	69	0 (0.0414)
CMR HEPA Filter Fire (TA-3-29)	0.770	0.000464	200	0 (0.12)

MEI = maximally exposed individual, rem = roentgen equivalent man, RANT = Radioactive Assay and Nondestructive Test, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, DVRS = Decontamination and Volume Reduction System, SHEBA = Solution High-Energy Burst Assembly, CMR = Chemistry and Metallurgy Research Building, HEPA = high-efficiency particulate air filter.

[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), 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, DVRS, Domes), 301,900 (TA-55-4).

Table D–5 Radiological Accident Onsite Worker Consequences for the No Action Alternative

Accident Scenario	*Noninvolved Worker at 110 Yards (100 meters)*	
	Dose (rem)	*Latent Cancer Fatalities* [a]
RANT Outdoor Container Storage Area Fire (TA-54-38)	532	0.638
WETF Fire (TA-16-205)	8.92	0.00535
WCRR Outdoor Storage Area Fire (TA-50-69)	44.7	0.0536
Waste Storage Dome Fire (TA-54)	1,950	2.34 [b]
Onsite Transuranic Waste Fire Accident (TA-54)	761	0.913
Plutonium Facility Storage Container Release (TA-55-4)	35.8	0.0430
Plutonium Facility Ion Column Rupture (TA-55-4)	9.09	0.00545
DVRS Operational Spill (TA-54)	51.4	0.0617
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	888	1.07 [b]
SHEBA Hydrogen Detonation (TA-18-168)	15.4	0.00924
CMR HEPA Filter Fire (TA-3-29)	5.38	0.00323

rem = roentgen equivalent man, RANT = Radioactive Assay and Nondestructive Test, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, DVRS = Decontamination and Volume Reduction System, SHEBA = Solution High-Energy Burst Assembly, CMR = Chemistry and Metallurgy Research Building, HEPA = high-efficiency particulate air filter.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields a LCF value greater than 1.00 as shown. This means that it is likely that an individual exposed to the indicated dose would contract a fatal latent cancer in their lifetime. 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 1.00.

Table D–6 Radiological Accident Offsite Population and Worker Risks for the No Action 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]
RANT Outdoor Container Storage Area Fire (TA-54-38)	0.01	0.00638	0.000858	0.0238
WETF Fire (TA-16-205)	1.1×10^{-5}	5.96×10^{-8}	3.95×10^{-8}	1.25×10^{-6}
WCRR Outdoor Storage Area Fire (TA-50-69)	0.0003	0.0000161	1.98×10^{-7}	0.0000477
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.000503	0.00254
Onsite Transuranic Waste Fire Accident (TA-54)	0.001	0.000913	0.000223	0.00343
Plutonium Facility Storage Container Release (TA-55-4)	10^{-6}	4.3×10^{-8}	1.50×10^{-9}	2.23×10^{-7}
Plutonium Facility Ion Column Rupture (TA-55-4)	10^{-6}	5.45×10^{-9}	7.68×10^{-10}	7.86×10^{-8}
DVRS Operational Spill (TA-54)	0.02	0.00123	0.000235	0.00222
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	0.001	0.001	0.000385	0.00368
SHEBA Hydrogen Detonation (TA-18-168)	0.0054	0.0000499	2.84×10^{-6}	0.000224
CMR HEPA Filter Fire (TA-3-29)	0.01	0.0000323	4.64×10^{-6}	0.00120

MEI = maximally exposed individual, RANT = Radioactive Assay and Nondestructive Test, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, DVRS = Decontamination and Volume Reduction System, SHEBA = Solution High-Energy Burst Assembly, CMR = Chemistry and Metallurgy Research Building, 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, DVRS, Domes), 301,900 (TA-55-4).

Table D–7 Radiological Accident Offsite Population Consequences for the Expanded Operations Alternative

Accident Scenario	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem)	*Latent Cancer Fatality* [a]	*Dose (person-rem)*	*Latent Cancer Fatalities* [b, c]
RANT Outdoor Container Storage Area Fire (TA-54-38)	71.5	0.0858	3,970	2.38
WETF Fire (TA-16-205)	5.91	0.00355	187	0.112
WCRR Outdoor Storage Area Fire (TA-50-69)	1.10	0.000660	265	0.159
Waste Storage Dome Fire (TA-54)	419	0.503	4,230	2.54
Onsite Transuranic Waste Fire Accident (TA-54)	186	0.223	5,720	3.43
Plutonium Facility Storage Container Release (TA-55-4)	2.50	0.00150	372	0.223
Plutonium Facility Ion Column Rupture (TA-55-4)	1.28	0.000768	131	0.0786
DVRS Operational Spill (TA-54)	19.6	0.0118	185	0.111
Explosion in a Pit at MDA G	55.2	0.0662	766	0.460
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	321	0.385	6,140	3.68
Fire at CMR Involving Sealed Sources (TA-3-29)	0.0987	0.0000592	11,600	6.96
CMR HEPA Filter Fire (TA-3-29)	0.774	0.000464	200	0.12

MEI = maximally exposed individual, rem = roentgen equivalent man, RANT = Radioactive Assay and Nondestructive Test, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, DVRS = Decontamination and Volume Reduction System, MDA = material disposal area, CMR = Chemistry and Metallurgy Research Building, HEPA = high-efficiency particulate air filter.

[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), 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).

Table D–8 Radiological Accident Onsite Worker Consequences for the Expanded Operations Alternative

Accident Scenario	Noninvolved Worker at 110 Yards (100 meters)	
	Dose (rem)	Latent Cancer Fatalities [a]
RANT Outdoor Container Storage Area Fire (TA-54-38)	532	0.638
WETF Fire (TA-16-205)	8.92	0.00535
WCRR Outdoor Storage Area Fire (TA-50-69)	44.7	0.0536
Waste Storage Dome Fire (TA-54)	1,950	2.34 [b]
Onsite Transuranic Waste Fire Accident (TA-54)	761	0.913
Plutonium Facility Storage Container Release (TA-55-4)	35.8	0.0430
Plutonium Facility Ion Column Rupture (TA-55-4)	9.09	0.00545
DVRS Operational Spill (TA-54)	51.4	0.0617
Explosion in a Pit at MDA G	405	0.486
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	888	1.07 [b]
Fire at CMR Involving Sealed Sources (TA-3-29)	1.21	0.000727
CMR HEPA Filter Fire (TA-3-)	5.38	0.00323

rem = roentgen equivalent man, RANT = Radioactive Assay and Nondestructive Test, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, DVRS = Decontamination and Volume Reduction System, MDA = material disposal area, CMR = Chemistry and Metallurgy Research Building, HEPA = high-efficiency particulate air filter.

[a] Increased risk of an LCF, assuming the accident occurs.

[b] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.00 as shown. This means that it is likely that an individual exposed to the indicated dose would contract a fatal latent cancer in their lifetime. 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 1.00.

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]	Maximally Exposed Individual [a]	Population to 50 Miles (80 kilometers) [b, c]
RANT Outdoor Container Storage Area Fire (TA-54-38)	0.01	0.00638	0.000858	0.0238
WETF Fire (TA-16-205)	1.1×10^{-5}	5.96×10^{-8}	3.95×10^{-8}	1.25×10^{-6}
WCRR Outdoor Storage Area Fire (TA-50-69)	0.0003	0.0000161	1.98×10^{-7}	0.0000477
Waste Storage Dome Fire (TA-54)	0.001	0.001	0.000503	0.00254
Onsite Transuranic Waste Fire Accident (TA-54)	0.001	0.000913	0.000223	0.00343
Plutonium Facility Storage Container Release (TA-55-4)	10^{-6}	4.30×10^{-8}	1.50×10^{-9}	2.23×10^{-7}
Plutonium Facility Ion Column Rupture (TA-55-4)	10^{-6}	5.45×10^{-9}	7.68×10^{-10}	7.86×10^{-8}
DVRS Operational Spill (TA-54)	0.02	0.00123	0.000235	0.00222
Explosion in a Pit at MDA G	0.01	0.00486	0.000662	0.00460
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	0.001	0.001	0.000385	0.00368
Fire at CMR Involving Sealed Sources (TA-3-29)	0.00024	1.74×10^{-7}	1.42×10^{-8}	0.00167
CMR HEPA Filter Fire (TA-3-29)	0.01	0.0000323	4.64×10^{-6}	0.00120

RANT = Radioactive Assay and Nondestructive Test, TA = technical area, WETF = Weapons Engineering Tritium Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, DVRS = Decontamination and Volume Reduction System, MDA = Material Disposal Area, CMR = Chemistry and Metallurgy Research Building, 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; 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, DVRS, Domes), 301,900 (TA-55-4).

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 (and 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, which are chiefly internal risks with dose to the body 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 could be 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, were only that nuclide present. Each of the nuclides was separately analyzed and it was found that cobalt-60 would lead to the maximum exposure to 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 the maximum exposure to individuals further from the release, such as the MEI at CMR, from plume exposure; and cesium-137 would lead to the maximum exposure to the general public from ground exposure from 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 CMR involving sealed sources scenario 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 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 contain 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 information and data that supports the impacts of facility accidents presented in Chapter 5. It includes the estimated accident frequency of occurrence, scenarios, and materials released.

The chemicals of concern at LANL facilities and potential impacts under the No Action Reduced and Expanded Operations Alternatives are shown in **Table D–10**. These have been 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 generally regarded as requiring action to prevent or mitigate exposures. The second guideline is the concentration above which severe irreversible health effects or 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 one 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 one hour without experiencing or developing life-threatening health effects.*

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	143 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	312 ppm	27.2 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	165 ppm	3.38 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]	197	500,000 ppm [c]	139	greater than ERPG-3	10,300 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.

[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 incorporation of those values into hazards assessments and emergency plans is beginning 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.*

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.

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 which can, at elevated levels, cause respiratory dysfunction, among 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 for which the potential for accidental releases of toxic chemicals exists. A fire during excavation which breaches the MDA enclosure and bypasses the HEPA filtration was chosen as a severe scenario. There is a great deal of uncertainty as to how much and which chemicals were disposed of in the MDAs; the MDA closest to the public (and thus with the potential for the greatest impact 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 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	143 ppm	12 ppm at 491 meters
Sulfur dioxide from waste cylinder storage at TA-54-216	0.00051	300 pounds (160 kilograms)	3 ppm	1,650	15 ppm	690	312 ppm	27.2 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	165 ppm	3.38 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]	197	500,000 ppm	139	> ERPG-3	10,300 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)	.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.

D.4 Site-wide Seismic Impacts

Two site-wide seismic events, denoted as 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 site-wide seismic event to occur, simultaneous radiological and chemical releases from multiple locations could result. The evolution 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

[2] *A g, standing for the acceleration due to gravity of 32 feet per second per second (9.8 meters per second per second) is a standard measure of ground movement associated with seismic events.*

that earlier document (called Site releases there) were based on information available subsequent to the writing of the *1999 SWEIS*. New information was reviewed and significant scenarios added as appropriate. An 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 nonradiological human health impacts expected. These seismic events would cause widespread failures of 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.

D.4.1 Source Term Data

Table D–12 shows the source term data used in the calculation of 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.

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 CMR 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.

Risks to individuals, on the other hand, cannot be summed because a single individual would not likely 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.

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:** TA-3-29 (CMR Building) *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:** TA-16-205 (WETF) *Seismic 2*													
Tritium release	Tritiated Water	grams	1,000	1	1.00	1	–	1	1,000	10	0	0	No
Identifier: SIT08 **Facility Name:** TA-18-168 (SHEBA) *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	1.00	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:** TA-21-155 (TSTA) *Seismic 1 and 2*													
Tritium release	Tritiated Water	grams	0.1	1	1.00	1	–	1	0.1	10	0	0	No
Identifier: SIT10. **Facility Name:** TA-21-209 (TSFF) *Seismic 1 and 2*													
Tritium release	Tritiated Water	grams	0.88	1	1.00	1	–	1	0.88	10	0	0	No
Identifier: SIT11. **Facility Name:** TA-50-1 (RLWTF) *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: SIT13. **Facility Name:** TA-50-69 (WCRR) *Seismic 2*													
Initial	Plutonium Equivalent	curies	–	–	–	–	–	–	0.39	10	0	0	No
Suspension			–	–	–	–	–	–	0.037	1,440	0	0	No
Identifier: SIT14. **Facility Name:** TA-54-38 (RANT) *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: SIT15. **Facility Name:** TA-55-4 (Plutonium Facility) *Seismic 2*													
Initial	Plutonium-238	grams	–	–	–	–	–	–	0.0129	10	0	0	Yes
	Plutonium-239		–	–	–	–	–	–	4.84	10	0	0	Yes
	Plutonium-240		–	–	–	–	–	–	0.323	10	0	0	Yes
	Plutonium-241		–	–	–	–	–	–	0.0251	10	0	0	Yes
	Plutonium-242		–	–	–	–	–	–	0.179	10	0	0	Yes
	Americium-241		–	–	–	–	–	–	0.0038	10	0	0	Yes
	Highly-enriched Uranium		–	–	–	–	–	–	0.241	10	0	0	Yes
Identifier: SIT19. **Facility Name:** TA-55-355 (SST) *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 (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
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

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?*
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 (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:** 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:** DVRS (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:** DVRS (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, CMR = Chemistry and Metallurgy Research Building, WETF = Weapons Engineering Tritium Facility, SHEBA = Solution High-Energy Burst Assembly, TSTA = Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, RANT = radioassay and nondestructive testing, SST = safe secure trailer, MEI = maximally exposed individual, DVRS = Decontamination and Volume Reduction System, 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 whereas an individual would be affected by only a subset of doses that are close to each other.

Table D–13 Site-wide Seismic 1 Radiological Accident Offsite Population Consequences for the No Action Alternative

Facility Impacted by Seismic 1 Event	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem)	*Latent Cancer Fatality* [a]	*Dose (person-rem)*	*Latent Cancer Fatalities* [b, c]
TA-3-29 (CMR)	62.0	0.0744	6,080	3.65
TA-18-168 (SHEBA)	0.0301	0.0000181	0.770	0.000462
TA-21-155 (TSTA)	0.00146	8.76×10^{-7}	0.0492	0.0000295
TA-21-209 (TSFF)	0.0125	7.50×10^{-6}	0.433	0.000260
TA-50-1 (RLWTF)	3.02	0.00181	515	0.309
TA-54-38 (RANT)	64.2	0.0770	1,120	0.672
TA-55-185 (Storage Shed)	5.98	0.00359	589	0.353
TA-54-412 DVRS (PC-2 Seismic)	2.76	0.00166	49.1	0.0295
	Max 64.2	Max 0.0770	Sum 8,354	Sum 5.01

MEI = maximally exposed individual, rem = roentgen equivalent man, TA = technical area, CMR = Chemistry and Metallurgy Research Building, SHEBA = Solution High-Energy Burst Assembly, TSTA =Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, RANT = Radioactive Assay and Nondestructive Test, DVRS = Decontamination and Volume Reduction System, 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, DVRS).

Table D–14 Site-wide Seismic 1 Radiological Accident Onsite Worker Consequences for the No Action Alternative

Facility Impacted by Seismic 1 Event	*Noninvolved Worker at 110 Yards (100 meters)*	
	Dose (rem)	*Latent Cancer Fatality* [a]
TA-3-29 (CMR)	1,940	2.33 [b]
TA-18-168 (SHEBA)	1.06	0.000636
TA-21-155 (TSTA)	0.0111	6.66×10^{-6}
TA-21-209 (TSFF)	0.0974	0.0000584
TA-50-1 (RLWTF)	121	0.145
TA-54-38 (RANT)	576	0.691
TA-55-185 (Storage Shed)	239	0.287
TA-54-412 DVRS (PC-2 Seismic)	10.1	0.00606

rem = roentgen equivalent man, TA = technical area, CMR = Chemistry and Metallurgy Research Building, SHEBA = Solution High-Energy Burst Assembly, TSTA =Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, RANT = Radioactive Assay and Nondestructive Test, DVRS = Decontamination and Volume Reduction System, PC = performance category.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.00 as shown. This means that it is likely that an individual exposed to the indicated dose would contract a fatal latent cancer in their lifetime. 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 1.00.

Table D–15 Site-wide Seismic 1 Radiological Accident Offsite Population and Worker Risks for the No Action Alternative

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]
TA-3-29 (CMR)	0.001	0.001	0.0000744	0.00365
TA-18-168 (SHEBA)	0.001	6.36×10^{-7}	1.81×10^{-8}	4.62×10^{-7}
TA-21-155 (TSTA)	0.001	6.66×10^{-9}	8.76×10^{-10}	2.95×10^{-8}
TA-21-209 (TSFF)	0.001	5.84×10^{-8}	7.50×10^{-9}	2.60×10^{-7}
TA-50-1 (RLWTF)	0.001	0.000145	1.81×10^{-6}	0.000309
TA-54-38 (RANT)	0.001	0.000691	0.0000770	0.000672
TA-55-185 (Storage Shed)	0.001	0.000287	3.59×10^{-6}	0.000353
TA-54-412 DVRS (PC-2 Seismic)	0.001	6.06×10^{-6}	1.66×10^{-6}	0.0000295
		Max 0.001	Max 0.0000770	Sum 0.00501

MEI = maximally exposed individual, TA = technical area, CMR = Chemistry and Metallurgy Research Building, SHEBA = Solution High-Energy Burst Assembly, TSTA =Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, RANT = Radioactive Assay and Nondestructive Test, DVRS = Decontamination and Volume Reduction System, 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; 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, DVRS).

There is potential for an individual at publicly accessible Diamond Drive, approximately 55 yards (50 meters) from CMR, 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 CMR MEI dose indicated in Table D–13. If an individual were at the Diamond Drive location for the duration of the CMR release, he would likely contract a fatal cancer during his lifetime.

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 for 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 from which there would be no releases during a Seismic 1 event but which would have releases in the event of this larger Seismic 2 event. This facility and CMR represent the major sources of risk for this event. The overall health risk to the general population from this event is seen to be approximately 0.005 per year, that is, a mean of one LCF in the entire general population (out to 50 miles [80 kilometers] from each release) every 200 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 Alternative

Facility Impacted by Seismic 2 Event	*MEI*		*Population to 50 Miles (80 kilometers)*	
	Dose (rem)	*Latent Cancer Fatality* [a]	*Dose (person-rem)*	*Latent Cancer Fatality* [b, c]
TA-3-29 (CMR)	62.0	0.0744	6,080	3.65
TA-16-205 (WETF)	6.43	0.00386	159	0.0952
TA-18-168 (SHEBA)	0.0301	0.0000181	0.770	0.000462
TA-21-155 (TSTA)	0.00146	8.76×10^{-7}	0.0492	0.0000295
TA-21-209 (TSFF)	0.0125	7.50×10^{-6}	0.433	0.000260
TA-50-1 (RLWTF)	3.02	0.00181	515	0.309
TA-50-69 (WCRR)	2.84	0.00170	237	0.142
TA-54-38 (RANT)	64.2	0.0770	1,120	0.672
TA-55-4 (Plutonium Facility)	4.21	0.00253	403	0.242
TA-55-185 (Storage Shed)	5.98	0.00359	589	0.353
TA-54-412 DVRS (PC-3 Seismic)	33.7	0.0404	601	0.361
Waste storage domes (TA-54)	462	0.554	7,430	4.46
TA-55-355 (SST)	3.94	0.00236	294	0.176
	Max 462	0.554	Sum 17,429	10.46

MEI = maximally exposed individual, rem = roentgen equivalent man, TA = technical area, CMR = Chemistry and Metallurgy Research Building, WETF = Weapons Engineering Tritium Facility, SHEBA = Solution High-Energy Burst Assembly, TSTA = Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, RANT = Radioactive Assay and Nondestructive Test, DVRS = Decontamination and Volume Reduction System, PC = performance category, SST = safe secure trailer.

[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 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).

The consequence to an individual at publicly accessible Diamond Drive from a Seismic 2 release from CMR could exceed that from the nearest site boundary. This consequence is the same as for the Seismic 1 event; the effects of the CMR 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 have been 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 concentrations in excess of these could have harmful health or life-threatening implications as defined in the table's footnotes. Hydrogen cyanide, phosgene, and formaldehyde are toxic gases which can, at elevated levels, 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. 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–17 Site-wide Seismic 2 Radiological Accident Onsite Worker Consequences for the No Action Alternative

Facility Impacted by Seismic 2 Event	*Noninvolved Worker at 110 Yards (100 meters)*	
	Dose (rem)	*LCF* [a]
TA-3-29 (CMR)	1,940	2.33 [b]
TA-16-205 (WETF)	5.86	0.00352
TA-18-168 (SHEBA)	1.06	0.000636
TA-21-155 (TSTA)	0.0111	6.66×10^{-6}
TA-21-209 (TSFF)	0.0974	0.0000584
TA-50-1 (RLWTF)	121	0.145
TA-50-69 (WCRR)	129	0.155
TA-54-38 (RANT)	576	0.691
TA-55-4 (Plutonium Facility)	47.9	0.0575
TA-55-185 (Storage Shed)	239	0.287
DVRS (PC-3 Seismic)	123	0.148
Waste storage domes (TA-54)	2,150	2.58 [b]
TA-55-355 (SST)	129	0.155

rem = roentgen equivalent man, LCF = latent cancer fatality, TA = technical area, CMR = Chemistry and Metallurgy Research Building, WETF = Weapons Engineering Tritium Facility, SHEBA = Solution High-Energy Burst Assembly, TSTA = Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, RANT = Radioactive Assay and Nondestructive Test, DVRS = Decontamination and Volume Reduction System, SST = safe secure trailer.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.00 as shown. This means that it is likely that an individual exposed to the indicated dose would contract a fatal latent cancer in their lifetime. 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 1.00.

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 have been 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 concentrations in excess could have harmful health or life-threatening implications, as defined in the table's footnotes.

Table D–18 Site-wide Seismic 2 Radiological Accident Offsite Population and Worker Risks for the No Action Alternative

Facility Impacted by Seismic 2 Event	Frequency (per year)	Onsite Worker: Noninvolved Worker at 110 Yards (100 meters) [a]	Offsite Population: MEI [a]	Offsite Population: Population to 50 Miles (80 kilometers) [b, c]
TA-3-29 (CMR)	0.0005	0.0005	0.0000372	0.00182
TA-16-205 (WETF)	0.0005	1.76×10^{-6}	1.93×10^{-6}	0.0000476
TA-18-168 (SHEBA)	0.0005	3.18×10^{-7}	9.03×10^{-9}	2.31×10^{-7}
TA-21-155 (TSTA)	0.0005	3.33×10^{-9}	4.38×10^{-10}	1.48×10^{-8}
TA-21-209 (TSFF)	0.0005	2.92×10^{-8}	3.75×10^{-9}	1.30×10^{-7}
TA-50-1 (RLWTF)	0.0005	0.0000726	9.06×10^{-7}	0.000155
TA-50-69 (WCRR)	0.0005	0.0000774	8.52×10^{-7}	0.0000711
TA-54-38 (RANT)	0.0005	0.000346	0.0000385	0.000336
TA-55-4 (Plutonium Facility)	0.0005	0.0000287	1.26×10^{-6}	0.000121
TA-55-185 (Storage Shed)	0.0005	0.000143	1.79×10^{-6}	0.000177
DVRS (PC-3 Seismic)	0.0005	0.0000738	0.0000202	0.000180
Waste storage domes (TA-54)	0.0005	0.0005	0.000277	0.00223
TA-55-355 (SST)	0.0005	0.0000774	1.18×10^{-6}	0.0000882
		Max 0.0005	Max 0.000277	Sum 0.00523

MEI = maximally exposed individual, TA = technical area, CMR = Chemistry and Metallurgy Research Building, WETF = Weapons Engineering Tritium Facility, SHEBA = Solution High-Energy Burst Assembly, TSTA =Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility, RLWTF = Radioactive Liquid Waste Treatment Facility, WCRR = Waste Characterization, Reduction, and Repackaging Facility, RANT = Radioactive Assay and Nondestructive Test, DVRS = Decontamination and Volume Reduction System, PC = performance category, SST = safe secure trailer.

[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 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).

Table D–19 Chemical Accident Impacts Under Seismic 1 Conditions

Chemical	Frequency (per year)	Quantity Released	ERPG-2 [a]: Value	ERPG-2 [a]: Distance to Value (meters)	ERPG-3 [b]: Value	ERPG-3 [b]: Distance to Value (meters)	Concentration: Noninvolved Worker at 100 Meters	Concentration: 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	18.6 ppm	0.252 ppm at 924 meters
Phosgene at TA-9-21	0.001	1 pound (0.45 kilogram)	0.2 ppm	280	1 ppm	120	1.38 ppm	0.0252 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	31.3 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).

Note: To convert meters to feet, multiply by 3.28.

Table D–20 Chemical Accident Impacts Under Seismic 2 Conditions

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
Hydrogen cyanide at TA-3-66 (Sigma Complex)	0.0005	13.5 pounds (6 kilograms)	10 ppm	140	25 ppm	86	18.6 ppm	0.252 ppm at 924 meters
Phosgene at TA-9-21	0.0005	1 pound (0.45 kilogram)	0.2 ppm	280	1 ppm	120	1.38 ppm	0.0252 ppm at 823 meters
Formaldehyde at TA 43-1 (Bioscience Facilities)	0.0005	14.1 liters (3.7 gallons)	10 ppm	180	25 ppm	110	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	3.38 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	0.0189 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	0.652 ppm at 1,117 meters
Beryllium at TA-3-141 (Beryllium Technology Facility)	0.0005	110 pounds (49 kilograms) (powder) [c]	0.025 milligrams per cubic meters	282	0.1 milligrams per cubic meters	116	0.126 ppm	0.00427 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] 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 feet, multiply by 3.28.

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 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 then be by evaporation.

Table D–20 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. The hydrogen cyanide, phosgene, and formaldehyde releases from the Seismic 1 event would also be released with this more severe Seismic 2 event; 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 Transuranic Waste Consolidation Facility (TWCF), located in TA-50 or TA-63. 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 would 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, TWCF, located in TA-50 or TA-63. 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 would be active for most of the time period of interest and because their accident impacts bound the impacts of the new facility. The TWCF 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 for the Expanded Operations Alternative as for 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 for the Expanded Operations Alternative as for 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–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, affecting the health and safety of LANL workers and the public. The discussion and analysis in Chapter 5, Sections 5.1 through 5.4 is largely extracted from LANL (LANL 2004).

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, with 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 at LANL for continued wildfire risk that includes consideration of the extensive environmental changes since 1999. Based on the results of this analysis, areas of concern were determined; these areas are consistent with those found in another recent wildfire risk analysis (Balice et al. 2005). A particular scenario, a wildfire initiated to the 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 potential for the most widespread environmental impact to LANL because there is continuous fuel from these offsite locations to 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 adjacent to and on the LANL site. 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 was begun in the evening, but, by 1 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 day 5 of the wildfire, May 8, spot fires began to occur on LANL lands. By May 10, the fire moved into the Los Alamos townsite and was proceeding north and east across the TA-16 mesa top. The fire was moving 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, and although fires moved onto LANL land, all major structures were secured and no releases of radiation occurred. The wildfire was declared fully contained on June 6, having burned 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]

The Cerro Grande Fire of 2000 had an enormous adverse impact on forests on and 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

[3] *The sum of these areas is approximately equal to 7,700 acres as cited elsewhere in this SWEIS.*

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 potentially release contaminants and materials downstream during rainfall events. Numerous cultural resource sites and traditional cultural properties are located in canyons or along drainage areas, and were at an 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 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 most 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 are seen in ponderosa pine (*Pinus ponderosa*), douglas-fir (*Pseudotsuga menziesii*) and piñon (*Pinus edulis*) pine trees. Many areas in piñon-juniper habitat have had the entire stand of piñon die, leaving only juniper (*Juniperus monosperma*). Bark beetles in western North America have been documented to cause large areas of high mortality that have 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. This mortality left a mosaic of live and dead trees.

In order to decrease the risk from catastrophic environmental fire, LANL has undertaken a tree-thinning project that was begun in January 2002. The goal of this project was to reduce the threat of wildfire to forested areas and structures on LANL property and 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) and includes both ponderosa pine and piñon–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 LANL 2004.

This analysis was largely based on data and results 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. The typical vegetation in this area consists of piñon-juniper woodlands, ponderosa pine forests, mixed conifer forests, aspen forests and grasslands. Occasional barren areas, shrub lands and spruce-fir forests can also be found in the study region. Numerous developed areas, including the Los Alamos townsite and 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 had previously been parameterized with locally collected data representing the fuels and fire hazards of the Los Alamos region. The parameterized fire behavior modeling system had also been 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 which 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 that had been 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 had been 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 (3 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, and 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 Highway 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, the intervening areas along Highway 501 and the western boundary of LANL are also relatively high in fire risks.

Fourth, portions of the mesa-canyon areas between TA-40 and TA-21 are relatively high in fire risks. 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 levels of fire risks.

Fifth, the remaining portions of LANL and its immediate surroundings are relatively less at risk from wildfires.

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 2004a.

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 that was 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 piñon-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 over story 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 by the Cerro Grande Fire.

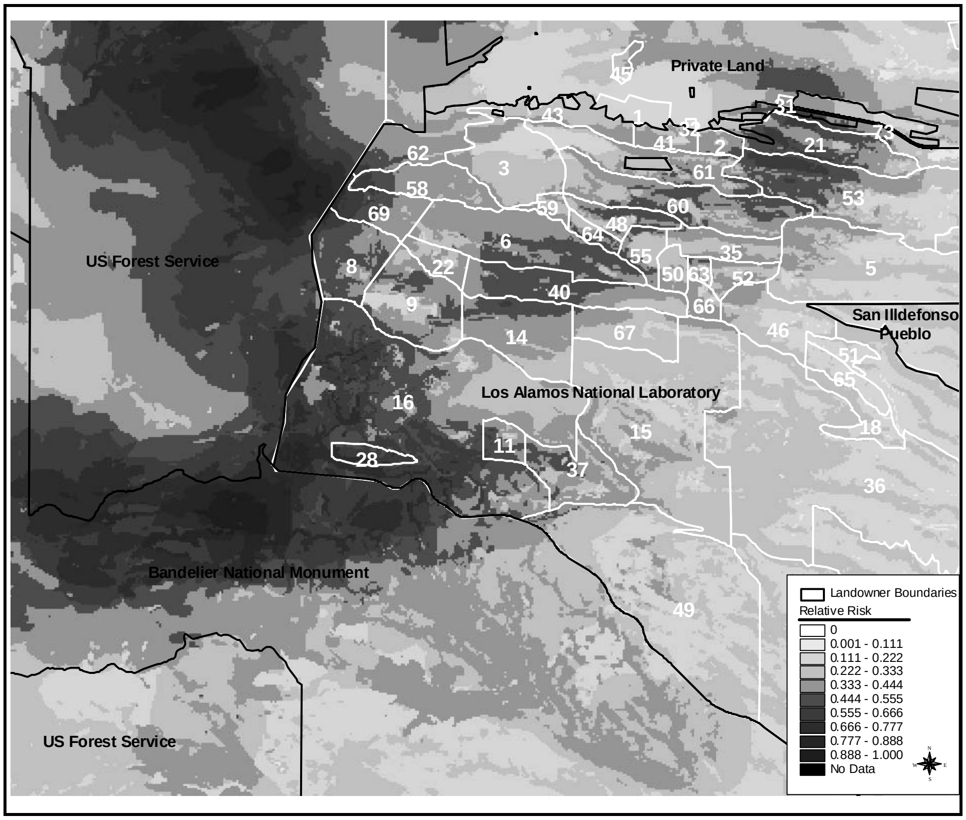


Figure D–1 Relative Risk of Wildfire in the Los Alamos Region (1999)

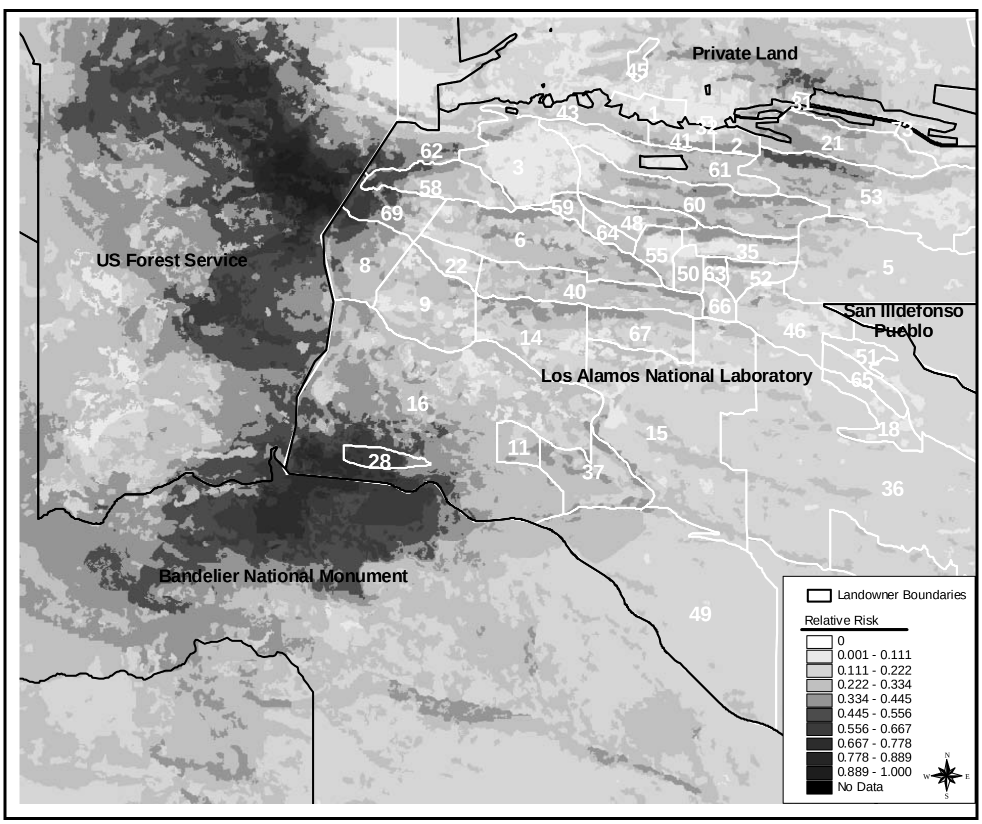


Figure D–2 Relative Risk of Wildfire in the Los Alamos Region (2002)

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 worsen to the point that the fire extends from the ground surface through the fuel ladders into the forest over story. 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 for 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 would most likely 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 have also not changed since the *1999 SWEIS*. The mountainous environments to the west of LANL, and the canyon-mesa environments at LANL present difficulties in management and suppression of fires, and create safety and management issues related to transportation and movements across these topographic barriers. The patchwork of land management agencies in the Los Alamos region has also not changed since the *1999 SWEIS*. This creates unique problems to wildfire hazard management that can only be resolved through strong interactions and collaborations among the individual agencies.

Some aspects of weather have changed since the *1999 SWEIS*, and some have not. The 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 not been altered since the writing of the *1999 SWEIS*. What has changed with respect to weather conditions since the time of the *1999 SWEIS* is that the climate has grown significantly hotter and drier. This is similar to the 1950s drought in that the precipitation levels have been somewhat similar. However, this is in contrast to that drought in that recent temperatures have been significantly higher (Breshears et al. 2005).

The levels of fuels in the Los Alamos region are the aspects of wildfire hazards that have been extensively changed since the *1999 SWEIS*. First, the Cerro Grande Fire greatly reduced the fuels in more than 42,000 acres (17,000 hectares) of forested landscape at LANL and to the west of LANL. This is especially true in the severely burned areas where reestablishment 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 have resulted in very little net change in the levels of fuels in these areas. Moreover, reseeding with grasses in the severely burned areas of the Cerro Grande Fire, along with other rehabilitation techniques, has 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 piñon-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 risk of wildfire analysis that incorporates altered fuel conditions that have occurred in the past few years suggest the heightened likelihood of some general wildfire scenarios to occur, relative 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 could also be started on LANL. 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 weathers 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 also tend more readily to 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. Thus, TA-16, TA-28, TA-58, TA-62, and TA-69 would be at the greatest risk from wildfires. With the second greatest risk from wildfires occurring 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 would also 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, with an increase in danger to adjacent buildings and facilities.

Fires that originate from within the boundaries of LANL would likely 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, and this 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, including topographic barriers, heavy fuel loads on north-facing aspects, and modified canyon wind patterns, that would complicate the direction of wildfire spread. The result is that fires would tend to spread readily in down-canyon and up-canyon directions, as well as traveling 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 then assumed that the fire necessarily continued 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 that have passed 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 (appreciable amounts of) radiological materials, 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 is dependent 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 is dependent on the joint probability of fuel load indices for fuel adjacent to buildings, 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 once per 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 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 for a release to occur resulting from a wildfire and resulting in radiological exposures of 0.05 per year. This translates to a 5-in-100-year chance of occurrence, which is equal to once 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, as well as 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 takes into effect the environmental changes and fuel reduction mitigation that have taken place 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). There is a high frequency of lightning and lightning-caused fires in the Jemez Mountains that were 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 data and fire danger data for April through June of 1980 through 1998. During these months, fire risk and frequency are greatest. 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.

For determining 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 in order to eliminate 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, meaning from the south) through 292.5 degrees (west-northwesterly). Three-day periods from the same dataset were then examined to determine if the precipitation, wind speed, and wind direction fell above (or within) set thresholds. 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 of them 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 fire fighting 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 in order 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 are found 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), 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 State Road 4 and State Road 501, the southwest edge of LANL, at noon on the second day. Protective actions are already underway by LANL, such as relocating some radionuclides and 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 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 piñon-juniper woodlands and defined by fuel continuity and density.

From the completed specific analysis for 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 TA-15, TA-37, and TA-66 that were used in the previous wildfire scenario. Following the continuous fuel lines and steered somewhat by southwesterly winds, the fire enters and crosses Pajarito Canyon and Twomile Canyon, and by 1 a.m. of the third day burns up to the Pajarito Road control line just west of TA-66.

Although it would be expected that the control line would 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 State Road 501. On the LANL site, the fire is assumed to consume all combustible structures in its path that are evaluated as having moderate or higher risk from wildfire under the LANL Building Appraisal Program. The fire also exposes the surface of contaminated earth previously protected by vegetation in the firing sites and canyons. This text separately discusses the exposures from fire burning the soil cover and suspending the underlying soil and the exposures from burning structures. Exposures from the latter are calculated individually, thus 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, and does not address the direct effects of the fire on the townsite. It is recognized that there is continuous fuel joining 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 the same computer code used on the other radiological release scenarios described in this appendix, MACCS2. 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 can occur most frequently in the period of 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 and, 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 is 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, is chosen that reflects that the 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 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 under story vegetation collected at one of 12 LANL Environmental Surveillance Program onsite locations in 1998, 0.066[3] μg/g-dry in over story vegetation at one of the same 12 locations and same year, 0.05[3] μg/g-dry in pine needles from TA-16 in 1985, 0.72[5] μg/g-dry in over story vegetation at the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility in 2002; and 1.5[6] μg/g-dry in piñon tree bark at a firing site in 2001 (Gonzales et al. 2003). Other than total uranium, the *1999 SWEIS* does not identify the concentrations used in source term calculations. Ignoring the other radionuclides, and based on the 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 one millirem. Although the Cerro Grande Fire burned only about 7,500 acres (3,040 hectares) of forest within LANL, the estimated inhalation dose to a maximally exposed individual based on measurements of 0.2 millirem (LANL 2001) supports the hypothesis that vegetation (and soil) contributes 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 surveillance data from the top 2 inches of soil measured in the 2001 through 2004 time period was 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 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 as compared to the radiological consequence of the fire's effects on certain buildings at LANL.

---

[4] *Computed using ash/dry weight ratio of 0.1 from Fresquez and Ferenbaugh (1999).*

[5] *Computed using ash/dry weight ratio of 0.08 from Fresquez and Ferenbaugh (1999).*

[6] *Computed by converting radioisotopic data to uranium mass data and using ash/dry weight ratio of 0.029 for bark from Gonzales et al. (2003).*

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 (WETF) in TA-16 were validated in the field in order 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 on the basis of 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, and for other conditions 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 WETF 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 building could substantially reduce the likelihood of the building igniting and could also reduce the release of radiological materials by lowering the intensity of the fire. Since 1999, however, the wildfire vulnerability of two (Buildings 229 and 230) formerly high risk waste storage domes at TA-54 has been lowered to Moderate. The WETF 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, since 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 from Table D–21 and that were within relatively high wildfire risk areas, were selected for quantitative contaminant risk assessment. Two additional facilities in TA-16, Building 205 (WETF) and Building 411 (Device Assembly) were also included, because, even though individual facilities may have low vulnerability, TA-16 is among the TAs at greatest risk from a wildfire.

D.5.4.2 Public Exposure from Burning Buildings

The individual exposures assume no sheltering inside buildings or vehicles and that no protective actions are 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 (State Route 502) could evacuate 800 cars per hour, and the combination of the East Jemez and Pajarito Roads could evacuate another 800 cars per hour.

In 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, and, at 1:15 p.m., the County emergency personnel broadcast the directive for all of the people of Los Alamos to evacuate their homes immediately. Although some projections had indicated that it would take up to 12 hours to get all 12,000 Los Alamos residents down the mountain using the single road (State Route 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; and, by 6 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 been dispersed during the fire. Radiological dose calculations performed based on air monitoring data were 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 a maximally exposed individual 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 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 first 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 the 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 seen to be 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) (minimum)*	*Heat (mega-watts)*	*Release Height (meters)*	*Wake?*
Identifier: WILDF01. **Facility Name:** TA-3-66/451 (Sigma Complex).													
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:** TA-16-205 (WETF).													
Fire	Tritiated Water	grams	1,000	1	1	1	–	1	1,000	60	20	0	No
Identifier: WILDF05. **Facility Name:** TA-48-1 (Radiochemistry Laboratory).													
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:** TA-54 Waste storage domes (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

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) (minimum)	Heat (mega-watts)	Release Height (meters)	Wake?
Identifier: DOMEM-MEI. **Facility Name:** TA-54 waste storage domes (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
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:** TA-16-411 (Device Assembly).													
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:** TA-54-412 (DVRS).													
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:** TA-8-23 (Radiography).													
Fire	Plutonium Equivalent	curies	–	–	–	–	–	–	0.0026	60	20	0	No

MAR = material at risk, TA = technical area; WETF = Weapons Engineering Tritium Facility, MEI = maximally exposed individual, DVRS = Decontamination and Volume Reduction System.

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)	*Latent Cancer Fatality* [a]	*Dose (person-rem)*	*Latent Cancer Fatalities* [b, c]
TA-03-66/451 (Sigma Complex)	0.00389	2.33×10^{-6}	4.75	0 (0.00285)
TA-16-205 (WETF)	0.0605	0.0000363	112	0 (0.0673)
TA-48-1 (Radiochemistry Laboratory)	0.00107	6.42×10^{-7}	0.436	0 (0.000262)
TA-54 (Waste storage domes)	1,930	2.32 [d]	91,300	55 (54.8)
TA-16-411 (Device Assembly)	1.48×10^{-6}	8.88×10^{-10}	0.000174	0 (1.04×10^{-7})
TA-54-412 (DVRS)	4.91	0.00295	1,160	0 (0.696)
TA-8-23 (Radiography)	0.000332	1.99×10^{-7}	0.562	0 (0.000337)

MEI = maximally exposed individual, rem = roentgen equivalent man, TA = technical area, WETF = Weapons Engineering Tritium Facility, DVRS = Decontamination and Volume Reduction System.

[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-03-66/451; 404,913 for TA-16-205 and TA-16-411; 299,508 for TA-48-1; 343,069 for Waste Storage Domes and DVRS; and 349,780 for TA-8-23.

[d] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.00 as shown. This means that it is likely that an individual exposed to the indicated dose would contract a fatal latent cancer in their lifetime. 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 1.00.

Table D–24 Radiological Accident Onsite Worker Consequences for a Wildfire Accident

Accident	*Noninvolved Worker at 110 Yards (110 meters)*	
	Dose (rem)	*Latent Cancer Fatality* [a]
TA-03-66/451 (Sigma Complex)	0.0759	0.0000455
TA-16-205 (WETF)	0.333	0.000200
TA-48-1 (Radiochemistry Laboratory)	0.0155	9.30×10^{-6}
TA-54 (Waste storage domes)	8,730	10.5 [b]
TA-16-411 (Device Assembly)	0.0000173	1.04×10^{-8}
TA-54-412 (DVRS)	16.4	0.00984
TA-8-23 (Radiography)	0.00191	1.15×10^{-6}

rem = roentgen equivalent man, TA = technical area, WETF = Weapons Engineering Tritium Facility, DVRS = Decontamination and Volume Reduction System.

[a] Increased risk of an LCF to an individual, assuming the accident occurs.

[b] Based on a dose-risk-conversion factor of 0.0006 LCF per rem, the indicated dose yields an LCF value greater than 1.00 as shown. This means that it is likely that an individual exposed to the indicated dose would contract a fatal latent cancer in their lifetime. 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 1.00.

Note: To convert meters to feet, multiply by 3.28.

Table D–25 Radiological Accident Offsite Population and Worker Risks for a Wildfire Accident

Accident	Frequency (per year)	Onsite Worker: Noninvolved Worker at 110 Yards (100 meters) [a]	Offsite Population: MEI [a]	Offsite Population: Population to 50 Miles (80 kilometers) [b, c]
TA-03-66/451 (Sigma Complex)	0.05	2.28×10^{-6}	1.17×10^{-7}	0 (0.000143)
TA-16-205 (WETF)	0.05	9.99×10^{-6}	1.82×10^{-6}	0 (0.00336)
TA-48-1 (Radiochemistry Laboratory)	0.05	4.65×10^{-7}	3.21×10^{-8}	0 (1.31×10^{-5})
TA-54 (Waste storage domes)	0.05	0.05	0.116	3 (2.74)
TA-16-411 (Device Assembly)	0.05	5.19×10^{-10}	4.44×10^{-11}	0 (5.22×10^{-9})
TA-54 (DVRS)	0.05	0.000492	0.000147	0 (0.0348)
TA-8-23 (Radiography)	0.05	5.73×10^{-8}	9.96×10^{-9}	0 (1.69×10^{-5})

MEI = maximally exposed individual, TA = technical area, WETF = Weapons Engineering Tritium Facility, DVRS = Decontamination and Volume Reduction System.

[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 Waste Storage Domes and DVRS; and 349,780 for TA-8-23.

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 2.78 per year, that is, 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 Section 4.6.1, Public Health in the LANL Vicinity). 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 0.116 probability (almost 12 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 and, therefore, this risk is thought to be very conservative.

Each of the building releases 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, likely, a 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, TWCF, located in TA-50 or TA-63. The impacts from this new facility would be less than those of the existing facilities because of the new location and because less material would be stored, the rest being 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. TWCF accident impacts are described in Appendix H.

D.5.5.3 Chemical

The chemicals of concern at LANL facilities under the No Action Alternative, 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 concentrations in excess of those 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 (pounds)	ERPG-2 [a] Value (ppm)	ERPG-2 [a] Distance to Value (meters)	ERPG-3 [b] Value (ppm)	ERPG-3 [b] Distance to Value (meters)	Concentration: Noninvolved Worker at 100 Meters (ppm)	Concentration: MEI at 1,000 Meters (ppm)	Concentration: Nearest Site Boundary (12 m TA-43) (924 m TA-3)
Formaldehyde at TA-43-1	0.05	14.1 liters (3.7 gallons)	10	141	25	89	19.7	0.23	Exceeds ERPG-3
Hydrogen Cyanide at TA-3-66	0.05	13.5 pounds (6 kilograms)	10	110	25	70	11.6	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 feet, multiply by 3.28.

Table D–26 shows the concentrations of each chemical, if it were released, at specified distances. 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 formaldehyde release. The distances to the ERPG-2 and ERPG-3 levels of concern are 120 yards (110 meters) and 77 yards (70 meters) respectively for a hydrogen cyanide release. 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. Table D–26 also shows the estimated concentration at the nearest site boundary located at a distance of 13 yards

(12 meters) and 1,010 yards (924 meters) for TA-43 and TA-3 respectively, from the release point. 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 fire fighting. 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, continuing through time and space, and frequently having 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, there exists 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 water courses 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 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 water courses 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. Due to extensive rehabilitation after the Cerro Grande Fire, runoff, soil erosion, and sedimentation were minimized. To understand the possible impact to downstream water bodies, runoff events after the fire were monitored and sampled by the Laboratory. An extensive network of automated samplers and stream gages served as the cornerstone of this effort. Due to a general lack of intense “monsoon” type 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 Highway 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 are 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 both in 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 water courses have only rarely had sufficient flow to reach the Rio Grande, and because of this they have become “discharge sinks” for some contaminants. Increases in runoff amounts and frequency would increase the potential to remove and transport contaminants from the ground surface, and subsurface, and stream channels on LANL 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 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 (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 in turn further reduce erosion. This gradual reestablishment 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 reestablished, 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 if nesting is occurring. Threatened and endangered species have remained 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 could be the general disturbance caused by the firefighting effort itself (such as, fire fighting 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 water courses also would be affected, and perhaps several would be removed for a period of time because of changes in channel morphology. With the degradation of riparian vegetation and wetlands would be an associated reduction or loss of habitat for a variety of invertebrates, small and large mammals, amphibians, reptiles, and a diversity of birds.

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 and 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. Also, 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. Also, a high intensity fire 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 (such as, bulldozers and fire trucks) 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 either be 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 also is an ongoing, interagency, collaborative program to reduce the threat of catastrophic wildfire from 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: 1) noninvolved worker and 2) 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 the operation of the facility 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 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 leading to a fatality, whereas in a severe earthquake accident, the involved workers are likely to be hurt and killed by the collapse of the building before they could 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 authors of this SWEIS carefully considered provisions of National Environmental Policy (NEPA) Act, Council on Environmental Quality Guidelines and DOE NEPA Guidelines on acceptable procedures for estimating environmental impacts under conditions of data uncertainties and limited information. These provisions include the use of the "sliding scale approach" (DOE 2002b), which gives the analyst an opportunity to take into account 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. These sections show the estimated exposure 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 the occurrence 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 was 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 (that is remaining outside directly in the path of the plume), no deposition (thereby maximizing the inhalable plume concentration), no plume meander (that is, the individual is exposed to the plume centerline for the entire event), and use of an annual 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, that is, 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 location 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, 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 Outdoor Container Storage Area Fire (TA-54-38)	RAD01	Pueblo Boundary (402)	71.5	532	135	55	32.8	22.6	13.2	8.83	4.99
WETF Fire (TA-16-205)	WETFF	W. Jemez Rd (393)	5.91	8.92	7.3	5.08	3.66	2.75	1.73	1.13	0.628
WCRR Outdoor Storage Area Fire (TA-50-69)	RAD07	Trailer Park (1161)	1.1	44.7	10.8	3.79	2.08	1.37	0.767	0.479	0.256
Waste Storage Dome Fire (TA-54)	DOMEF	Pueblo Boundary (267)	419	1,950	461	157	83.6	53.8	29	18.1	9.33
Onsite Transuranic Waste Accident (TA-54)	DOMET	Pueblo Boundary (267)	186	761	202	86.6	52.2	36.1	21.2	14.1	7.98
Plutonium Facility Storage Container Release (TA-55-4)	RAD10	Royal Crest Trailer Park (1016)	2.5	35.8	14.5	6.47	3.84	2.56	1.44	0.915	0.494
Plutonium Facility Ion Column Rupture (TA-55-4)	RAD14	Royal Crest Trailer Park (1016)	1.28	9.09	5.42	2.89	1.84	1.31	0.777	0.494	0.267
DVRS Operational Spill (TA-54)	DVRS01	Site Boundary (227)	19.6	51.4	17.4	6.83	3.81	2.52	1.39	0.877	0.457
DVRS Building Fire and Spill Due to Forklift Collision (TA-54)	DVRS05	Site Boundary (227)	321	888	285	113	64.3	43	24.2	15.7	8.39
SHEBA Hydrogen Detonation	SHEBA	Pueblo Boundary (976)	0.877	15.4	4.35	1.93	1.2	0.854	0.521	0.357	0.205
CMR HEPA Filter Fire (TA-3-29)	CMR02	Town Site Boundary (924)	0.774	5.38	2.72	1.46	0.967	0.712	0.45	0.303	0.177
Fire Impacting Sealed Sources, CMR, Wing 9 (TA-3-29)	SEAL2CF	Town Site Boundary (924)	0.0987	1.21[a]	0.276	0.129	0.106	0.0958	0.0796	0.0645	0.0440
Explosion in a Pit at MDA G	MDAGEXP	Pueblo Boundary (355)	55.2	405	95.8	32.6	17.3	11.2	6.01	3.74	1.92
Site Wide Seismic Event (Section D.4)											
TA-3-29 (CMR) Seismic 1 & 2	CMR08	Town Site Boundary (924)	62.0	1940	470	161	85.6	55.1	29.6	17.8	9.11
TA-16-205 (WETF) Seismic 2	SIT02	W. Jemez Rd (393)	6.43	5.86	8.02	5.41	3.77	2.78	1.7	1.1	0.598

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-18-168 (SHEBA) Seismic 2	SIT08	Pueblo Boundary (976)	0.0301	1.06	0.25	0.0852	0.0452	0.0291	0.0157	0.00975	0.00502
TA-21-155 (TSTA) Seismic 1 & 2	SIT09	State Route 502 (357)	0.00146	0.0111	.00259	.000877	.000464	.000298	.00016	.0000949	.0000477
TA-21-209 (TSFF) Seismic 1 & 2	SIT10	State Route 502 (363)	0.0125	0.0974	0.0228	0.00771	0.00408	0.00262	0.00140	0.000835	0.000420
TA-50-1 (RLWTF) Seismic 1 & 2	SIT11	Royal Crest Trailer Park (1082)	3.02	121	29	9.94	5.29	3.41	1.79	1.09	0.565
TA-50-69 (WCRR) Seismic 2	SIT13	Royal Crest Trailer Park (1161)	2.84	129	30.8	10.5	5.56	3.58	1.92	1.16	0.591
TA-54-38 (RANT) Seismic 1 & 2	SIT14	Pueblo Boundary (402)	64.2	576	136	46.4	24.7	15.9	8.55	5.32	2.74
TA-55-4 (Plutonium Facility) Seismic 2	SIT15	Royal Crest Trailer Park (1016)	4.21	47.9	21.4	10.1	6.2	4.31	2.51	1.58	0.847
TA-55-185 (Storage Shed) Seismic 1 & 2	SIT16	Royal Crest Trailer Park (1068)	5.98	239	56.9	19.4	10.3	6.63	3.55	2.14	1.10
TA-55-355 (SST Facility) Seismic 2	SIT19	Royal Crest Trailer Park (1048)	3.94	129	33.4	11.7	6.26	4.05	2.18	1.32	0.674
DVRS (PC-2 Seismic) Seismic 1	DVRS08	Site Boundary NNE (227)	2.76	10.1	2.39	0.821	0.438	0.283	0.153	0.0956	0.0495
DVRS (PC-3 Seismic) Seismic 2	DVRS12	Site Boundary NNE (227)	33.7	123	29.3	10	5.35	3.45	1.87	1.17	0.605
TA-54 Waste Storage Domes Seismic 2	DOMEM	Pueblo Boundary (267)	462	2150	509	173	92.1	59.3	31.9	19.9	10.2
Site Wide Wildfire Event (Section D.5)											
TA-03-66/451 (Sigma Complex)	WILDF01	Town Site Boundary (924)	0.00389	0.0759	.0202	.00831	.00497	.00358	.00251	.00218	.00204
TA-16-205 (WETF)	WILDF02	W. Jemez Rd (393)	0.0605	0.333	0.103	0.0503	0.0354	0.0337	0.0401	0.0479	0.0536
TA-48-1 (Radiochemistry Lab)	WILDF05	Royal Crest Trailer Park (677)	0.00107	0.0155	.00405	.00161	.000939	.000642	.000377	.000254	.000154
TA-54 (Waste Storage Domes)	DOMEM	Pueblo Boundary (267)	1,930	8,730	2,120	760	422	280	158	102	56.1

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)	1.48×10^{-6}	0.0000173	4.53×10^{-6}	1.80×10^{-6}	1.05×10^{-6}	7.12×10^{-7}	4.12×10^{-7}	2.72×10^{-7}	1.56×10^{-7}
TA-54 (DVRS)	WDVRS06	NNE of facility (227)	4.91	16.4	4.36	1.84	1.12	0.855	0.723	0.748	0.771
TA-8-23 (Radiography)	WILDF10	WSW Boundary (412)	.000332	.00191	.000592	.000289	.000203	.000194	.00023	.000275	.000308
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)	6.31	32.5	16.8	9.44	7.12	6.13	5.06	4.24	3.07
Seismic Induced Building Collapse and Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC16	Royal Crest Trailer Park (941)	29.6	152	79	44.3	33.4	28.7	23.7	19.9	14.4
Seismic Induced Building Collapse with No Fire Involving Plutonium-238 in General Purpose Heat Source Modules	MRSC15	Royal Crest Trailer Park (941)	19.4	171	82.1	40.9	25.6	18.1	10.8	6.87	3.74
Spill of Plutonium-238 Residue from 2-Liter Bottles Outside of Hot Cell	MRSC13	Royal Crest Trailer Park (941)	0.00662	0.0448	0.0236	0.0128	0.00848	0.0062	0.00385	0.00252	0.00141
Hot Cell Plutonium-238 Spill with No Confinement	MRSC14	Royal Crest Trailer Park (941)	2.12	14.3	7.56	4.11	2.71	1.98	1.23	0.808	0.452
Main Vault Fire	MRSC17	Royal Crest Trailer Park (941)	12.8	65.9	34.1	19.1	14.4	12.4	10.3	8.59	6.22
Material Disposal Area Remediation Accidents (Section I.5)											
Explosion at MDA G	MDAGEXP	Pueblo Boundary (355)	55.2	405	95.8	32.6	17.3	11.2	6.01	3.74	1.92

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
Fire at MDA B	MDABFIR	Nearest Boundary (45)	1.26	0.280	0.0656	0.0223	0.0118	0.00759	0.00406	0.00242	0.00122
Sealed Sources Accidents (Section J.3)											
Aircraft Crash at TA-54, Area G	SEAL1CM	Site Boundary NNE (267)	0.0843	0.517[a]	0.0910	0.0401	0.0244	0.0170	0.00996	0.00656	0.00363
Severe Earthquake and Fire at CMR	SEAL2CF	Town Site Boundary (924)	0.0987	1.21[a]	0.276	0.129	0.106	0.0958	0.0796	0.0645	0.0440
Severe Earthquake and Fire at TA-48	SEAL3CF	Royal Crest Trailer Park (941)	0.0980	1.21[a]	0.276	0.129	0.106	0.0958	0.0796	0.0645	0.0440
RH-Transuranic Waste Management Facilities Accidents (Section H.4)											
Explosion at MDA G RH-Transuranic Shaft 205	GS205EX	Pueblo Boundary (355)	0.31	2.27	0.538	0.183	0.0973	0.0626	0.0337	0.021	0.0108
Explosion at MDA G RH-Transuranic Shaft 206	GS206EX	Pueblo Boundary (355)	0.74	5.43	1.29	0.438	0.233	0.15	0.0806	0.0502	0.0258
Seismic Event Affecting RH-Transuranic in TWCF	DOMSEIS	Trailer Park (1,437)	0.0371	2.33	0.555	0.19	0.101	0.0649	0.0345	0.0209	0.0107
Seismic Event Affecting Transuranic Relocated from Area G Waste Domes to TWCF	DOMES	Trailer Park (1,437m)	28.8	1820	432	147	78.2	50.3	26.9	16.2	8.32

MEI = maximally exposed individual, rem = roentgen equivalent man, 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, TWCF = Transuranic Waste Consolidation Facility.

[a] Doses include component from external exposure to source.

Note: To convert meters to feet, multiply by 3.2808.

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 occur 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 therefore includes contributions from all meteorological conditions, is presented in this SWEIS.

There are two aspects of the code's structure basic 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 to further downwind distances (DOE 2004d); such close-in results frequently over predict the atmospheric concentrations because they do not take into account the initial momentum of the release nor the initial size of the release. The impacts of structures and other obstacles on plume dispersion are also not accounted for. Although most of the results presented in this SWEIS are for distances at least 100 meters downwind from a hypothesized release source, a couple (MEIs from CMR 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 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 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 relating to whether land at a specific location and time is suitable for human habitation (habitability), and (2) decisions relating 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 (ICRP) 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 for the source to be defined in one of four ways (direct source, puddle source, tank source, or pipe source) in order to model various accident scenarios. The source configuration input is used to either specify the chemical source term or to provide ALOHA with the necessary information and data to calculate transient chemical release rates and 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 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 release or release of short duration, 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 (that is, wind speed). The wind direction and wind 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 the initial dilution of the plume; it determines the relative proportion of ambient air that initially mixes with the chemical source emission. Atmospheric turbulence causes the puff or plume to increasingly mix 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, and 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 neutrally buoyant or 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 potentially occur with gases that have a density greater than air due to either a high molecular weight or being sufficiently cooled. A chemical cloud with sufficient aerosol content can also result in the bulk cloud density being 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 as compared to the spreading that occurs with a neutrally buoyant release.

In addition to the source term and downwind concentration calculations, ALOHA allows for the 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 general public. While ERPGs and TEELs are not explicitly a 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 maximally exposed individual) are calculated and presented.

D.10 References

AIHA (American Industrial Hygiene Association), 2005, Current AIHA ERPGs, Available at http://www.aiha.org/Committees/documents/erpglevels.pdf, January.

Allen, C., 1996, *Response of Elk Populations to the La Mesa Fire in Fire Effects in Southwestern Forests; Proceedings of the Second La Mesa Fire Symposium*, U.S. Forest Service General Technical Report RM-GTR-0286, Available at http://biology.usgs.gov/s+t/SNT/noframe/sw159.htm 74914.

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. 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. Meyers, 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, 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.

DOE (U.S. Department of Energy), 1999a, *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico* (DOE/EIS-0238), 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*, Vol. III, DOE/EIS-238, Albuquerque Operations Offices, Albuquerque, New Mexico.

DOE (U.S. Department of Energy), 2000, *Special Environmental Assessment for Actions Taken in Response to the Cerro Grande Fire at Los Alamos National Laboratory*, DOE/SEA-3, Los Alamos, New Mexico.

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, August 2002.

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 and Replacement Project at Los Alamos National Laboratory, Los Alamos, New Mexico*, (DOE/EIS-350), November.

DOE (U.S. Department of Energy), 2003b, *Safety Evaluation Report for TA-54 Area G*, National Nuclear Security Administration, Los Alamos Site Operations, November.

DOE (U.S. Department of Energy), 2003c, Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE) ISCORS Technical Report No. 1, DOE/EH-412/001/0802 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 for the Decontamination and Volume Reduction (DVRS) Glove Box in Support of Quick-to-WIPP Project*, National Security Administration, Los Alamos National Laboratory, June.

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, Office of Environment, Safety, and Health, DOE-EH-4.2.1.4-MACCS2-Code Guidance, 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.

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-5201/1-88-020, Washington, DC, September.

EPA, (U.S. Environmental Protection Agency), 1993, *External Exposures 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, Washington, DC.

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 and CAP88 PC, Environmental Protection Agency, 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*, LA-UR-99-253, Los Alamos National Laboratory, Los Alamos, New Mexico, January.

Gonzales, G., C. Bare, P. Valerio, and S. Mee, 2003, *Radionuclide Activity Concentrations in Conifer Trees at the Los Alamos National Laboratory*, Los Alamos National Laboratory Report LA-UR-03-7237, Los Alamos, New Mexico.

Gonzales, G., A. Ladino, and P. Valerio, 2004, *Qualitative Assessment of Wildfire-Induced Radiological Risk at Los Alamos National Laboratory*, Interim Internal Status Report-2003, LA-UR-03-7238, Los Alamos, New Mexico.

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.

LANL (Los Alamos National Laboratory), 2001, *Updated Calculation of the Inhalation Dose from the Cerro Grade Fire Based on Final Air Data*, LA-UR-01-1132, February.

LANL (Los Alamos National Laboratory), 2002, *Radiological and Nonradiological Effects After the Cerro Grande Fire*, LA-13914, 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, 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, September 2004.

LANL (Los Alamos National Laboratory), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

McHugh, C., T. Kolb and J. Wilson, 2003, *Bark Beetle Attacks on Ponderosa Pine Following Fire in Northern Arizona*, Environmental Entomology, Vol. 32, No. 42, October 18.

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*, Finney, M.A., Missoula, Montana, March.

USDA (United States Department of Agriculture) 2002, Forest Service, *Changes in Fire Hazard as a Result of the Cerro Grande Fire*, Fire Management Today, Volume 62, Winter 2002, 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

E.1 Introduction

The purpose of this appendix is to serve as a summary of the current understanding of groundwater flow at the 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.

A comprehensive study of the geology, hydrologic processes, and site characteristics of an area must be understood in order to formulate a conceptual model of a groundwater flow system. Geologic information must be used in conjunction with the hydrologic data in order 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 of recharge, discharge, and how water borne 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, LANL 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 and these activities have resulted in modification of the conceptual models (Newman and Robinson 2005). As a result of further agreements, LANL will be expanding data collection activities, along with 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 how numerical models have been developed. 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 with references provided.

E.2 Regional Setting

Los Alamos National Laboratory 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).

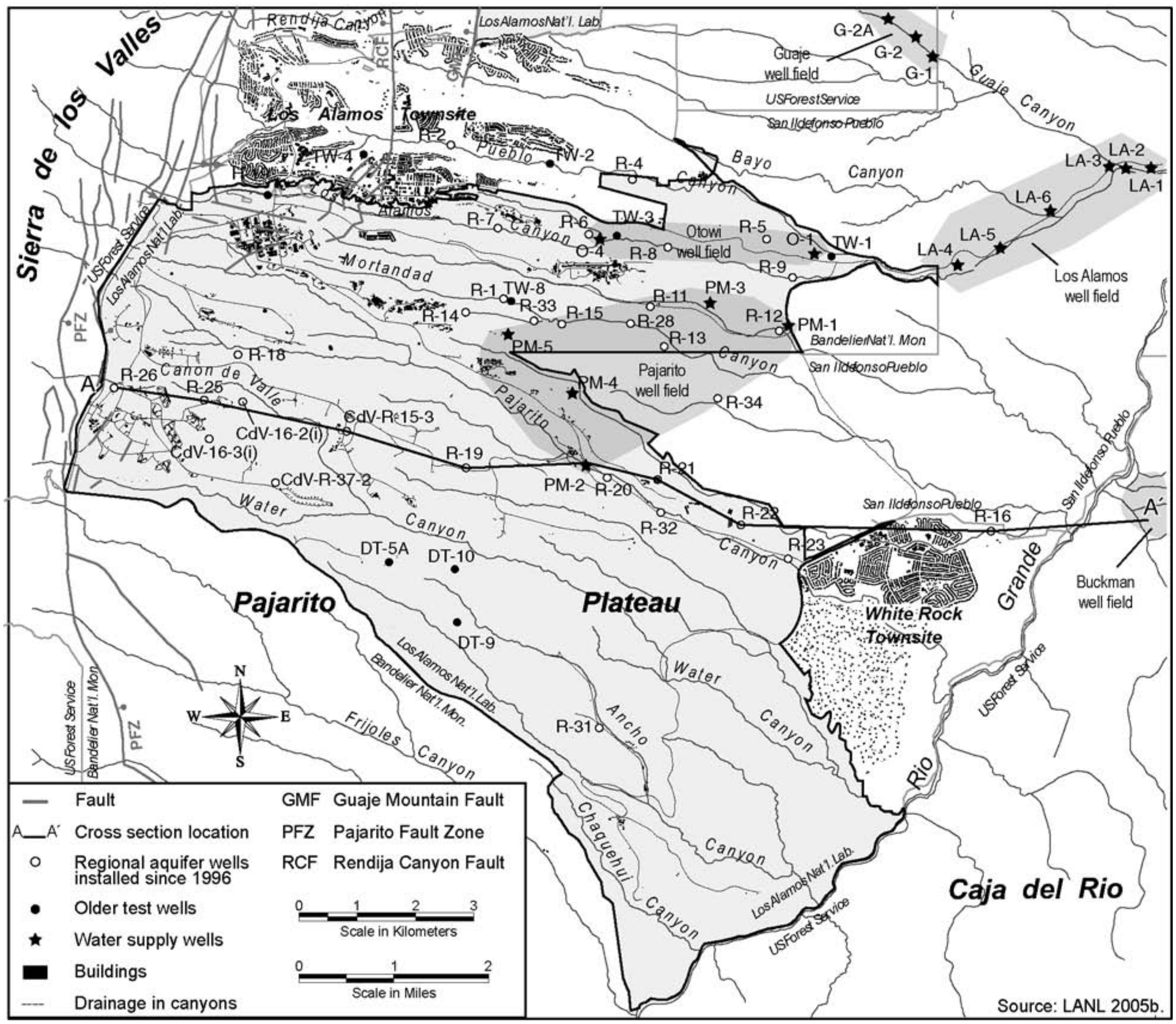


Figure E–1 Location Map of the Central Pajarito Plateau

The drainage of the high slopes of the Jemez region (Sierra de los Valles) extends across the tuff outcrops of the laboratory area. The precipitation potential of the north central part of New Mexico is strongly altitude dependent. Rainfall and snowmelt in the higher elevations is about 18 inches (46 centimeters) and 14 inches (36 centimeters) in 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 inter-glacial). 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 having 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 late Campanian time (approximately 75 million years ago) of the Cretaceous through Eocene time (35 million years ago) resulted in the formation of 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 separated by an uplifted area in north and central New Mexico extending into southern Colorado. The structures formed were the San Juan Basin to the west and the Raton Basin to the east 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).

At the end of Eocene time, about 35 million years ago, three large scale processes began and continued until the late Pleistocene: 1) wide-spread volcanism, 2) extension of the crust (rifting) from Colorado through New Mexico to west Texas, 3) and 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, elongate, 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).

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

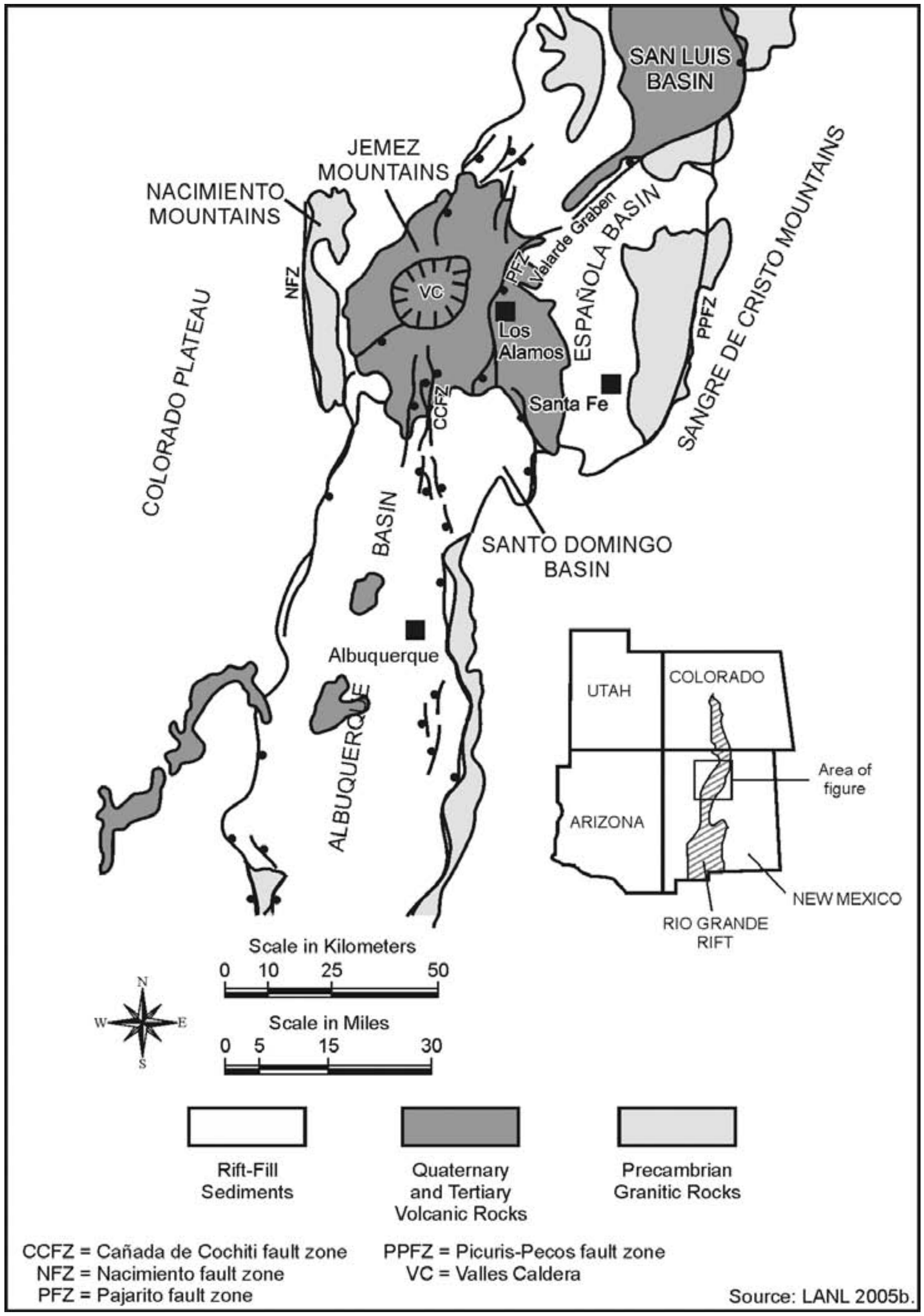


Figure E–2 Locations of Major Structural and Geologic Elements in the Vicinity of Los Alamos National Laboratory

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 which has been examined 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).

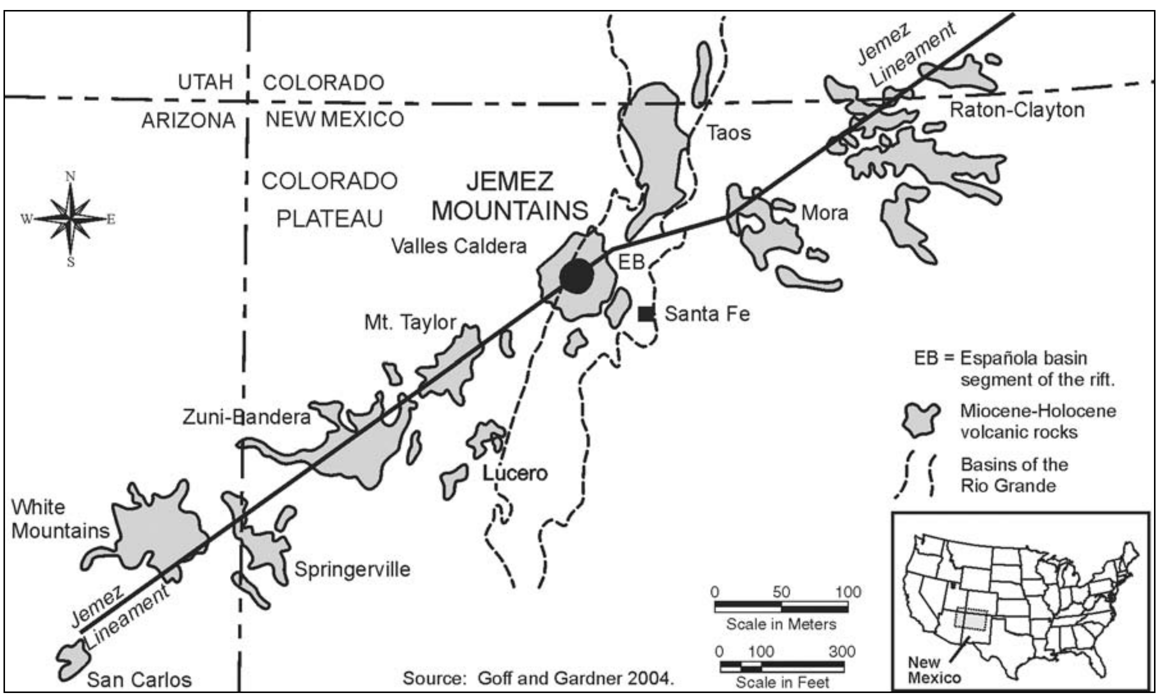


Figure E–3 Location Map of the Jemez Mountains and Valles Caldera with Respect to the Jemez Volcanic Lineament, the Colorado Plateau and the Rio Grande Rift

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 is conducting detailed examination of basalt and rhyolite outcrops and drill-hole data from beneath the Pajarito Plateau. The new data have provided insight into the ages of the rocks and the data are being used to determine if 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 for understanding hydrologic and chemical properties when developing conceptual models of groundwater flow and transport. A summary of the units present in the region, approximate ages and a short description is given in **Table E–1**. Further descriptions and relationships of these units with the alluvial units under the Pajarito Plateau are provided in Section E.5 on the 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 led to forming 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 the 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, not clear how relates to Otowi (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.

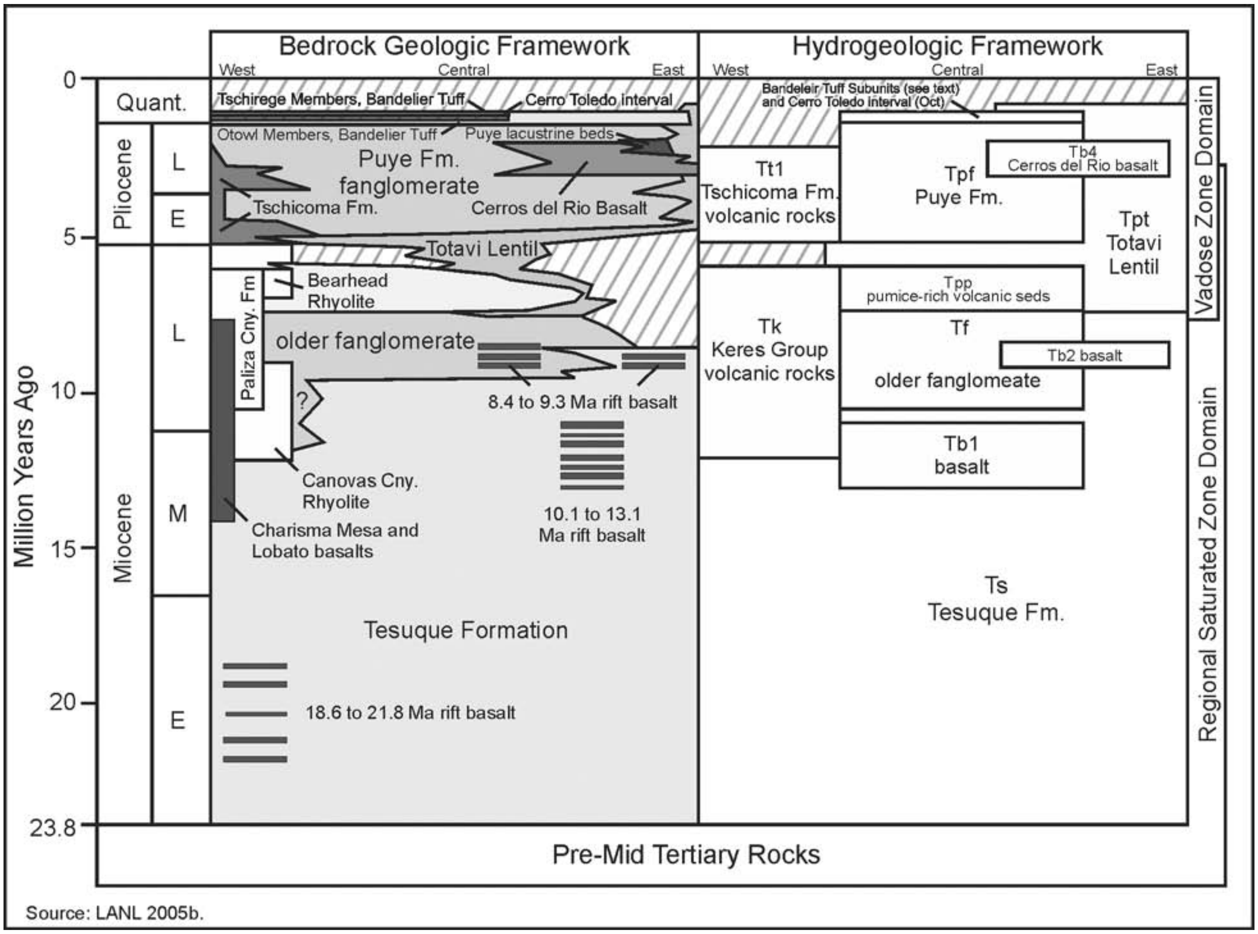


Figure E–4 Pajarito Plateau Stratigraphy and Hydrogeologic Units

E.5.1 Santa Fe Group

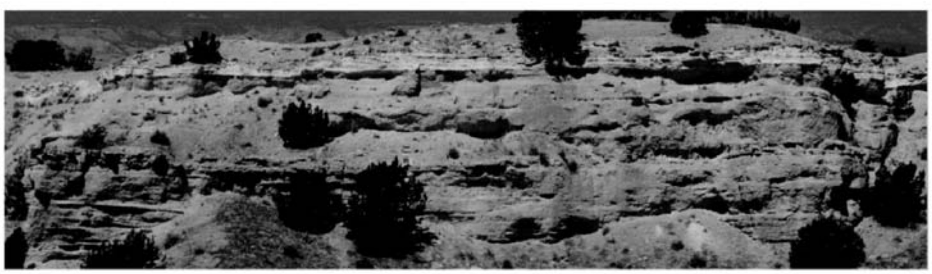
The basins along the Rio Grande Rift average several tens of miles long and are filled with sediments that reach depths of a few tens of thousands of feet. This thick accumulation of sediments in the Española Basin was derived from Precambrian rocks exposed in the highlands north and east of the basin. 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 has been 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). Inter-fingered 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 that are older than the Tesuque in the LANL region. Most of what is known about the Tesuque Formation's lithologic and hydrologic properties is 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, 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 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 are 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, that is, 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 had 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 thickness (up to 2,500 feet [762 meters] in the Sierra de los Valles) where present (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 and, 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 and consists 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 in 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. 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 encounters 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 forming steep, narrow canyons that become wider down gradient 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 which is the source of the tuff (Broxton and Vaniman 2005). The high temperatures were maintained longer due to the thicker deposits thus increasing 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, non-welded 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 unwelded, 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; then 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 to 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 Holocene and Pleistocene age occurs on the canyon floors at LANL. Continuous alluvial deposits of Pleistocene age 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. Thickness of the alluvium 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) and 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 are the result of 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 defines 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** and **E–8**. Figure E–7 is along the Los Alamos Canyon and Figure E–8 is along the 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 definition of hydrologic units is that the gross character of a unit can be modeled relatively consistently. The following discussion presents a comparison of the geologic framework to the hydrologic framework (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.

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 the pumping has on nearby wells completed in the same interval as the pumped well. 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, and by discharge from LANL outfalls. Liquid waste water from LANL released to the outfalls above the canyons was responsible for contamination of alluvial groundwater in the past. The waste water 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. 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 snow-melt 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 if the alluvial systems on the plateau are in communication with the deep perched water or the regional aquifer and to determine if 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 by 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 when a saturated zone becomes unsaturated due to a decline in water level and water is trapped in a zone of high permeability and cannot 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; 4) and, 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 usually 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 that are 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). Depth to 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 are 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 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 area, 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. But like the Tpp, it is heterogeneous and anisotropic. Vertically, heterogeneity is due to layering and laterally 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. 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 Qbo and Qbog, 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 as is found in the welded tuffs in the upper Bandelier (Birdsell et al. 2005). The Guaje Pumice Bed at the base of the Otowi Member is designated hydrologic unit Qbog. It is well-sorted and stratified and 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 the 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 becoming 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 becoming 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 if 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 present a summary of extensive observational data of deep perched water on the plateau and a discussion of the controls on the distribution of deep perched water and how perched zones may develop (Robinson et al. 2005). There is a description and 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 of 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 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 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)* (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. And 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 the 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 including uranium and barium from six sampling rounds.

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. Tritium measurements of groundwater from within the Sierra de los Valles fractured volcanic rocks indicate that groundwater is less that 60 years old, whereas, groundwater in the discharge area at White Rock Canyon ranges from 3,000 to 10,000 years old (LANL 2005b). Carbon-14 dates of regional groundwater in the LANL area indicate that a component of the groundwater is several tens of thousands of years old becoming older from west to east. The presence of tritium though 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, dissolution and sorption of ions from groundwater by minerals. These are important controls on the evolution of groundwater as it migrates and on mobility of contaminant ions.

In the natural groundwater, sodium, calcium and bicarbonate are the most abundant major ion solutes. Slica 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 Cerros del Rio basalt. 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 to 15.4 molar at pH 7) and, consequently, 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 to 27.1 molar at pH 7) but has 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 of 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 of 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, soluble silica glass that is present reacts with the groundwater and forms clay minerals including kaolinite and smectite. Smectite increases 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 to the regional aquifer as well as 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 non-contaminated 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 also 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 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 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 in the LANL are generally from liquid effluent disposal into canyons or from surface impoundments on the mesa tops and rarely from solid waste disposal. These effluents have degraded shallow perched water in some canyons (LANL 2005b). Canyons that have received radioactive effluent are 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 and its tributary Cañon de Valle. Los Alamos County and LANL 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 reaches the deep regional groundwater because it is separated from the perched water by hundreds of feet of dry 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, knowledge of geochemistry, and knowledge of 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. Non-reactive 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 contaminants do not accumulate. Because 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 below the maximum contaminant level in Mortandad Canyon.

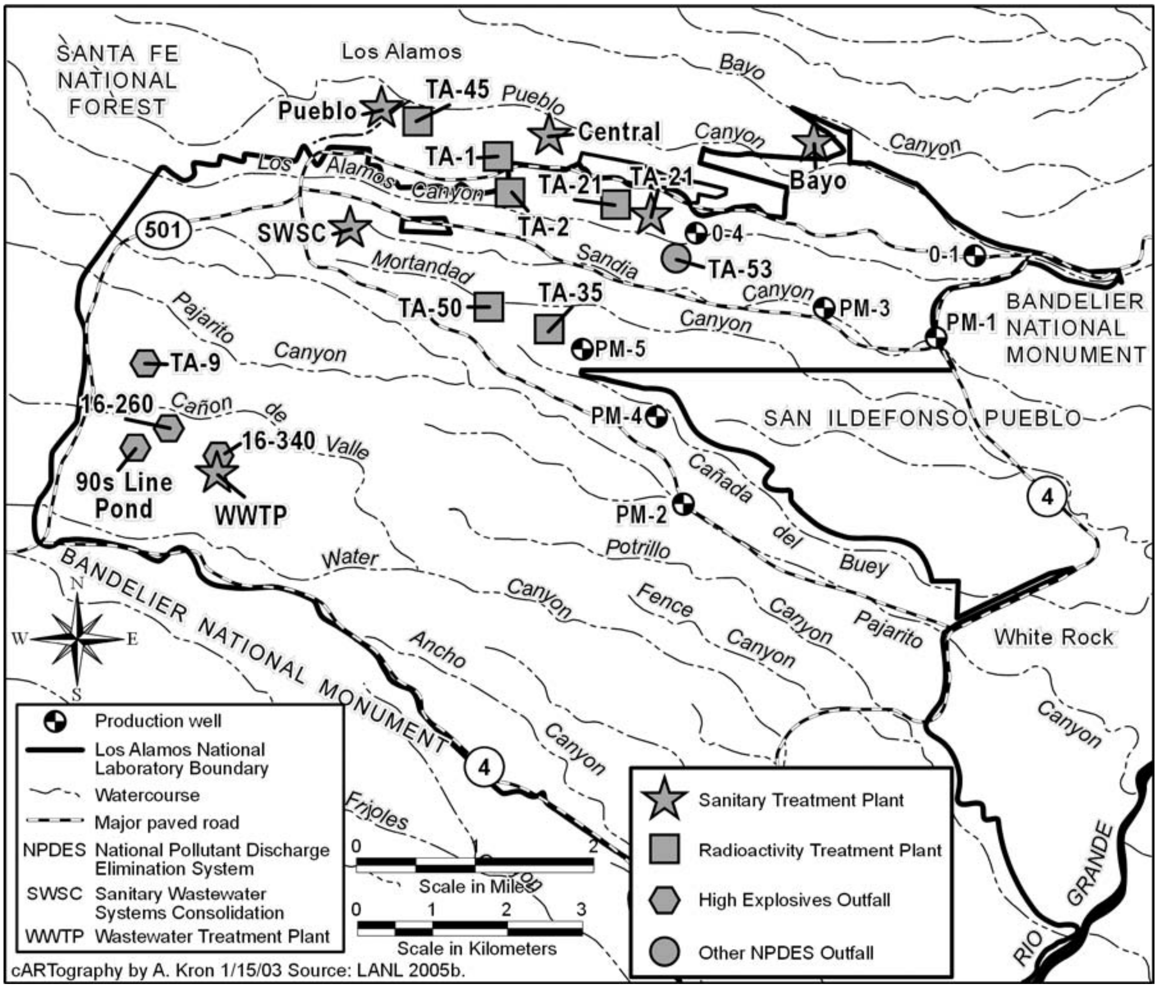


Figure E–10 Major Liquid Release Sources that have Potentially Affected Groundwater at Los Alamos National Laboratory. Most of these are now inactive.

As mentioned above, perched groundwater is separated from alluvial groundwater by several hundred feet of dry rock and, 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 dry rock. Recharge to the regional aquifer also occurs over a long time and, again, contaminants are usually found below alluvial groundwater from canyon bottoms or below mesa-tops where large amounts of effluents were 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 discharge near the recharge sources 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 that may be due to a component of surface water because it is similar to rainfall and Rio Grande data.

Four alternative models are presented in the *Hydrogeologic Synthesis Report* (LANL 2005b). The models are described and examined for strength 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

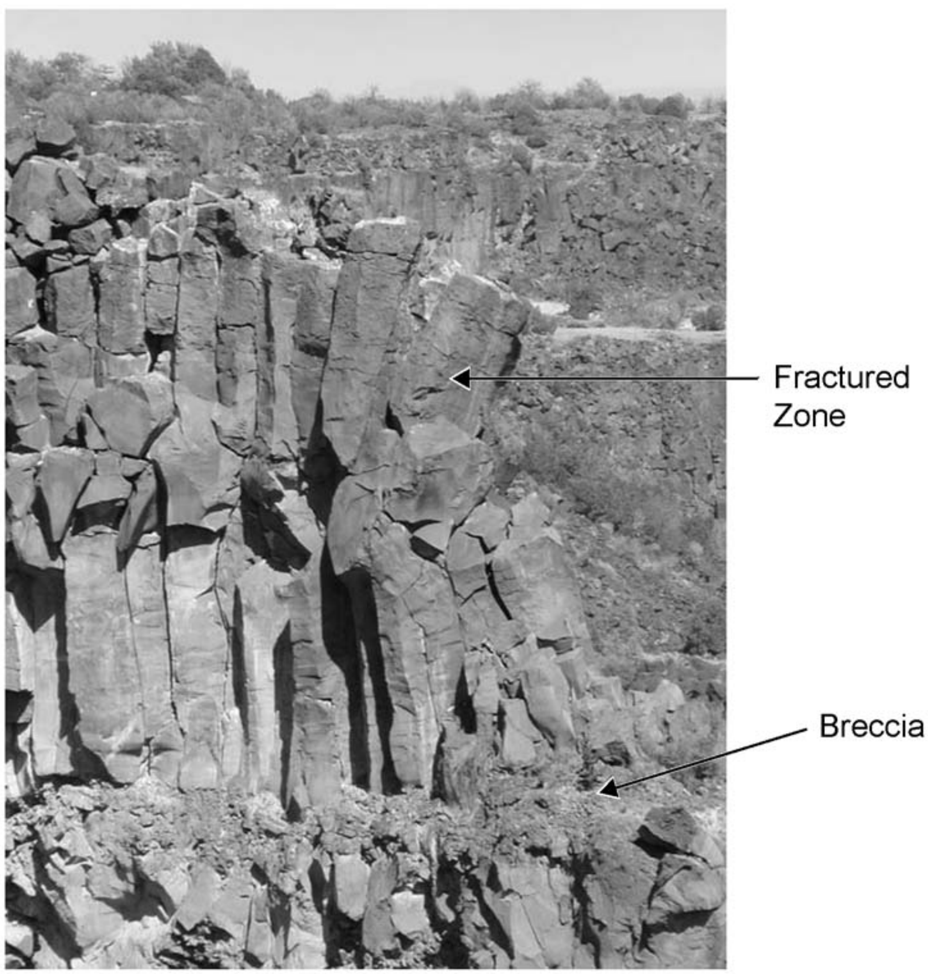
A conceptual model of the geohydrologic system at LANL is being used for most numerical simulations by LANL workers and others (Robinson et al. 2005; Robinson, McLin, and Viswanathan 2005; Robinson, Broxton, and Vaniman 2005; Birdsell et al. 2005; Stauffer and Stone 2005; LANL 1995). The conceptual model was developed and supported with field data. This section describes the components of the conceptual model and how they fit in 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) and 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 sub-surface moisture underneath. Also, 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 principle 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 with a result that 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 in 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 a highly fractured basalt that overlies a massive un-fractured flow interior (Birdsell et al. 2005). This conceptual model is supported by cited reports of water content measurements, major ion measurements, contaminant transport measurements and 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 for the purpose of advancing 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 which 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 which 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 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 was 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 (FEHM) 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 non- 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 most of the contaminants released reside in the vadose zone or in the case of tritium has decayed. 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 an assumption is made 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 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 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 just being in 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 for water for Santa Fe, Española, Los Alamos, various pueblos, and LANL. There is a concern about water levels dropping 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 occurs 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 and 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 points out that this is attributable to 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. It is pointed out that one hypothesis is that springs may be from draining perched aquifers. Another 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 have been developed about the regional aquifer. 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 becoming confined eastward. Specific storage data indicate that parts of the aquifer exhibit "leakey-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 the shallow zones that receive water from local recharge. Parameter uncertainty impacts the ability to make predictions of fluxes and velocities through individual units down gradient 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 were 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 in the 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 and 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 an increase of 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 that 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 but 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 on 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.

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.

Cather, S. M., 2004, “Laramide Orogeny in Central and Northern New Mexico and Southern Colorado,” *Geology of New Mexico, A Geologic History*, Special Publication 11, G. H. Mack and K. A. Giles (ed.), pp. 203-248, New Mexico Geologic Society, 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,” *Geology of New Mexico, A Geologic History*, Special Publication 11, G. H. Mack and K. A. Giles (ed.), pp. 295-312, New Mexico Geologic Society, 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.

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.

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.

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.

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.

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.

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.

Smith, G. A., 2004, "Middle to Late Cenozoic Development of the Rio Grande Rift and Adjacent Regions in Northern New Mexico," *Geology of New Mexico, A Geologic History*, Special Publication 11, G. H. Mack and K. A. Giles (ed.), pp. 331-358, New Mexico Geologic Society, 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.

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, pp. 718-728.

APPENDIX F
ENVIRONMENTAL SAMPLE DATA

APPENDIX F
ENVIRONMENTAL SAMPLE DATA

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 storm water 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 are americium-241, cesium-137, cobalt-60, neptunium-237, plutonium-238, plutonium-239, plutonium-240, potassium-40, radium-226, radium-228, sodium-22, strontium-90, tritium, uranium-234, uranium-235, uranium-236, and uranium-238. Soil samples include only the first 11 radioisotopes because the radiological content of the soil collected within and around LANL have been very low and, for the most part, have not increased over time. Soils will now be sampled once every 3 years. Additional radioisotopes were measured in 2004 data. 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 are representative of 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 the time period of 2001 through 2004, radiological samples were obtained from 15 onsite canyons, as well as sites along the boundary of LANL with non-LANL land. Further measurements were made of samples around the surrounding counties. These samples were used to measure radioactivity levels, and the data was subjected to statistical analysis. The data was subdivided into three principal regions of interest: onsite, perimeter, and regional.

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 present in the environment in and around LANL due to this wildfire. The current measured distribution of radioisotopes in the environment was used to calculate doses to special receptors reported in Appendix C of this Site-Wide Environmental Impact Statement (SWEIS). The current radioisotope distribution in soil, surface water or storm water runoff, sediment, and groundwater were also used in calculating worker and public doses from a postulated wildfire accident in Appendix D.

Since environmental measurements of radioisotopes in and around LANL now exist for the time period of 2001 through 2004, and the same data was developed for the *Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory, Los Alamos, New Mexico (1999 SWEIS)* for the years 1991 through 1996, a graphical presentation was prepared to compare the distribution for each radioisotope and for each of the four environmental media (groundwater, sediment, soil, and surface water or storm water 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 2004 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 was based on measurements at locations within the site, around the perimeter, and in the area surrounding LANL. 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 are representative of relatively long half-life nuclides with potentially 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 since that is the only data available for both time periods. In addition, strontium-90 data is not available for soil data from both time periods. Each soil graph also presents the LANL human health risk based Screening Action Level (SAL) (LANL 2001) that LANL uses as a criterion for acceptable soil radioisotope mass concentration level except for tritium, which is defined as a volumetric concentration value. The SAL is an indicator as to whether further study or environmental remediation is required. These LANL SALs for soil were first developed in 2001 and are based on the U.S. Environmental Protection Agency (EPA) guidance of a 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 was 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 2004 data as shown in **Table F–1**. **Figures F–1** through **F–6** are graphs for groundwater for each measured isotope as shown in Table F–1.

Table F–1 Groundwater Data Set Comparison

Location Number	*1991 through 1996 Data*	*2001 through 2004 Data*
1	Alluvial Groundwater	Canyon Alluvial Groundwater Systems
2	Spring from Basalt	Pueblo/LosAlamos/Sandia Canyon Area Perched System in Conglomerates and Basalt
3	Main Aquifer	Regional Aquifer Springs
4	Test Wells	Test Wells
5	Springs	Other Springs
6	Springs from Volcanics	Perched Groundwater System in Volcanics
7	San Ildefonso	San Ildefonso Pueblo
8	Intermediate Perched	Intermediate Perched Groundwater Systems Pueblo/Los Alamos/Sandia Canyon Area Perched System in Conglomerates and Basalt
9	Not measured	Regional Aquifer Wells Hydrogeologic Characterization Wells
10	Not measured	Water Supply Wells
11	Not measured	Santa Fe Water Supply Wells

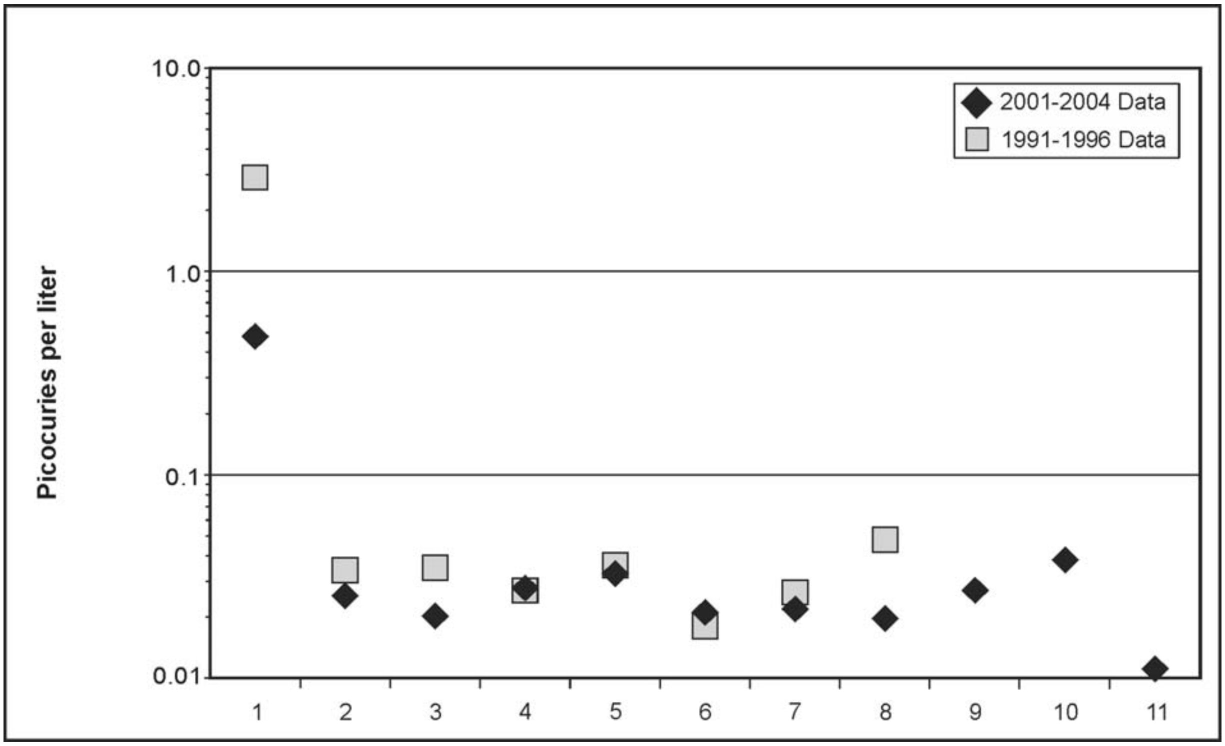


Figure F–1 Americium-241 Measured Mean Concentration Value in Groundwater

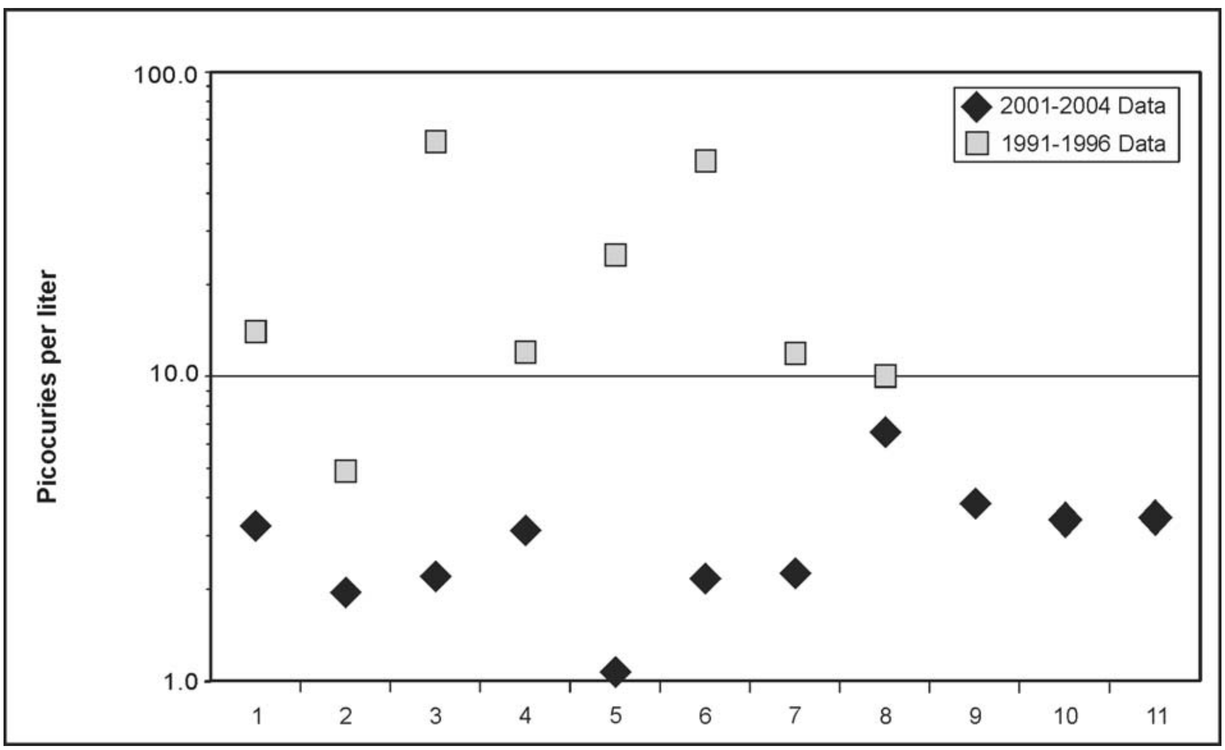


Figure F–2 Cesium-137 Measured Mean Concentration Value in Groundwater

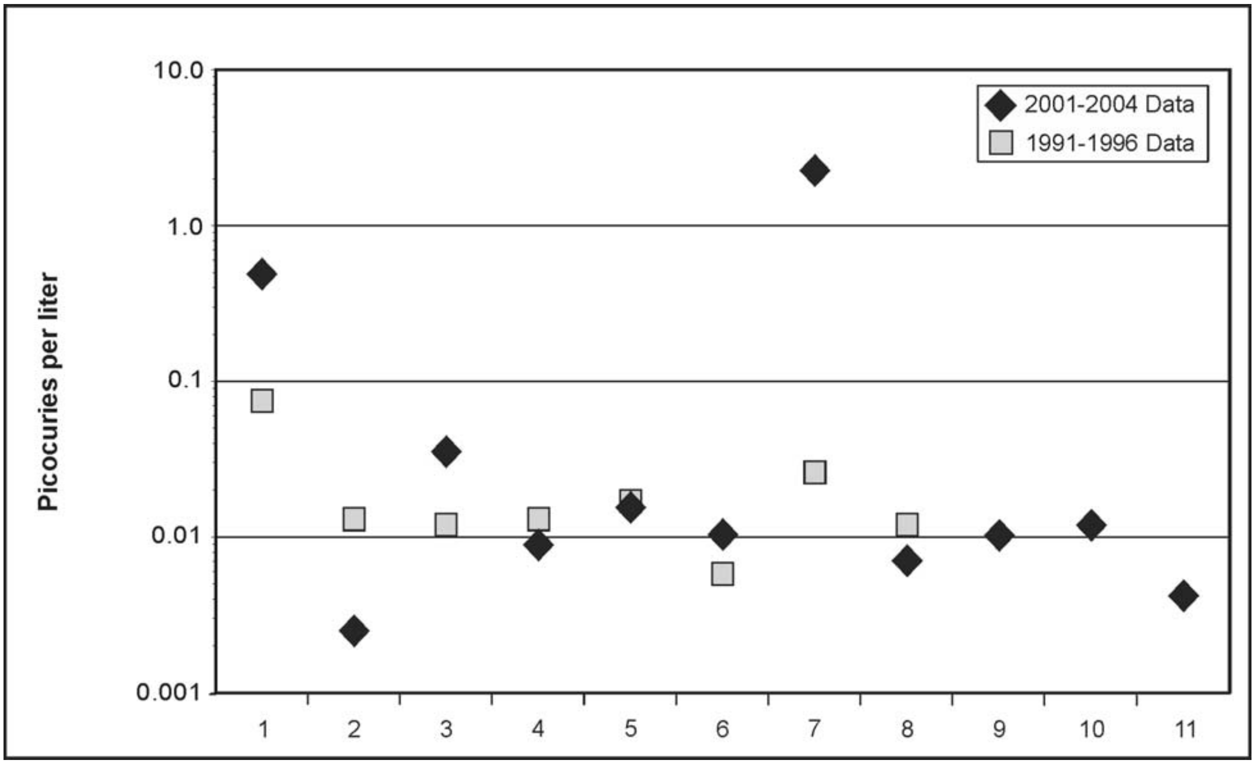


Figure F–3 Plutonium-238 Measured Mean Concentration Value in Groundwater

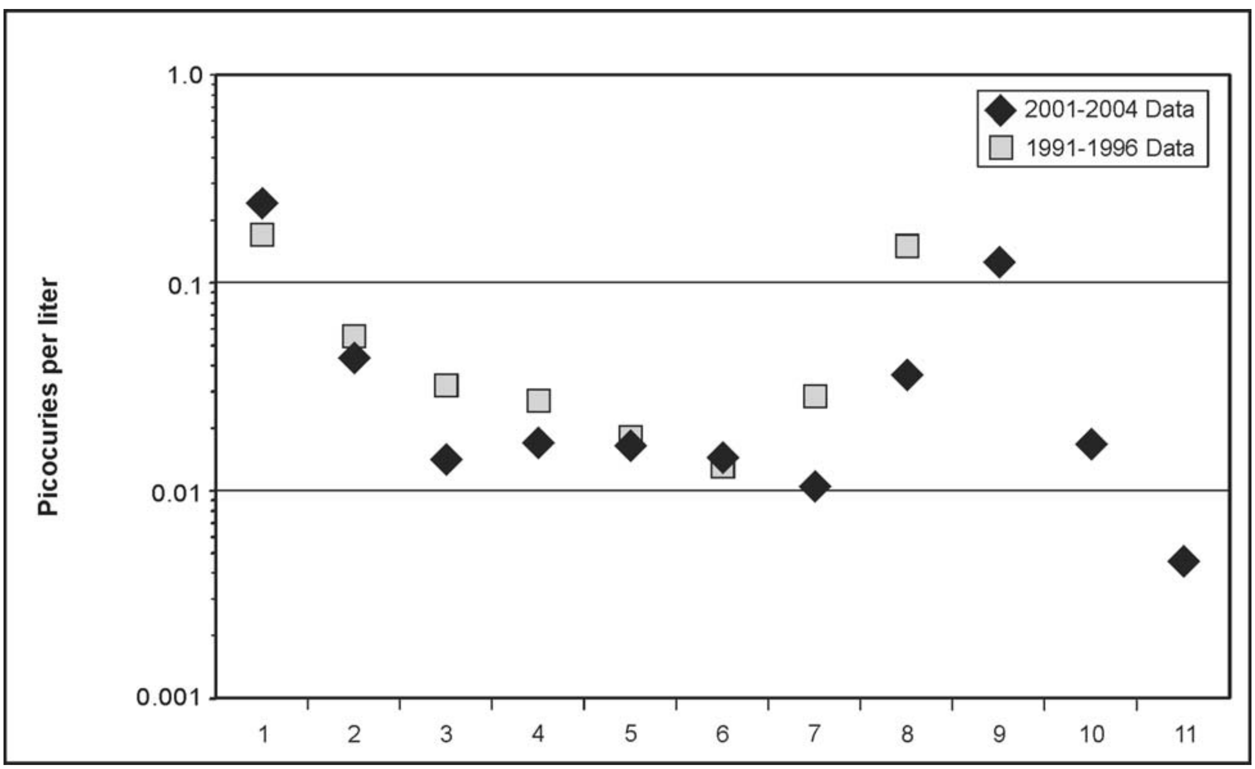


Figure F–4 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value in Groundwater

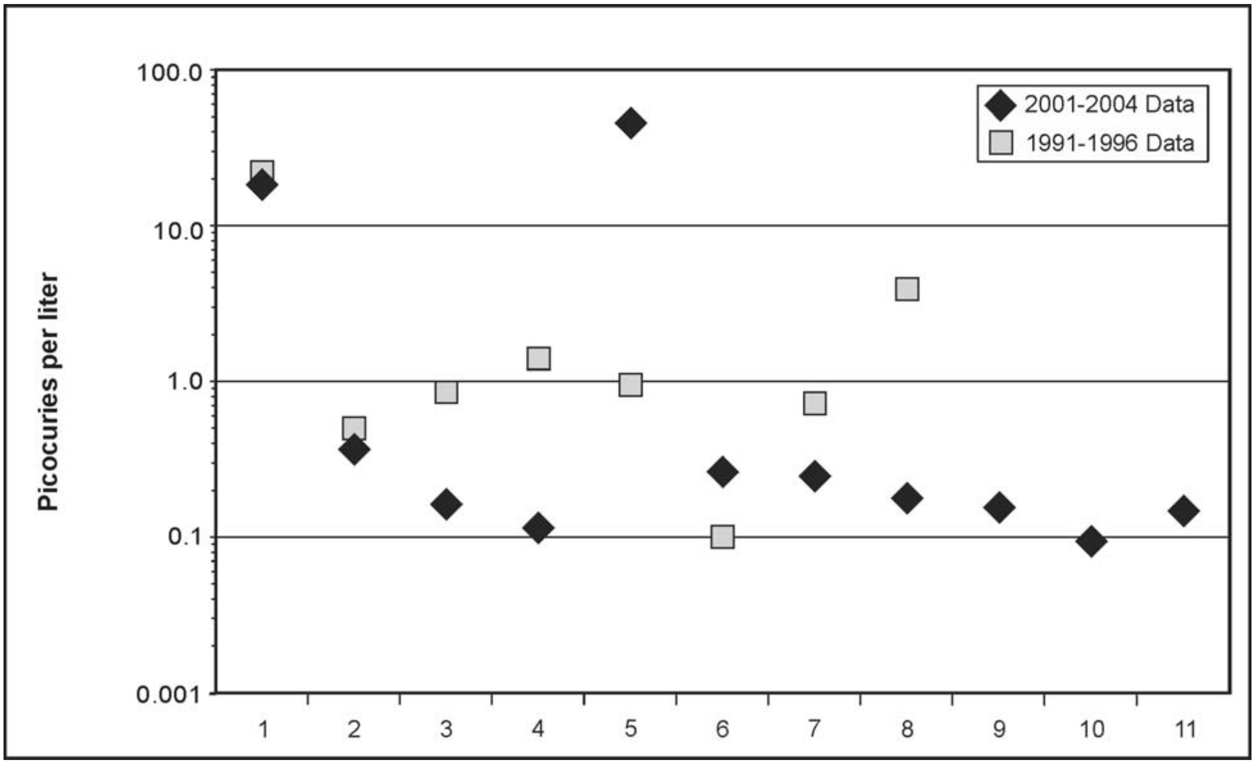


Figure F–5 Strontium-90 Measured Mean Concentration Value in Groundwater

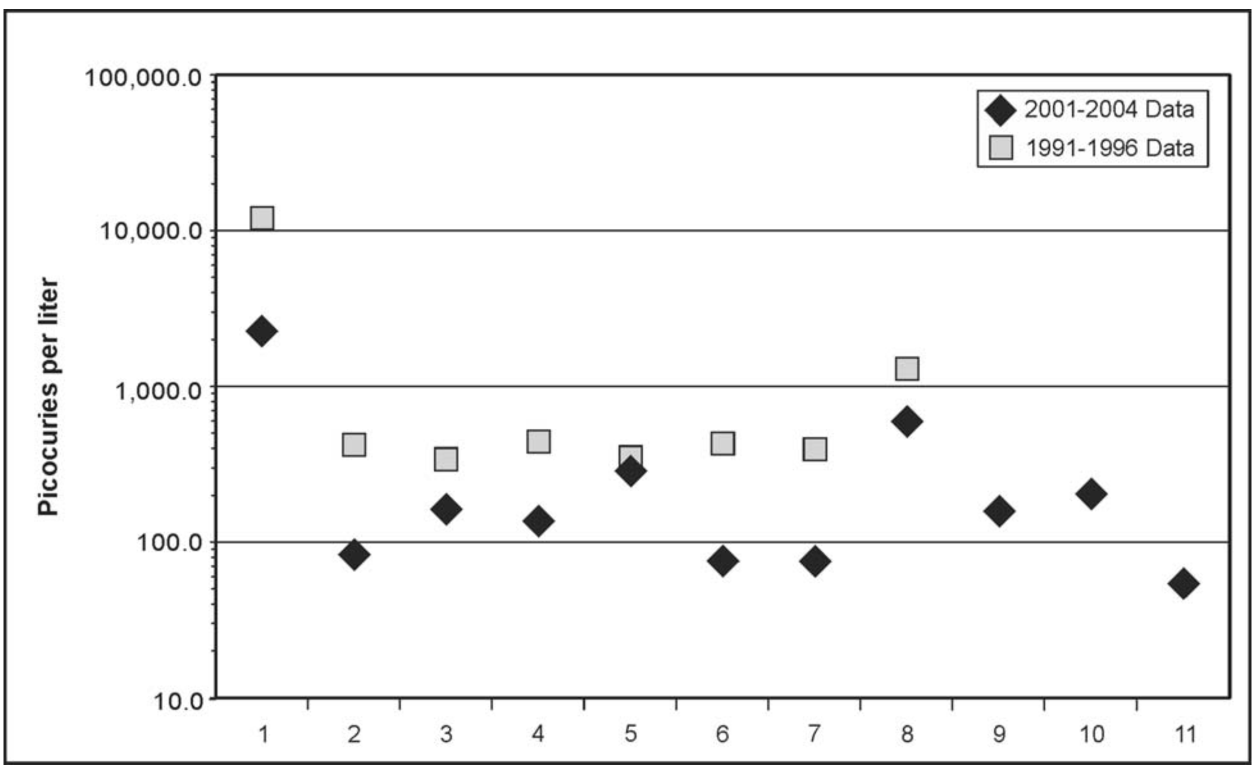


Figure F–6 Tritium Measured Mean Concentration Value in Groundwater

Figures F–7 through **F–12** are sediment graphs for each measured isotope. The data points are in the order shown in **Table F–2**. In 2001 through 2004 data, sediment measurements were provided for Fence and Indio Canyons (two data points on the far right side of the graph) for some isotopes which were not considered in the 1991 through 1996 data.

Table F–2 Sediment Data Set Comparison

Location Number	*1991 through 1996 Data*	*2001 through 2004 Data*
1	Regional Canyons	Regional Canyons
2	Perimeter Canyons	Perimeter Canyons
3	Onsite Canyons	Onsite Canyons
4	Gauje Canyon	Gauje Canyon
5	Bayo Canyon	Bayo Canyon
6	Pueblo Canyon	Pueblo Canyon
7	Los Alamos Canyon	Los Alamos Canyon
8	Sandia Canyon	Sandia Canyon
9	Mortandad Canyon	Mortandad Canyon
10	Cañada del Buey Canyon	Cañada del Buey Canyon
11	Pajarito Canyon	Pajarito Canyon
12	Potrillo Canyon	Potrillo Canyon
13	Water Canyon	Water Canyon
14	Ancho Canyon	Ancho Canyon
15	Chaquehui Canyon	Chaquehui Canyon
16	Frijoles Canyon	Frijoles Canyon
17	Not measured	Fence Canyon
18	Not measured	Indio Canyon

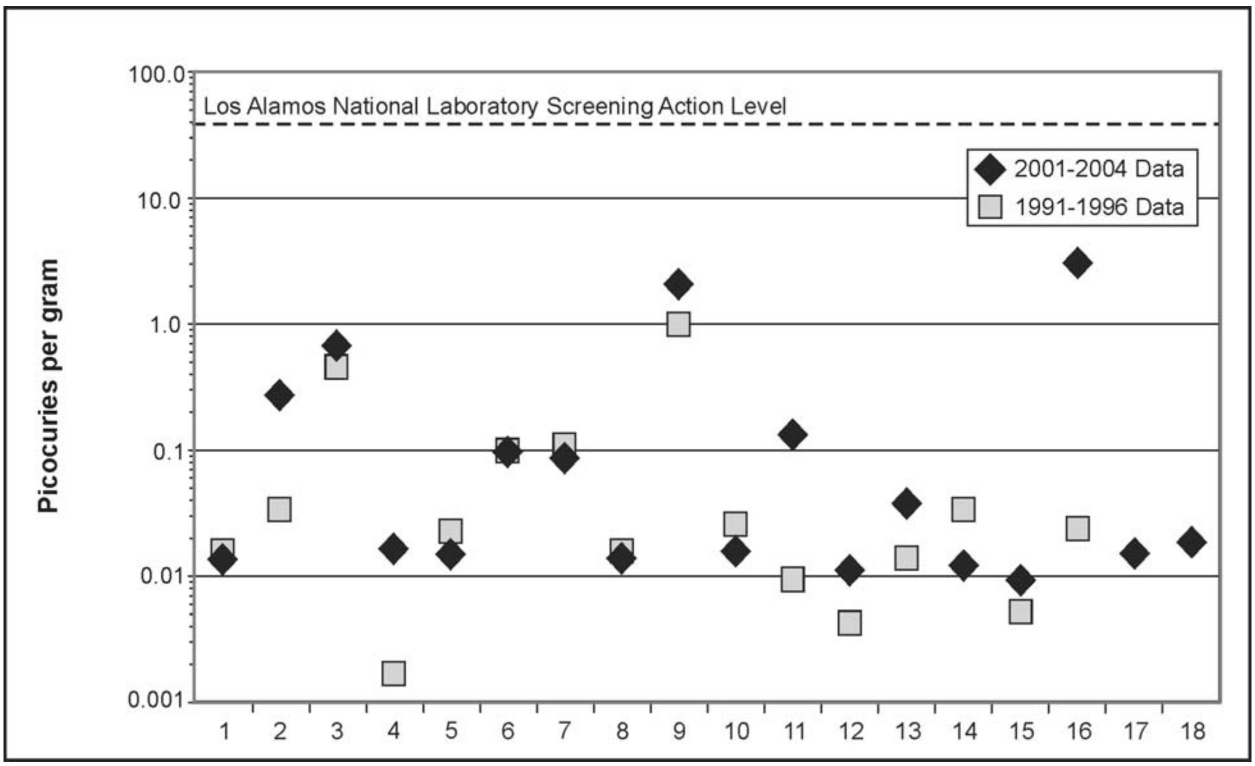


Figure F–7 Americium-241 Measured Mean Concentration Value in Sediment

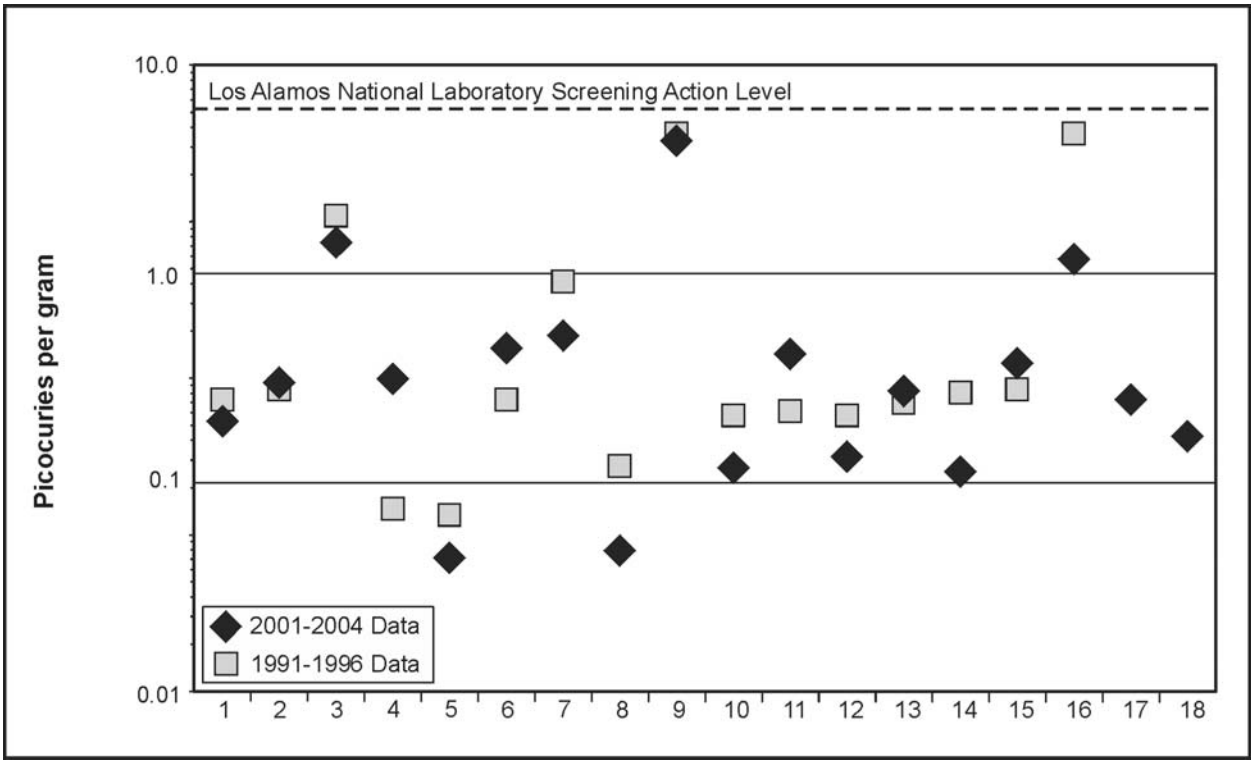


Figure F–8 Cesium-137 Measured Mean Concentration Value in Sediment

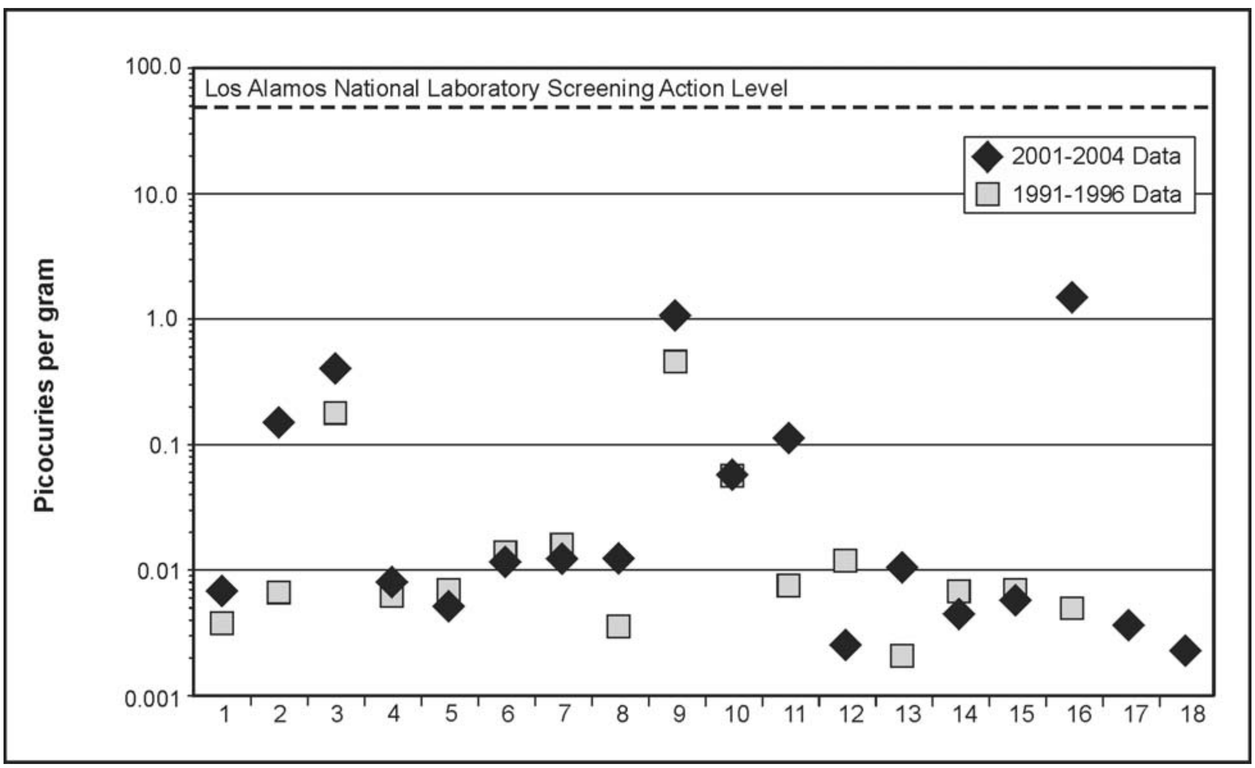


Figure F–9 Plutonium-238 Measured Mean Concentration Value in Sediment

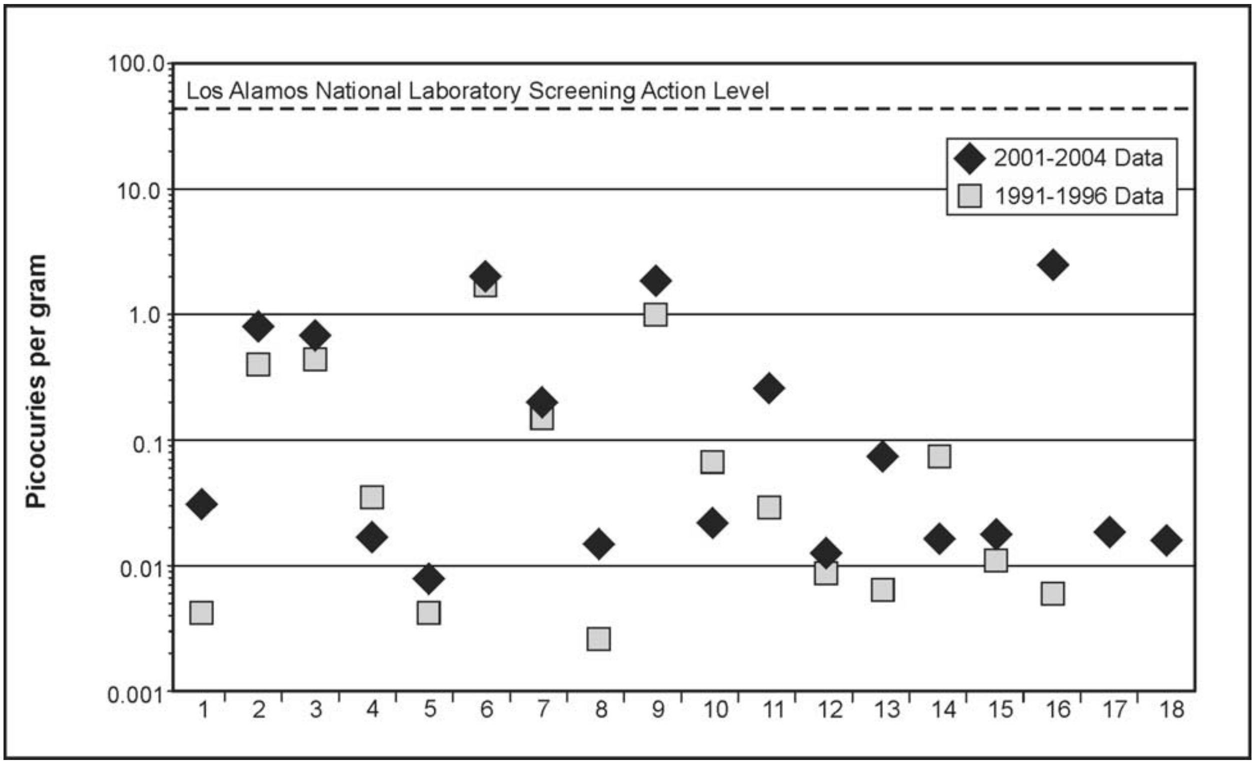


Figure F–10 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value in Sediment

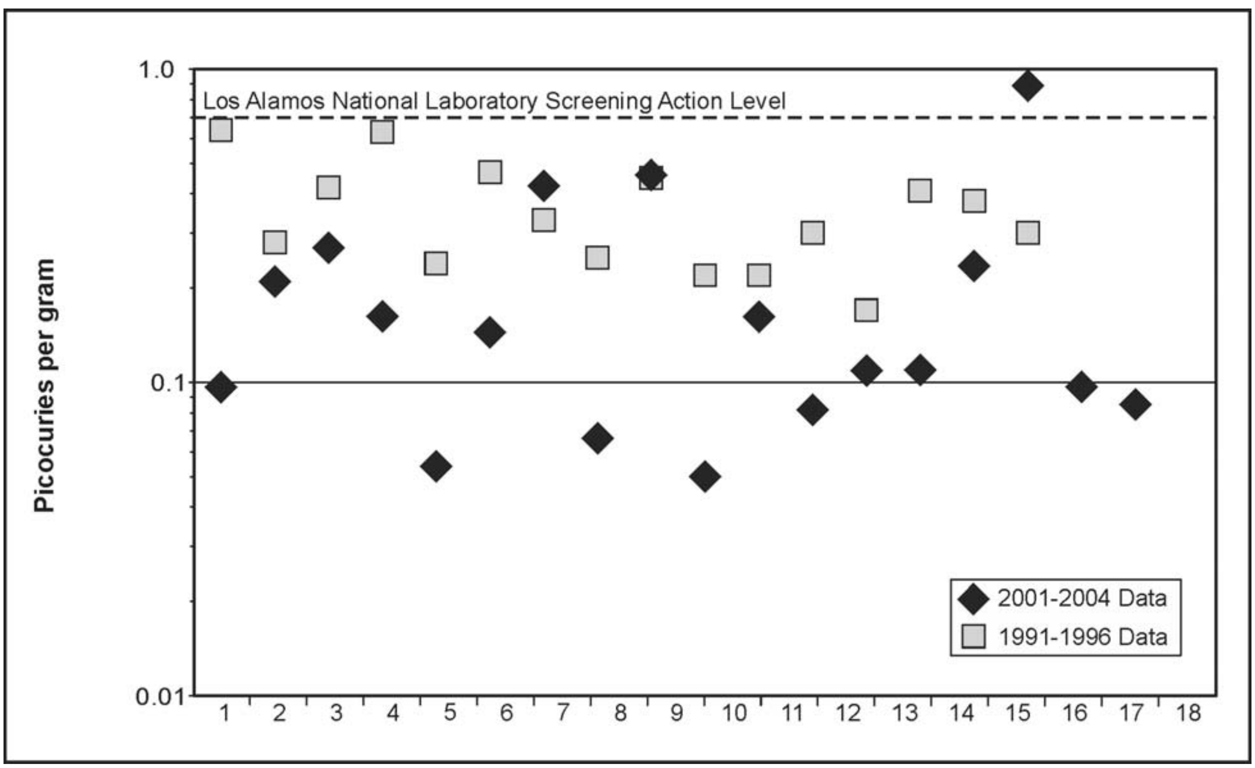


Figure F–11 Strontium-90 Measured Mean Concentration Value in Sediment

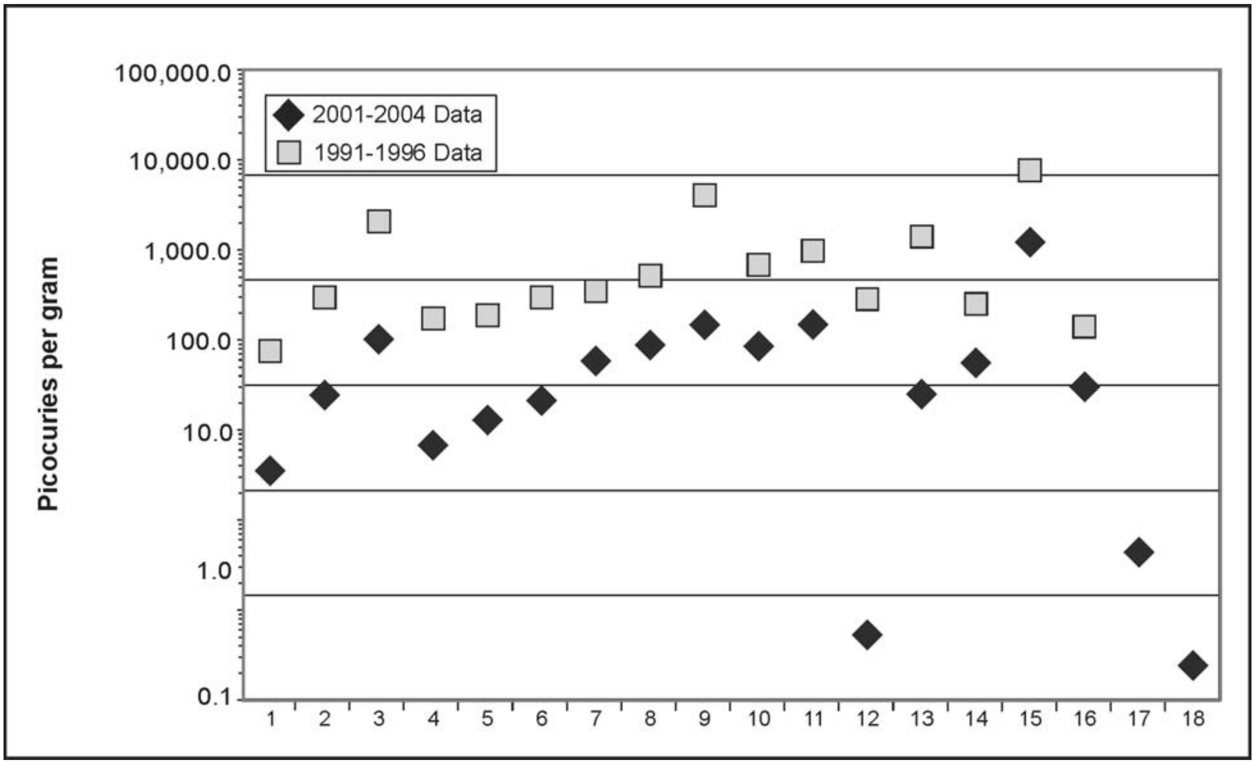


Figure F–12 Tritium Measured Mean Concentration Value in Sediment

Figures F–13 through **F–18** are storm water runoff graphs for each measured isotope. Data points are in the canyon order provided in **Table F–3**. The 1991 through 1996 data includes Cañada del Buey and Chaquehui Canyons, unlike 2001 through 2004 data. Americium-241 data is not available for Ancho and Frijoles Canyons for the 2001 through 2004 data. Cesium-137 data is not available for Chaquehui Canyon for 1991 through 1996 and Ancho Canyon for 2001 through 2004 data. Plutonium-239 and plutonium-240 data are not available for Frijoles Canyon for 2001 through 2004 data. Strontium-90 data is not available for Guaje Canyon for 1991 through 1996 and Ancho Canyon for 2001 through 2004 data. Tritium data is not available for Ancho Canyon for 2001 through 2004.

Table F–3 Storm Water Data Set Comparison

Location Number	*1991 through 1996 Data*	*2001 through 2004 Data*
1	Regional Canyons	Regional Canyons
2	Perimeter Canyons	Perimeter Canyons
3	Onsite Canyons	Onsite Canyons
4	Gauje Canyon	Gauje Canyon
5	Los Alamos Canyon	Los Alamos Canyon
6	Pajarito Canyon	Pajarito Canyon
7	Water Canyon	Water Canyon
8	Mortandad Canyon	Mortandad Canyon
9	Ancho Canyon	Ancho Canyon
10	Frijoles Canyon	Frijoles Canyon
11	Sandia Canyon	Sandia Canyon
12	Pueblo Canyon	Pueblo Canyon
13	Cañada del Buey Canyon	Not measured
14	Chaquehui Canyon	Not measured

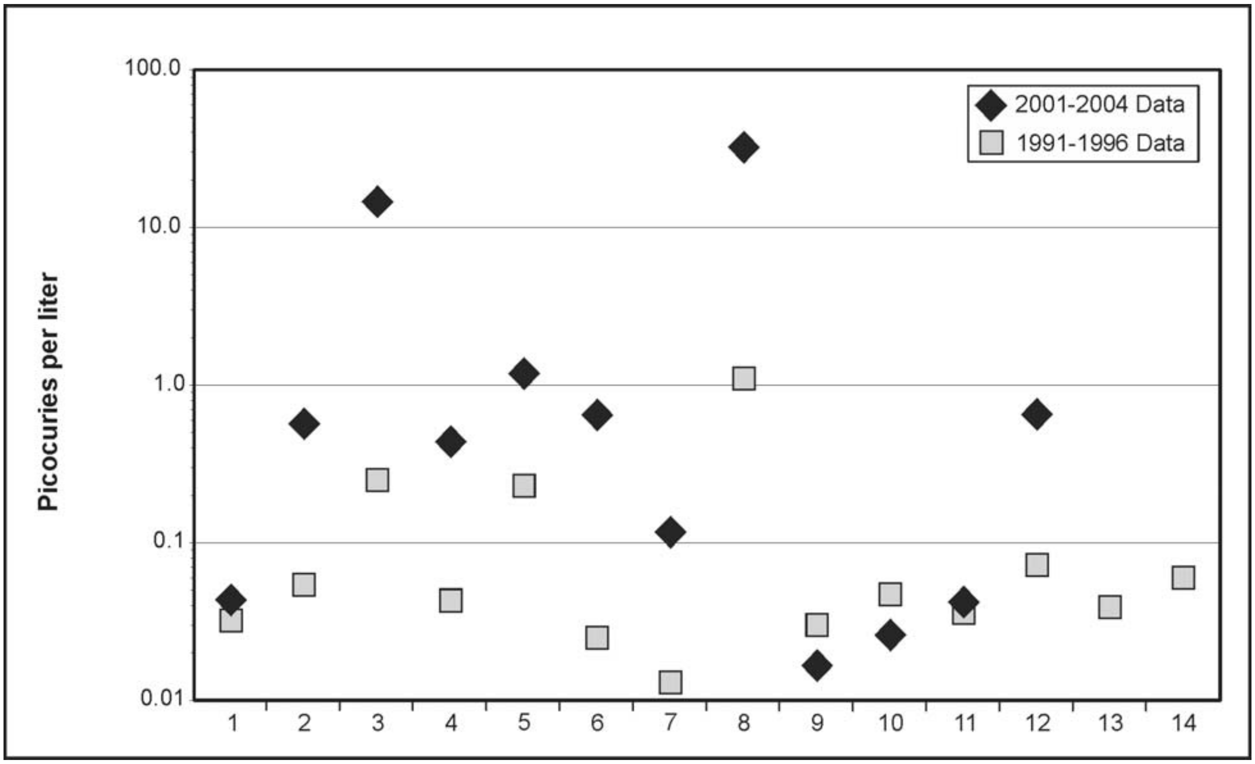


Figure F–13 Americium-241 Measured Mean Concentration Value for Storm Water Runoff

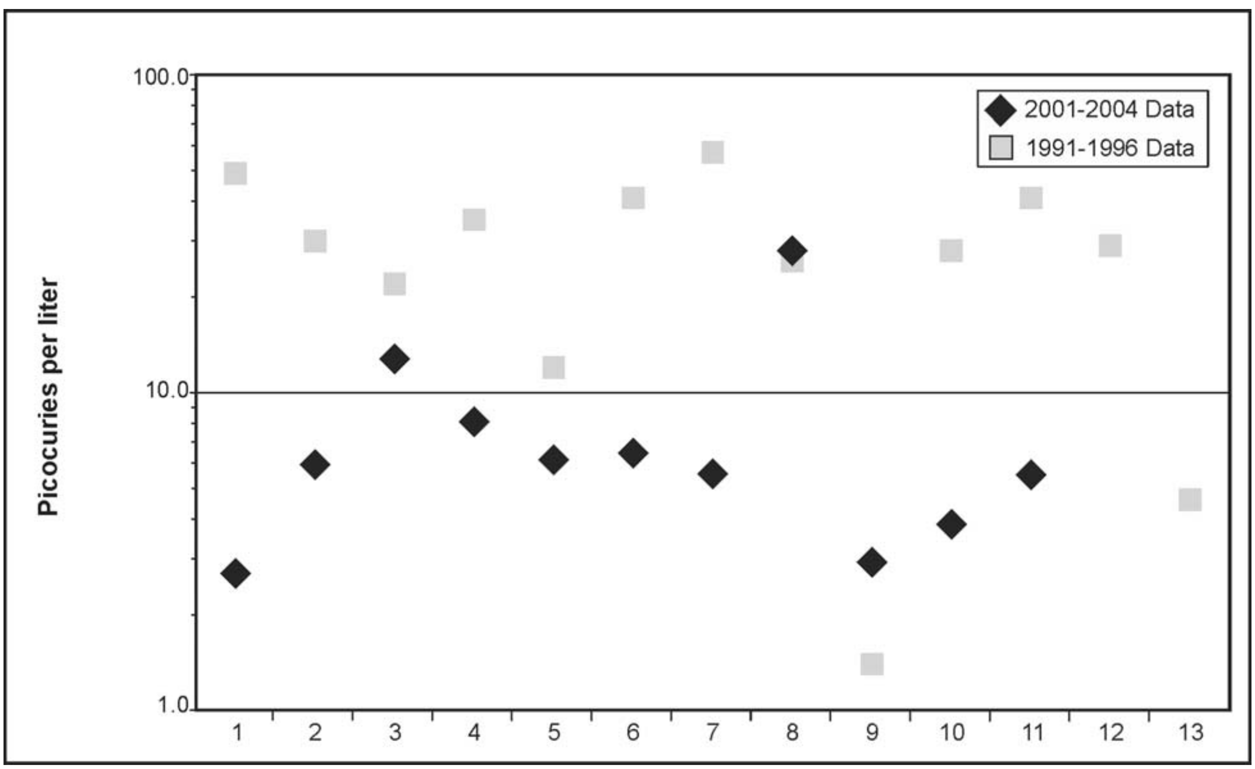


Figure F–14 Cesium-137 Measured Mean Concentration Value for Storm Water Runoff

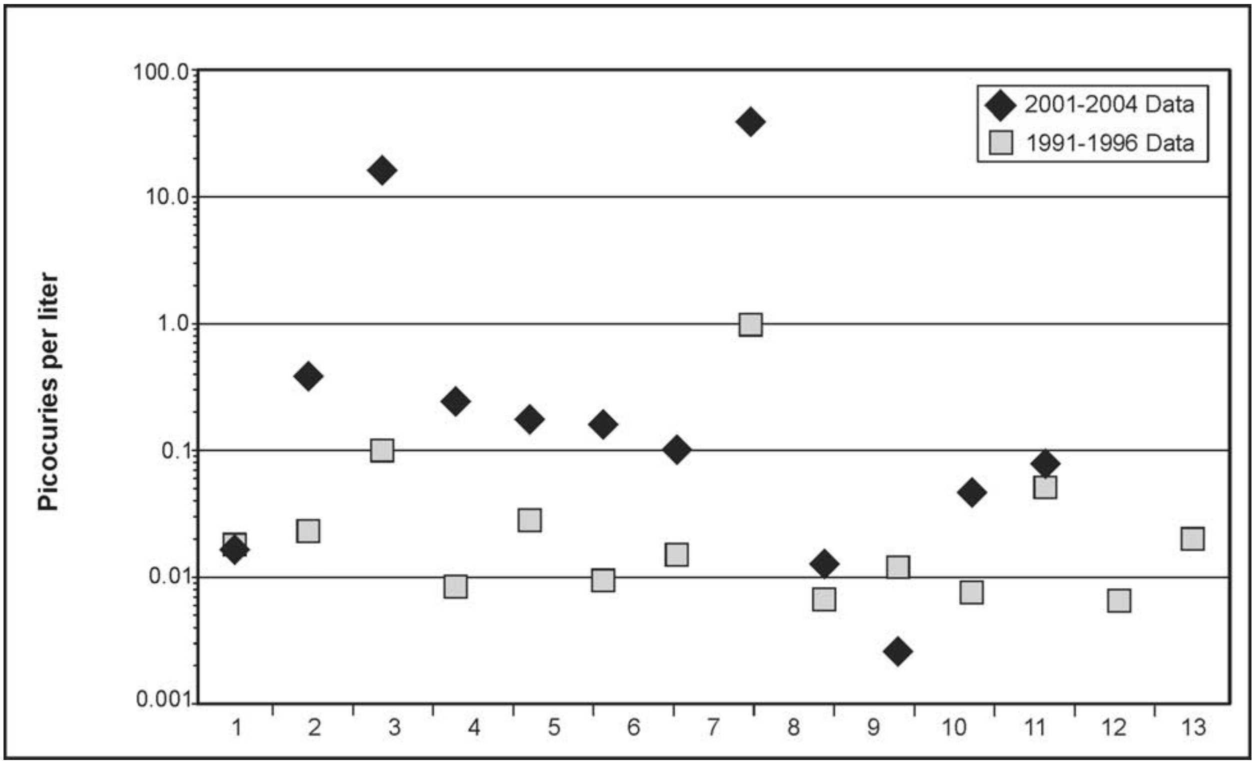


Figure F–15 Plutonium-238 Measured Mean Concentration Value for Storm Water Runoff

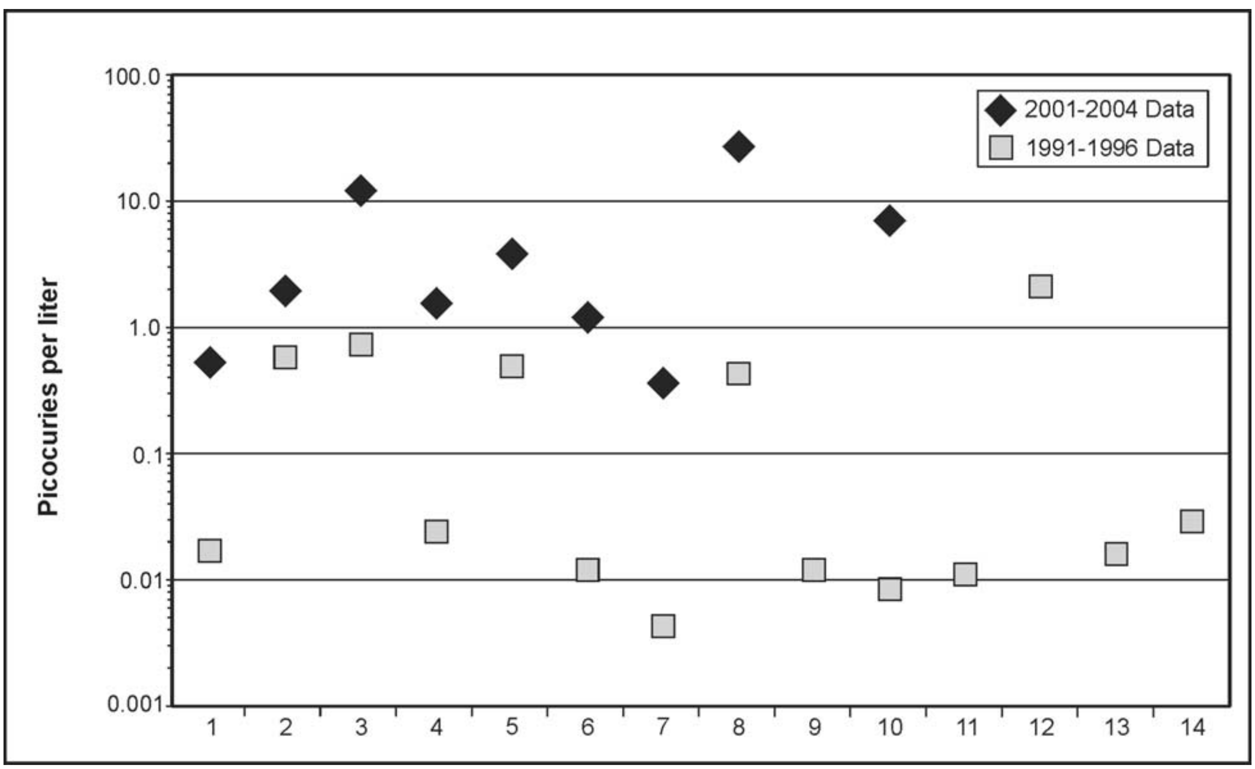


Figure F–16 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Storm Water Runoff

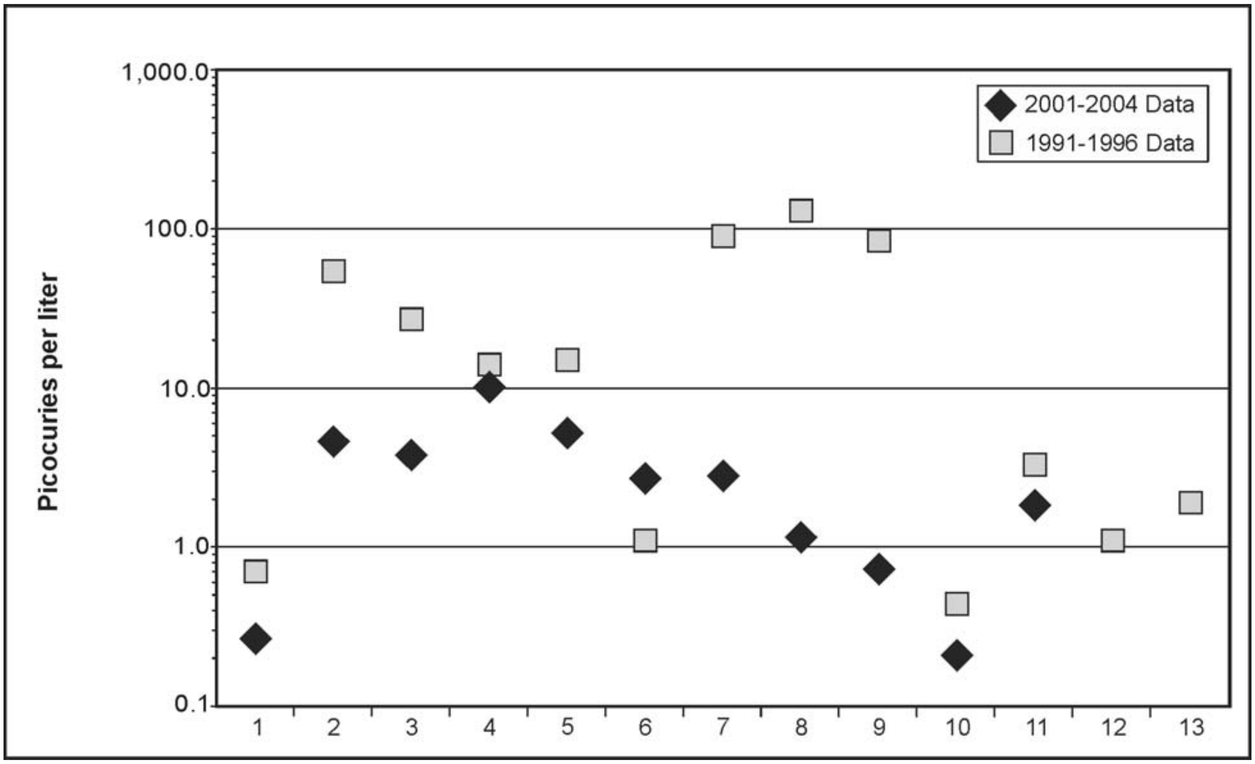


Figure F–17 Strontium-90 Measured Mean Concentration Value for Storm Water Runoff

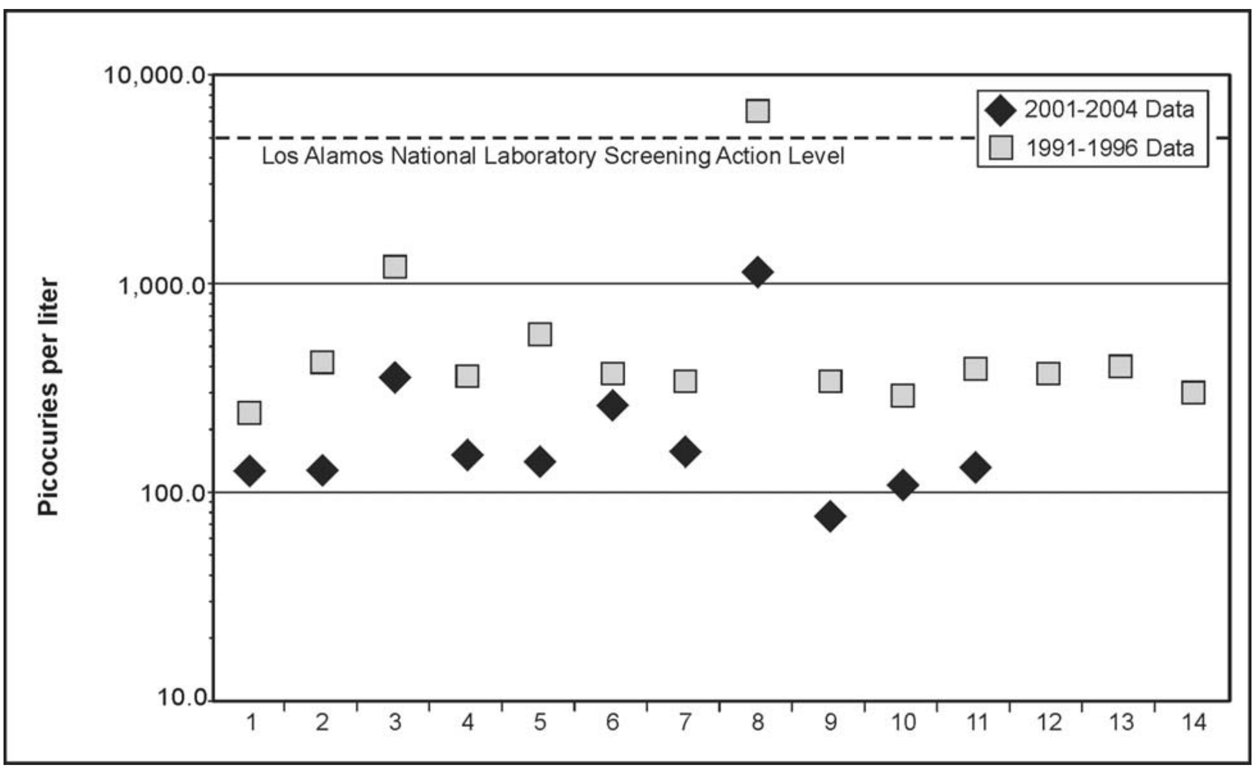


Figure F–18 Tritium Measured Mean Concentration Value for Storm Water Runoff

Figures F–19 through **F–23** show graphs for soils for each measured isotope. The data is grouped into the three principle regions of interest of Regional, Perimeter, and Onsite.

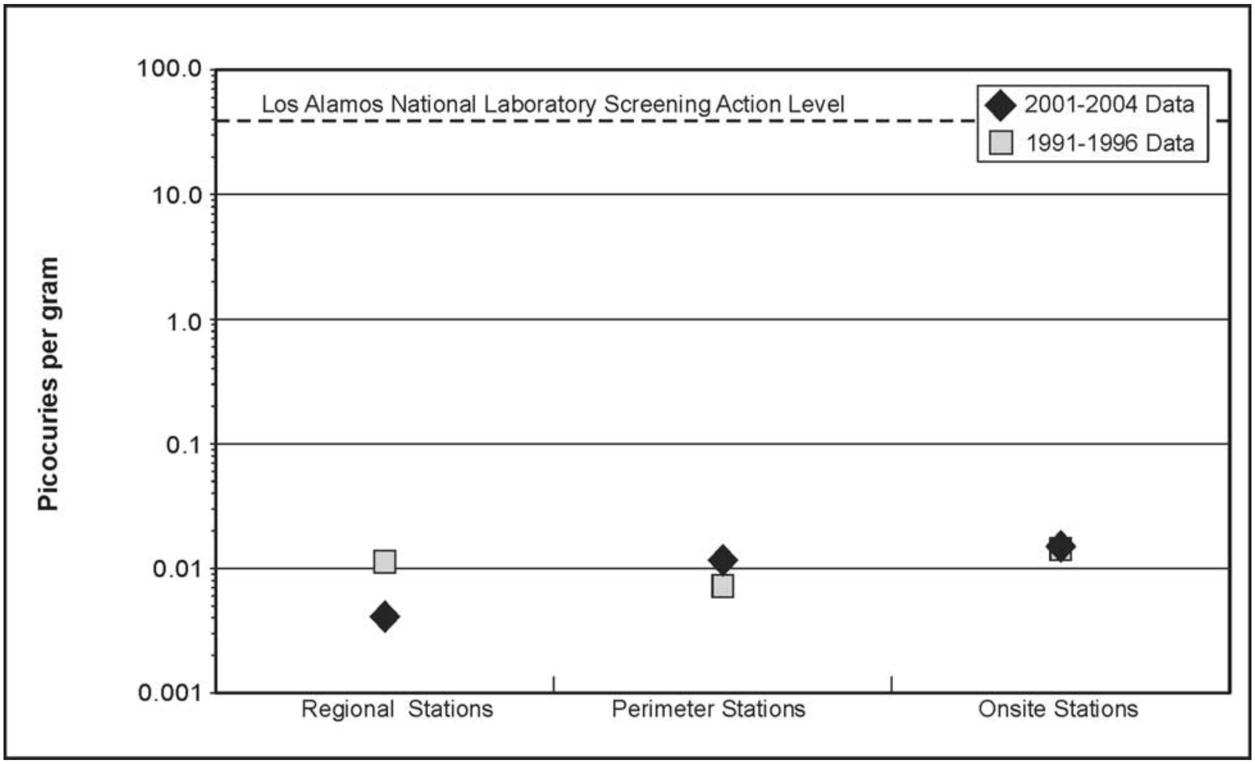


Figure F–19 Americium-241 Measured Mean Concentration Value for Soils

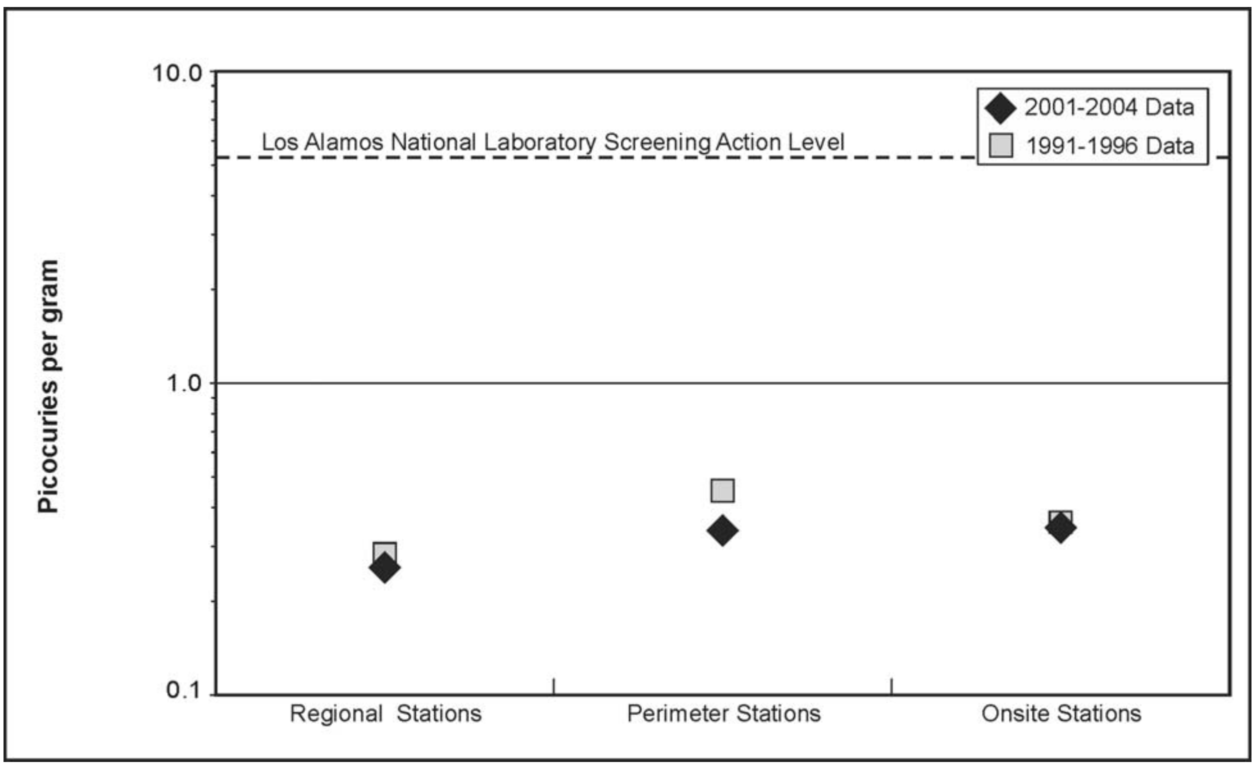


Figure F–20 Cesium-137 Measured Mean Concentration Value for Soils

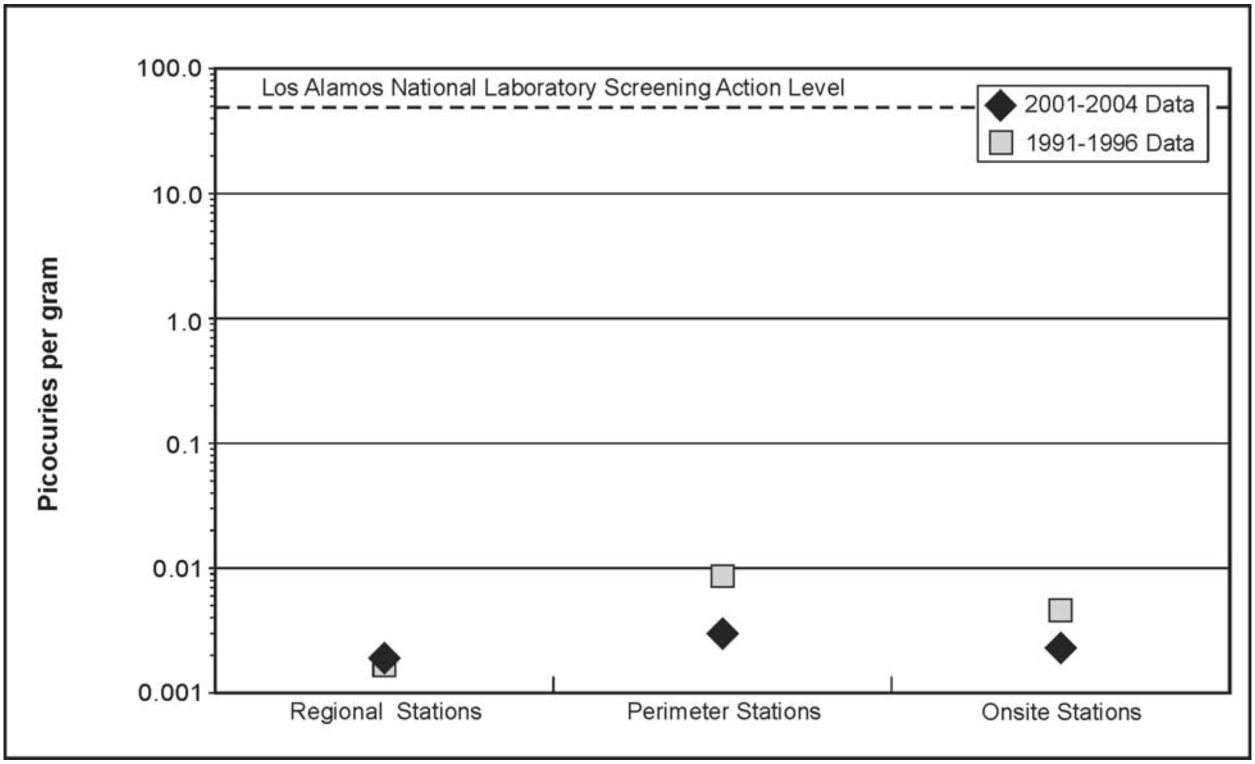


Figure F–21 Plutonium-238 Measured Mean Concentration Value for Soils

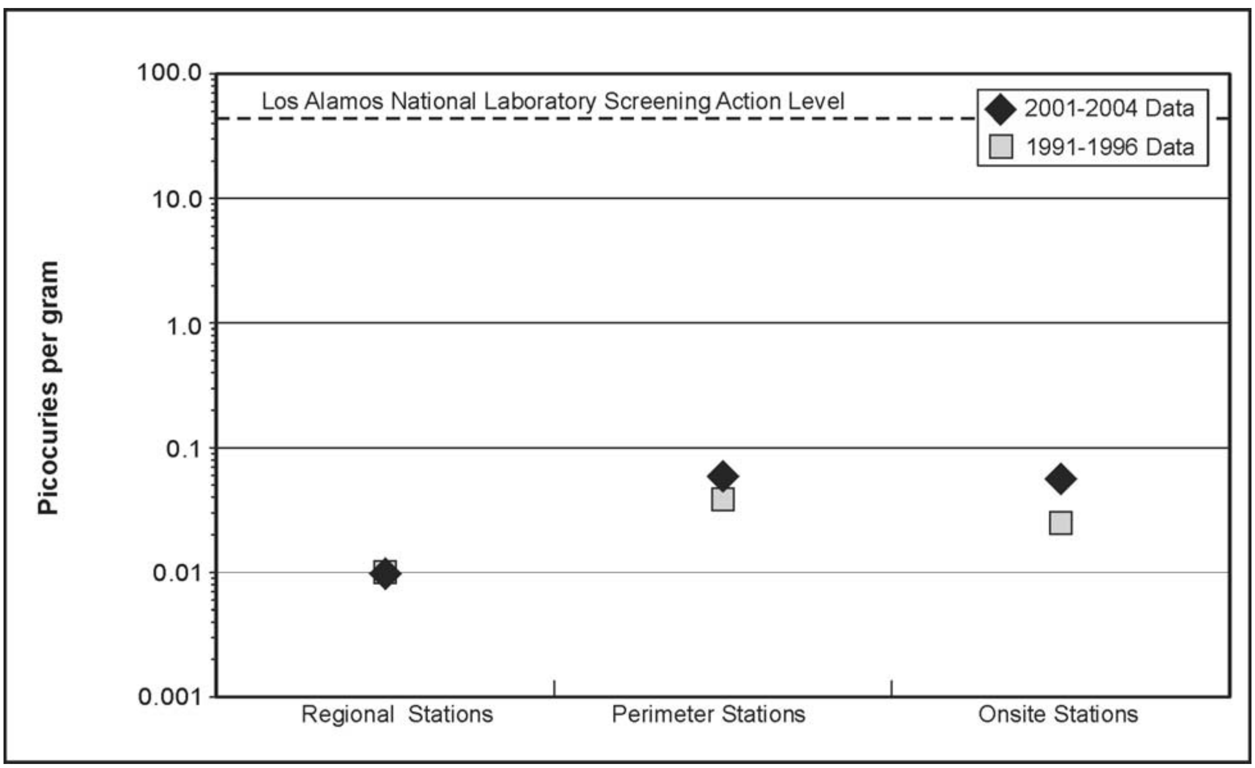


Figure F–22 Plutonium-239 and Plutonium-240 Measured Mean Concentration Value for Soils

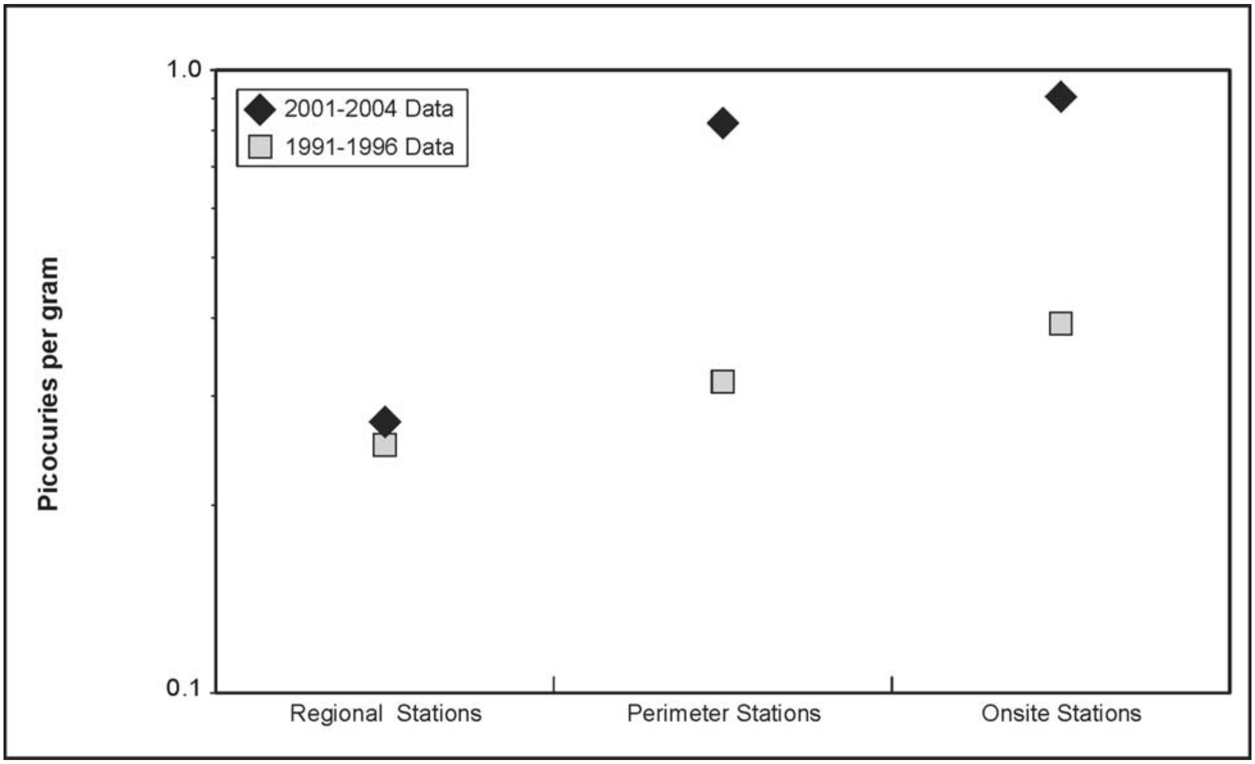


Figure F–23 Tritium Measured Mean Concentration Value for Soils

Groundwater data shows 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 climate region. Groundwater is also a potential source of drinking water for residences that use wells. In general, both transuranics and lighter radioisotopes had a higher concentration in groundwater for the 1991 through 1996 data than for the 2001 through 2004 data. No measurements exceeded applicable (tritium and strontium-90) EPA limits for drinking water.

In qualitatively evaluating the graphical presentation of measured radioisotope concentrations in and around LANL between the 1991 through 1996 time period and the 2001 through 2004 time period, only general observations can be made. More specific conclusions would require much more extensive statistical analysis 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 concentration 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 1991 through 1996 to 2001 through 2004, while lower atomic weight radioisotopes have decreased between these same two time periods. Since 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

Table F–4 Comparison of Measured 2001 through 2004 Radioisotope Groundwater Data to 1991 through 1996 Data

Radioisotope	*Noticeably Significant Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Other than one data point, both the 1991 through 1996 data and the 2001 through 2004 data was concentrated over one order of magnitude (0.01 to 0.1 picocuries per liter). The largest data point of about 3 picocuries per liter was from 1991 through 1996, and was much higher than the largest 2001 through 2004 data point of 0.5 picocuries per liter. Most of the 2001 through 2004 data is slightly lower than or equal to 1991 through 1996 data points.
Plutonium-239, Plutonium-240	Equivalent	Both sets of data showed a small spread over the same two orders of magnitude, but most 1991 through 1996 data points were slightly larger than the comparable 2001 through 2004 data.
Plutonium-238	Equivalent	Both data sets are closely clustered over the same two orders of magnitude. The highest 2001 through 2004 data point is about 3 picocuries per liter, whereas the largest 1991 through 1996 data point is about 0.8 picocuries per liter.
Cesium-137	1991 through 1996	All 2001 through 2004 data points were significantly lower than 1991 through 1996 by as much as a factor of 10 to 100.
Strontium-90	1991 through 1996	Some (five out of eight data points) of the 2001 through 2004 data was lower than the 1991 through 1996 data by factors of 2 to 20.
Tritium	1991 through 1996	Most of the 2001 through 2004 data is a factor of 2 to 10 times smaller than the comparable 1991 through 1996 data points. It should be noted that the largest mean value for the 1991 through 1996 data and for the 2001 through 2004 data is smaller than the EPA drinking water limit of 20,000 picocuries per liter.

EPA = U.S. Environmental Protection Agency.

Table F–5 Comparison of Measured 2001 through 2004 Radioisotope Sediment Data to 1991 through 1996 Data

Radioisotope	*Noticeably Significant Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	Equivalent	Three 2001 through 2004 data points are about a factor of 10 larger than 1991 through 1996 data. All other data points are close to each other. All data is below the LANL SAL.
Plutonium-239, Plutonium-240	Equivalent	Both sets of data showed a similar large spread over four orders of magnitude from 0.001 to 10 picocuries per gram, with all data below the LANL SAL.
Plutonium-238	Equivalent	Again, both sets of data exhibit a similar large spread over four orders of magnitude, but some 2001 through 2004 data points were greater than their 1991 through 1996 data set counterpart.
Cesium-137	1991 through 1996	Some 2001 through 2004 data points were lower than 1991 through 1996 by as much as a factor of 5. However, many data points from 2001 through 2004 were in the same range as the preponderance of 1991 through 1996 data points. All data is below the LANL SAL.
Strontium-90	1991 through 1996	This data from both time periods was clustered over only two orders of magnitude from 0.01 to 1 picocurie per gram. Most of the 2001 through 2004 data was lower than the 1991 through 1996 data, but by factors of two to three. One data point from 2001 through 2004 was greater than the 1991 through 1996 data points.
Tritium	1991 through 1996	The two sets of data are distinctly separate and tightly confined to a narrow band. All the 2001 through 2004 data is a factor of 5 to 1,000 times smaller than the comparable 1991 through 1996 data points.

SAL = Screening Action Level.

rainwater and 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, with rain and surface water. If there were no dramatic change in emissions of these measured radioisotopes from 1991 through 1996 to 2001 through 2004, the sediment data indicates that any radioactive material movement involving this sediment due to the Cerro Grande Fire was acted upon by natural forces of rain and surface water that significantly depleted sediment content of lighter weight and more soluble radioisotopes.

The transuranic radioisotopes exist in a larger concentration in the 2001 through 2004 data than in the 1991 through 1996 data, while 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. Another natural behavior consideration is the fact that the 12.2 year half-life of tritium will have resulted in the decay of a significant fraction of tritium between 1991 through 1996 and 2001 through 2004, which represents a time period of anywhere from 5 to 13 years.

Table F–6 Comparison of Measured 2001 through 2004 Radioisotope Storm Water Runoff or Surface Water Data to 1991 through 1996 Data

Radioisotope	*Noticeably Significant Larger Concentration Timeframe*	*Qualitative Trend Comments*
Americium-241	2001 through 2004	The 2001 through 2004 data was spread out over four orders of magnitude, whereas the 1991 through 1996 data was spread out over three orders of magnitude from 0.001 to 1 picocurie per liter. Most of the 2001 through 2004 data is 2 to 50 times higher than 1991 through 1996 data points. However, four of the twelve 2001 through 2004 data points were at the same or lower values as the 1991 through 1996 data.
Plutonium-239, Plutonium-240	2001 through 2004	Both sets of data showed a large spread over three orders of magnitude, but the 1991 through 1996 data is spread over the range of 0.001 to 10 picocuries per liter, whereas the 2001 through 2004 data is spread over the range of 0.1 to 100 picocuries per liter. The 2001 through 2004 data is 3 to 100 times greater than the 1991 through 1996 data.
Plutonium-238	2001 through 2004	Again, both sets of data exhibit a large spread over three to four orders of magnitude, but most 2001 through 2004 data points were factors of 3 to 100 greater than their 1991 through 1996 data set counterpart.
Cesium-137	1991 through 1996	Most, but not all, 2001 through 2004 data points were significantly lower than 1991 through 1996 by as much as a factor of 10. Only two out of the 11 data points from 2001 through 2004 were in the same range or higher than the 1991 through 1996 data points.
Strontium-90	1991 through 1996	Most (10 out of 11 data points) of the 2001 through 2004 data was lower than the 1991 through 1996 data by factors of 2 to 100. No 2001 through 2004 data exceeded 10 picocuries per liter, but seven 1991 through 1996 data points were between 10 and 200 picocuries per liter.
Tritium	1991 through 1996	All the 2001 through 2004 data is a factor of 2 to 10 times smaller than the comparable 1991 through 1996 data points. It should be noted that the largest mean value of less than 8,000 picocuries per liter for the 1991 through 1996 data and of about 1,000 picocuries per liter for the 2001 through 2004 data is much lower than the EPA drinking water limit of 20,000 picocuries per liter.

EPA = U.S. Environmental Protection Agency.

Unlike the previous sediment, surface runoff water, and groundwater data, the soil data shows that the 2001 through 2004 measurements are at a higher concentration for most radioisotopes than 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 2004 does not show any significant increase in emissions of these radioisotopes.

Table F–7 Comparison of Measured 2001 through 2004 Radioisotope Soil Data to 1991 through 1996 Data

Radioisotope (average worldwide soil concentration)	*Noticeably Significant 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 is equivalent to average worldwide concentrations.
Plutonium-239, Plutonium-240 (0.01 to 0.1 picocuries per gram)	Equivalent	All measurement values are more than a factor of 100 below the LANL SAL. All measurements are at or below worldwide average levels.
Plutonium-238 (0.01 to 0.1 picocuries per gram)	1991 through 1996	2001 through 2004 data is lower than the comparable 1991 through 1996 data at perimeter and onsite stations. Data is a factor of about 10,000 lower than the LANL SAL. Data is at or below worldwide average 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 is a factor of 10 below the SAL and at or about the worldwide measured level.
Tritium	2001 through 2004	The 2001 through 2004 data is significantly higher for the onsite and perimeter stations by as much as a factor of two as 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 at 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.
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.
Cesium-137	0.1 to 1 picocuries per gram soil (average 0.4)	Soluble	Ratio of sandy soil to water adhesion equals 280. Ratio of clay/loam soil to water adhesion equals 2,000 to 4,000.
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;
- The 2001 through 2004 data for soil shows a plutonium-238 concentration about 100 times greater than the 1991 through 1996 data and 10 to 100 times greater than worldwide averages;
- Tritium in surface water or storm water runoff at LANL from all the data is 10 to 100 times greater than the worldwide average;
- All 2001 through 2004 soil data is much lower (by orders of magnitude) than the relevant LANL SAL;
- All 2001 through 2004 tritium data for surface water and storm water runoff and groundwater is 10 to 100 times lower than the EPA drinking water limit;
- The largest difference in data between 1991 through 1996 and 2001 through 2004 is that the 2001 through 2004 sediment tritium concentration data is 1,000 to 100,000 times smaller than the 1991 through 1996 data;
- In general, transuranic concentration increased after 2000 in sediment and surface water or storm water runoff, while lighter radioisotope (strontium-90, cesium-137, and tritium) concentrations decreased in sediments and surface water or storm water runoff after 2000;
- All monitored radioisotope concentrations decreased after 2000 in groundwater;
- Most soil radioisotope concentrations increased after 2000 (possibly attributable to the redistribution of radioisotopes in biologic material that burned during the Cerro Grande Fire); and
- Changes from 1991 through 1996 to 2001 through 2004 in radioisotope concentration in surface water or storm water runoff and sediment coincide with the radioisotopes that are much more soluble in water.

The aforementioned observations are based on a qualitative assessment of plots of mean measured radioisotope concentration data. Differences in measurement technique or accuracy between the 1991 through 1996 data and the 2001 through 2004 data are not accounted for, nor are differences in LANL stack emissions from 1991 through 2004 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 storm water runoff data was measured by individual canyons. Soil data was grouped under the three regions of interest. The measured values of radioisotope and radioactivity that are presented were derived from environmental surveillance measurements. Groundwater, sediment, storm water runoff, and soil values were used to calculate "Detected," "Analyzed," "Minimum," "Maximum," "Mean," "Standard Deviation," and "95 percent Upper Confidence Limit (UCL) values."

Measurement data is identified as either analyzed or detected. The analyzed value is the total number of samples that were taken of an isotope. For each isotope, if its measured value plus two times the standard deviation is greater than the minimum detectable activity, it was reported as a detected value. The minimum value is the least measured value resultant for an isotope. The maximum value is the greatest measured value result for an isotope. The mean value is the average of the detected samples for an isotope. 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 or radioactivity that is equal to or greater than 95 percent of all the expected measured values assuming a normal distribution.

The measurement of each parameter involves obtaining a known sample volume or mass, transporting it to the laboratory, and subjecting the sample to the detection of a specific type and energy of radiation, which is detected and counted by instrumentation for a set period of time. Each radioisotope has a unique set of radiation emission energies, which identifies it just like fingerprints identify each human individual. The raw measurement data was evaluated in accordance with the following guidance:

- An "Analyzed" sample (in the following tables) is considered "Detected" if the measured value plus two standard deviations exceeds the instrument's minimum detectable activity;
- A minimum of two data values are required to calculate and present a mean, minimum, and maximum value;
- A minimum of three data values are required to calculate and present a standard deviation and 95 percent UCL value; and
- The 95 percent UCL or upper confidence limit is calculated by first calculating the mean and standard deviation on the mean of the measured or detected data and 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 media is solid or liquid and whether the measured parameter is in terms of radioactivity or mass.

The number of detectable LANL groundwater, sediment, surface water or storm water runoff, and soil data samples from 2001 through 2004 is shown in **Table F–9**. The statistical analysis of samples measured for these regions is presented in **Tables F–10** through **F–22** for groundwater, sediment, surface water or storm water runoff, and soil.

Table F–9 Number of Detectable Radiological Data Samples at Los Alamos National Laboratory

Radioisotope	Number of Detectable Samples (2001 through 2004)			
	Surface Water or Storm Water Runoff	Groundwater	Sediment	Soil
Americium-241	226	254	379	76
Cesium-137	106	118	389	76
Plutonium-238	153	172	267	76
Plutonium-239, Plutonium-240	200	168	354	76
Strontium-90	208	303	353	76
Tritium	99	159	204	76
Uranium-234	269	477	402	51
Uranium-235, Uranium-236	205	317	401	51
Uranium-238	272	458	402	51

Table F–10 Radiochemical Statistical Analysis of Groundwater – Canyon Alluvial Groundwater Systems [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	64	89	0.00	0.478	0.441	3.98	0.586
Cesium-137	pCi/L	22	87	0.00	3.23	1.81	16.5	3.99
Cobalt-60	pCi/L	2	18	2.06	2.33	–	2.60	–
Neptunium-237	pCi/L	3	18	6.62	10.5	3.48	13.4	14.4
Plutonium-238	pCi/L	40	88	0.00	0.489	0.469	2.19	0.634
Plutonium-239, Plutonium-240	pCi/L	46	88	0.00	0.240	0.181	1.78	0.293
Potassium-40	pCi/L	14	18	13.4	50.4	44.7	154	73.8
Radium-226	pCi/L	17	18	0.137	0.481	0.311	1.35	0.629
Sodium-22	pCi/L	5	18	3.05	4.06	1.00	5.33	4.94
Strontium-90	pCi/L	72	86	0.0999	18.3	5.22	81.6	19.5
Tritium	pCi/L	44	71	84.2	2259	308	8770	2350
Uranium-234	pCi/L	79	89	0.0138	0.499	0.245	3.24	0.553
Uranium-235, Uranium-236	pCi/L	52	89	0.00	0.0587	0.0199	0.212	0.0641
Uranium-238	pCi/L	75	89	0.00	0.220	0.0696	0.913	0.236
Uranium (calculated)	µg/L	86	89	0.00	0.613	0.192	2.82	0.653
Uranium (measured)	µg/L	24	24	0.02	0.314	0.321	1.16	0.442
Gross Alpha	pCi/L	53	87	0.512	2.87	0.921	19.3	3.12
Gross Beta	pCi/L	79	85	1.93	52.8	16.6	262	56.5
Gross Gamma	pCi/L	21	56	63.1	133	28.0	430	145
Acid/Pueblo Canyons [b]								
Americium-241	pCi/L	5	10	0.0168	0.0283	0.0103	0.0398	0.0373
Cesium-137	pCi/L	2	9	0.577	0.635	–	0.693	–
Cobalt-60	pCi/L	0	1	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	1	0.00	–	–	0.00	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	2	10	0.00395	0.00868	–	0.0134	–
Plutonium-239, Plutonium-240	pCi/L	8	10	0.0298	0.0941	0.0512	0.157	0.130
Potassium-40	pCi/L	1	1	–	15.3	–	–	–
Radium-226	pCi/L	2	2	0.253	0.484	–	0.714	–
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/L	10	10	0.275	0.811	0.389	1.42	1.05
Tritium	pCi/L	0	7	0.00	–	–	0.00	–
Uranium-234	pCi/L	10	10	0.0531	0.190	0.135	0.407	0.274
Uranium-235, Uranium-236	pCi/L	2	10	0.0133	0.0298	–	0.0463	–
Uranium-238	pCi/L	10	10	0.0202	0.116	0.0858	0.278	0.169
Uranium (calculated)	µg/L	10	10	0.0613	0.350	0.256	0.830	0.508
Uranium (measured)	µg/L	5	5	0.109	0.116	0.00614	0.123	0.121
Gross Alpha	pCi/L	6	10	0.978	1.30	0.450	2.97	1.66
Gross Beta	pCi/L	10	10	4.9	12.4	5.35	18.7	15.7
Gross Gamma	pCi/L	4	7	63.1	97.8	30.2	156	127
DP/Los Alamos Canyons [b]								
Americium-241	pCi/L	28	44	0.00	0.0295	0.00888	0.273	0.0328
Cesium-137	pCi/L	10	43	0.00	2.74	1.90	4.90	3.92
Cobalt-60	pCi/L	1	7	–	2.06	–	–	–
Neptunium-237	pCi/L	2	7	6.62	10.0	–	13.4	–
Plutonium-238	pCi/L	18	44	0.00	0.115	0.172	0.313	0.194
Plutonium-239, Plutonium-240	pCi/L	19	44	0.00	0.0209	0.0110	0.103	0.0259
Potassium-40	pCi/L	6	7	18.3	75.6	60.0	154	124
Radium-226	pCi/L	7	7	0.137	0.308	0.120	0.496	0.396
Sodium-22	pCi/L	0	7	0.00	–	–	0.00	–
Strontium-90	pCi/L	38	43	0.0999	14.9	3.23	52.1	15.9
Tritium	pCi/L	21	33	84.2	176	46.5	399	196
Uranium-234	pCi/L	38	44	0.0174	0.142	0.0482	0.749	0.157
Uranium-235, Uranium-236	pCi/L	23	44	0.00717	0.0379	0.0281	0.118	0.0494
Uranium-238	pCi/L	34	44	0.00939	0.0843	0.0571	0.243	0.103
Uranium (calculated)	µg/L	43	44	0.01	0.239	0.0800	1.11	0.263
Uranium (measured)	µg/L	14	14	0.02	0.189	0.140	0.484	0.262
Gross Alpha	pCi/L	20	42	0.512	1.35	0.503	3.08	1.57
Gross Beta	pCi/L	38	42	3.19	36.1	8.78	97.4	38.9
Gross Gamma	pCi/L	10	24	64.0	148	72.8	430	193
Mortandad Canyon [b]								
Americium-241	pCi/L	22	23	0.132	0.858	0.673	3.98	1.14
Cesium-137	pCi/L	7	22	0.800	5.44	3.58	16.5	8.10
Cobalt-60	pCi/L	0	8	0.00	–	–	0.00	–

Measured Radiochemical		**2001 through 2004**						
		Detected	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Neptunium-237	pCi/L	1	8	–	11.4	–	–	–
Plutonium-238	pCi/L	13	22	0.0101	0.708	0.650	2.19	1.06
Plutonium-239, Plutonium-240	pCi/L	13	22	0.0104	0.478	0.431	1.78	0.713
Potassium-40	pCi/L	6	8	13.4	31.2	12.1	45.0	40.9
Radium-226	pCi/L	6	7	0.242	0.708	0.405	1.35	1.03
Sodium-22	pCi/L	5	8	3.05	4.06	1.00	5.33	4.94
Strontium-90	pCi/L	20	23	1.47	34.9	7.70	81.6	38.3
Tritium	pCi/L	21	22	2480	4768	911	8770	5158
Uranium-234	pCi/L	22	23	0.421	1.14	0.368	3.24	1.29
Uranium-235, Uranium-236	pCi/L	22	23	0.0249	0.0762	0.0160	0.212	0.0829
Uranium-238	pCi/L	22	23	0.161	0.436	0.117	0.913	0.485
Uranium (calculated)	µg/L	23	23	1.68×10^{-6}	1.28	0.274	2.82	1.39
Uranium (measured)	µg/L	5	5	0.691	0.862	0.222	1.16	1.06
Gross Alpha	pCi/L	16	21	0.777	4.29	2.03	12.4	5.29
Gross Beta	pCi/L	20	21	10.7	117	17.6	262	125
Gross Gamma	pCi/L	6	20	79.4	101	18.9	150	116
Cañada del Buey [b]								
Americium-241	pCi/L	2	4	0.00247	0.0158	–	0.0291	–
Cesium-137	pCi/L	2	4	3.49	3.75	–	4.01	–
Cobalt-60	pCi/L	0	0	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	0	0.00	–	–	0.00	–
Plutonium-238	pCi/L	1	4	–	0.00200	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	4	–	0.00636	–	–	–
Potassium-40	pCi/L	0	0	0.00	–	–	0.00	–
Radium-226	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	0	0.00	–	–	0.00	–
Strontium-90	pCi/L	0	3	0.00	–	–	0.00	–
Tritium	pCi/L	0	4	0.00	–	–	0.00	–
Uranium-234	pCi/L	3	4	0.101	0.153	0.0700	0.202	0.232
Uranium-235, Uranium-236	pCi/L	2	4	0.0124	0.0231	–	0.0337	–
Uranium-238	pCi/L	3	4	0.0381	0.105	0.0786	0.161	0.194
Uranium (calculated)	µg/L	3	4	0.129	0.319	0.227	0.480	0.576
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	5	6	0.674	6.89	6.53	19.3	12.6
Gross Beta	pCi/L	3	4	3.26	8.66	7.64	21.4	17.3
Gross Gamma	pCi/L	0	3	0.00	–	–	0.00	–
Pajarito Canyon [b]								
Americium-241	pCi/L	7	8	0.00548	0.0370	0.0198	0.0576	0.0516
Cesium-137	pCi/L	1	9	–	0.382	–	–	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Cobalt-60	pCi/L	1	2	–	2.60	–	–	–
Neptunium-237	pCi/L	0	2	0.00	–	–	0.00	–
Plutonium-238	pCi/L	6	8	0.00	0.00397	0.00972	0.0238	0.0117
Plutonium-239, Plutonium-240	pCi/L	5	8	0.00488	0.0104	0.00568	0.0198	0.0154
Potassium-40	pCi/L	1	2	–	49.9	–	–	–
Radium-226	pCi/L	2	2	0.360	0.407	–	0.454	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	4	7	0.197	0.292	0.102	0.393	0.392
Tritium	pCi/L	2	5	145	146	–	146	–
Uranium-234	pCi/L	6	8	0.0138	0.245	0.243	1.08	0.440
Uranium-235, Uranium-236	pCi/L	3	8	0.00	0.0449	0.0390	0.0694	0.0890
Uranium-238	pCi/L	6	8	0.00	0.199	0.161	0.869	0.328
Uranium (calculated)	µg/L	7	8	0.00	0.522	0.379	2.62	0.803
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	6	8	0.592	0.830	0.336	1.83	1.10
Gross Beta	pCi/L	8	8	1.93	6.01	0.202	12.9	6.15
Gross Gamma	pCi/L	1	2	–	78.0	–	–	–

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–11 Radiochemical Statistical Analysis of Groundwater – Pueblo/Los Alamos/Sandia Canyon Area Perched System In Conglomerates and Basalt [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	5	13	0.0144	0.0255	0.00723	0.0338	0.0318
Cesium-137	pCi/L	3	14	0.847	1.95	1.36	2.91	3.49
Cobalt-60	pCi/L	0	8	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	8	–	10.3	–	–	–
Plutonium-238	pCi/L	1	13	–	0.00250	–	–	–
Plutonium-239, Plutonium-240	pCi/L	2	13	0.0416	0.0434	–	0.0451	–
Potassium-40	pCi/L	8	8	4.34	25.8	19.3	56.6	39.2
Radium-226	pCi/L	7	8	0.154	0.848	0.454	1.31	1.18
Sodium-22	pCi/L	1	8	–	2.89	–	–	–
Strontium-90	pCi/L	5	15	0.154	0.365	0.215	0.611	0.554
Tritium	pCi/L	2	13	70	83.3	–	96.5	–
Uranium-234	pCi/L	10	14	0.0757	0.464	0.237	0.673	0.611
Uranium-235, Uranium-236	pCi/L	5	14	0.0159	0.0501	0.0428	0.113	0.0875

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium-238	pCi/L	10	14	0.0319	0.298	0.149	0.425	0.391
Uranium (calculated)	µg/L	14	14	0.0231	0.726	0.458	1.31	0.966
Uranium (measured)	µg/L	3	3	0.02	0.883	0.748	1.34	1.73
Gross Alpha	pCi/L	7	14	0.628	1.29	0.820	2.51	1.90
Gross Beta	pCi/L	13	14	0.796	8.71	5.28	15.7	11.6
Gross Gamma	pCi/L	2	12	82.8	88.1		93.3	

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–12 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Springs [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	18	70	0.0112	0.0202	0.00413	0.0354	0.0221
Cesium-137	pCi/L	8	71	1.21	2.21	0.888	3.98	2.82
Cobalt-60	pCi/L	3	20	0.353	1.82	1.61	3.55	3.65
Neptunium-237	pCi/L	2	21	10.4	19.3	–	28.2	–
Plutonium-238	pCi/L	11	69	0	0.0353	0.0214	0.074	0.0480
Plutonium-239, Plutonium-240	pCi/L	5	69	0.00529	0.0141	0.00615	0.0205	0.0195
Potassium-40	pCi/L	14	20	6.03	30.8	14.1	54.8	38.1
Radium-226	pCi/L	13	22	0.212	0.484	0.297	1.20	0.645
Sodium-22	pCi/L	0	20	0.00	–	–	0.00	–
Strontium-90	pCi/L	20	67	0.0557	0.163	0.0296	0.300	0.176
Tritium	pCi/L	22	85	54.8	163	144	588	223
Uranium-234	pCi/L	62	68	0.0441	1.09	0.636	5.84	1.25
Uranium-235, Uranium-236	pCi/L	37	67	0.00870	0.0787	0.0348	0.552	0.0899
Uranium-238	pCi/L	62	68	0.0190	0.594	0.432	3.77	0.701
Uranium (calculated)	µg/L	66	67	0.00791	1.90	0.850	11.3	2.11
Uranium (measured)	µg/L	43	43	0.0200	6.09	7.90	19.6	8.45
Gross Alpha	pCi/L	36	69	0.625	3.41	1.42	11.5	3.87
Gross Beta	pCi/L	57	68	0.649	3.08	1.07	17.0	3.35
Gross Gamma	pCi/L	20	58	50.4	187	78.2	1420	221
White Rock Canyon Group I [b]								
Americium-241	pCi/L	8	26	0.0112	0.0195	0.00642	0.0354	0.0240
Cesium-137	pCi/L	2	26	1.22	2.55	–	3.88	–
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	2	0.00	–	–	0.00	–
Plutonium-238	pCi/L	5	27	0	0.0180	0.0314	0.0740	0.0456

Measured Radiochemical		**2001 through 2004**						
		Detected	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Plutonium-239, Plutonium-240	pCi/L	2	27	0.00965	0.0116	–	0.0135	–
Potassium-40	pCi/L	1	2	–	53.7	–	–	–
Radium-226	pCi/L	1	2	–	0.602	–	–	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	9	25	0.0557	0.156	0.0449	0.300	0.185
Tritium	pCi/L	8	34	166	293	179	588	417
Uranium-234	pCi/L	25	26	0.0600	0.506	0.183	1.14	0.578
Uranium-235, Uranium-236	pCi/L	13	26	0.00870	0.0429	0.0451	0.255	0.0674
Uranium-238	pCi/L	24	26	0.0356	0.223	0.145	0.617	0.281
Uranium (calculated)	µg/L	25	26	0.0592	0.775	0.377	1.91	0.922
Uranium (measured)	µg/L	24	24	0.02	1.48	0.571	2.27	1.71
Gross Alpha	pCi/L	14	25	0.625	1.09	0.191	1.66	1.19
Gross Beta	pCi/L	22	25	0.845	3.84	2.45	17.0	4.86
Gross Gamma	pCi/L	6	17	85.9	155	63.5	232	206
White Rock Canyon Group II [b]								
Americium-241	pCi/L	4	15	0.0131	0.0208	0.00693	0.0316	0.0276
Cesium-137	pCi/L	1	16	–	3.05	–	–	–
Cobalt-60	pCi/L	1	5	–	1.56	–	–	–
Neptunium-237	pCi/L	1	5	–	10.4	–	–	–
Plutonium-238	pCi/L	1	14	–	0.00803	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	14	0.00	–	–	0.00	–
Potassium-40	pCi/L	3	5	6.03	26.2	24.6	53.7	54.1
Radium-226	pCi/L	4	5	0.276	0.622	0.408	1.20	1.02
Sodium-22	pCi/L	0	5	0.00	–	–	0.00	–
Strontium-90	pCi/L	4	14	0.121	0.179	0.0134	0.201	0.192
Tritium	pCi/L	6	20	167	282	97.7	407	360
Uranium-234	pCi/L	12	14	0.0441	0.323105	0.0457	0.993	0.349
Uranium-235, Uranium-236	pCi/L	6	14	0.0156	0.0287	0.00337	0.0485	0.0314
Uranium-238	pCi/L	12	14	0.0399	0.163	0.0433	0.477	0.187
Uranium (calculated)	µg/L	14	14	0.00791	0.444	0.113	1.44	0.503
Uranium (measured)	µg/L	6	6	0.02	0.5115	0.616	1.61	1.00
Gross Alpha	pCi/L	4	16	0.738	1.08	0.413	1.37	1.48
Gross Beta	pCi/L	11	15	0.649	2.18	0.940	3.84	2.74
Gross Gamma	pCi/L	3	14	76.9	96.7	21.6	112	121
White Rock Canyon Group III [b]								
Americium-241	pCi/L	3	11	0.0170	0.0188	0.00255	0.0239	0.0217
Cesium-137	pCi/L	0	11	0.00	–	–	0.00	–
Cobalt-60	pCi/L	1	3	–	3.55	–	–	–
Neptunium-237	pCi/L	0	3	0.00	–	–	0.00	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/L	2	10	0.00530	0.0309	–	0.0564	–
Plutonium-239, Plutonium-240	pCi/L	2	10	0.00529	0.00754	–	0.00978	–
Potassium-40	pCi/L	3	3	17.9	29.3	10.3	38.1	41.0
Radium-226	pCi/L	3	3	0.233	0.356	0.114	0.458	0.485
Sodium-22	pCi/L	0	3	0.00	–	–	0.00	–
Strontium-90	pCi/L	2	9	0.169	0.203	–	0.236	–
Tritium	pCi/L	3	12	64.9	133	85.4	229	230
Uranium-234	pCi/L	9	10	0.0818	1.67	0.880	5.69	2.25
Uranium-235, Uranium-236	pCi/L	7	10	0.0173	0.130	0.134	0.552	0.229
Uranium-238	pCi/L	9	10	0.0495	0.947	0.607	3.54	1.34
Uranium (calculated)	µg/L	10	10	0.0413	2.41	1.06	10.8	3.07
Uranium (measured)	µg/L	1	1	–	0.156	–	–	–
Gross Alpha	pCi/L	8	10	0.651	2.80	2.09	9.07	4.25
Gross Beta	pCi/L	7	10	1.26	2.60	0.762	4.05	3.16
Gross Gamma	pCi/L	3	9	66.2	71.0	6.72	83.5	78.6
White Rock Canyon Group IV [b]								
Americium-241	pCi/L	2	10	0.019	0.0213	–	0.0236	–
Cesium-137	pCi/L	3	10	1.21	1.47	0.251	1.71	1.76
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	3	0.00	–	–	0.00	–
Plutonium-238	pCi/L	1	10	–	0.00538	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	10	0.00	–	–	0.00	–
Potassium-40	pCi/L	2	2	19.9	26.0	–	32.1	–
Radium-226	pCi/L	2	3	0.212	0.247	–	0.282	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	5	10	0.0562	0.152	0.0495	0.186	0.195
Tritium	pCi/L	4	12	54.8	64.6	1.04	81.8	65.6
Uranium-234	pCi/L	8	10	0.4	3.36	2.86	5.84	5.35
Uranium-235, Uranium-236	pCi/L	7	9	0.0452	0.143	0.0844	0.257	0.205
Uranium-238	pCi/L	9	10	0.019	1.59	1.54	3.77	2.60
Uranium (calculated)	µg/L	9	9	0.00981	6.54	3.36	11.3	8.73
Uranium (measured)	µg/L	12	12	17.2	18.6	0.786	19.6	19.0
Gross Alpha	pCi/L	8	10	1.17	8.54	4.36	11.5	11.6
Gross Beta	pCi/L	8	10	1.55	4.48	2.57	7.40	6.26
Gross Gamma	pCi/L	5	10	50.4	235	252	1420	456

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.

[a] Main heading as indicated in Table F–1.

[b] Subheadings are individual areas contributing to main heading.

Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–13 Radiochemical Statistical Analysis of Groundwater – Test Wells [a]

Measured Radiochemical		*2001 through 2004*						
		Detected	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Americium-241	pCi/L	16	40	0.00329	0.0278	0.00805	0.0664	0.0317
Cesium-137	pCi/L	12	46	0.132	3.12	2.00	16.3	4.25
Cobalt-60	pCi/L	0	11	0.00	–	–	0.00	–
Neptunium-237	pCi/L	5	12	9.45	14.9	5.89	21.2	20.1
Plutonium-238	pCi/L	12	39	0.00	0.00891	0.00525	0.0149	0.0119
Plutonium-239, Plutonium-240	pCi/L	8	39	0.00477	0.0169	0.00896	0.0272	0.0231
Potassium-40	pCi/L	10	11	1.91	26.1	17.8	57.2	37.1
Radium-226	pCi/L	8	12	0.173	0.434	0.276	0.904	0.625
Sodium-22	pCi/L	1	11	–	2.06	–	–	–
Strontium-90	pCi/L	22	57	0.00350	0.115	0.0726	0.238	0.145
Tritium	pCi/L	16	40	0	137	81.2	303	176
Uranium-234	pCi/L	33	39	0.0352	0.516	0.109	2.01	0.553
Uranium-235, Uranium-236	pCi/L	12	39	0.00576	0.0502	0.0309	0.18	0.0677
Uranium-238	pCi/L	32	39	0.00843	0.215	0.130	1.02	0.260
Uranium (calculated)	µg/L	39	39	0.0114	0.647	0.0733	3.21	0.670
Uranium (measured)	µg/L	11	11	0.0200	0.656	0.953	3.46	1.22
Gross Alpha	pCi/L	15	38	0.173	1.28	0.524	3.08	1.55
Gross Beta	pCi/L	34	38	0.708	2.13	0.281	4.22	2.22
Gross Gamma	pCi/L	9	30	52.3	93.5	51.0	271	127
Pueblo Canyon (includes Acid Canyons) [b]								
Americium-241	pCi/L	4	7	0.0146	0.0259	0.00988	0.0398	0.0356
Cesium-137	pCi/L	2	9	0.971	1.50	–	2.03	–
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	2	–	21.1	–	–	–
Plutonium-238	pCi/L	3	7	0.00	0.00861	0.00749	0.0139	0.0171
Plutonium-239, Plutonium-240	pCi/L	1	7	–	0.00477	–	–	–
Potassium-40	pCi/L	2	2	1.91	13.7	–	25.4	–
Radium-226	pCi/L	2	2	0.176	0.298	–	0.42	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	7	14	0.0170	0.0542	0.0229	0.0960	0.0712
Tritium	pCi/L	6	8	53.4	157	35.3	208	185
Uranium-234	pCi/L	6	7	0.0352	1.66	0.457	2.01	2.02
Uranium-235, Uranium-236	pCi/L	5	7	0.00576	0.0814	0.0726	0.18	0.145
Uranium-238	pCi/L	6	7	0.00843	0.758	0.471	1.02	1.14
Uranium (calculated)	µg/L	7	7	0.0176	2.28	0.792	3.21	2.87
Uranium (measured)	µg/L	1	1	–	3.46	–	–	–
Gross Alpha	pCi/L	5	8	0.429	2.25	0.954	3.08	3.09
Gross Beta	pCi/L	8	8	2.2	3.31	0.700	4.22	3.79

Measured Radiochemical		2001 through 2004						
		Detected	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Gross Gamma	pCi/L	3	6	61.4	120	82.9	271	214
Upper Los Alamos Canyon (includes DP Canyon) [b]								
Americium-241	pCi/L	4	9	0.00954	0.0151	0.00859	0.0279	0.0235
Cesium-137	pCi/L	5	12	0.132	4.36	4.91	16.3	8.66
Cobalt-60	pCi/L	0	3	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	3	0.00	–	–	0.00	–
Plutonium-238	pCi/L	3	9	0.00	0.00701	0.00749	0.0149	0.0155
Plutonium-239, Plutonium-240	pCi/L	2	9	0.0124	0.0198	–	0.0272	–
Potassium-40	pCi/L	2	3	10.6	21.1	–	31.5	–
Radium-226	pCi/L	1	3	–	0.173	–	–	–
Sodium-22	pCi/L	1	3	–	2.06	–	–	–
Strontium-90	pCi/L	4	12	0.0571	0.0865	0.0373	0.168	0.123
Tritium	pCi/L	1	7	–	53.1	–	–	–
Uranium-234	pCi/L	7	9	0.0492	0.235	0.210	0.444	0.390
Uranium-235, Uranium-236	pCi/L	0	9	0.00	–	–	0.00	–
Uranium-238	pCi/L	7	9	0.0195	0.0651	0.0771	0.180	0.122
Uranium (calculated)	µg/L	9	9	0.0410	0.283	0.247	0.550	0.444
Uranium (measured)	µg/L	1	1	–	0.629	–	–	–
Gross Alpha	pCi/L	2	10	0.381	0.578	–	0.774	–
Gross Beta	pCi/L	9	10	0.708	2.06	0.610	3.12	2.46
Gross Gamma	pCi/L	3	5	55.0	59.7	6.70	67.4	67.3
Mortandad Canyon [b]								
Americium-241	pCi/L	1	4	–	0.00880	–	–	–
Cesium-137	pCi/L	2	8	2.16	2.23	–	2.30	–
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	2	2	9.62	15.4	–	21.2	–
Plutonium-238	pCi/L	1	4	0.00	–	–	0.00	–
Plutonium-239, Plutonium-240	pCi/L	0	4	0.00	–	–	0.00	–
Potassium-40	pCi/L	2	2	28.8	31.2	–	33.6	–
Radium-226	pCi/L	1	1	–	0.268	–	–	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	3	11	0.00370	0.132	0.119	0.238	0.266
Tritium	pCi/L	2	7	0.00	40.5	–	80.9	–
Uranium-234	pCi/L	4	4	0.264	0.377	0.0422	0.412	0.418
Uranium-235, Uranium-236	pCi/L	2	4	0.0382	0.0438	–	0.0493	–
Uranium-238	pCi/L	4	4	0.0226	0.125	0.0886	0.194	0.212
Uranium (calculated)	µg/L	4	4	0.390	0.486	0.0832	0.600	0.567
Uranium (measured)	µg/L	3	3	0.520	0.542	0.0206	0.561	0.565
Gross Alpha	pCi/L	3	4	0.960	1.08	0.132	1.22	1.23

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	3	4	2.36	2.70	0.445	3.01	3.20
Gross Gamma	pCi/L	0	5	0.00	–	–	0.00	–
Ancho Canyon [b]								
Americium-241	pCi/L	7	20	0.00329	0.0286	0.0106	0.0664	0.0364
Cesium-137	pCi/L	3	17	1.9	4.52	3.59	7.06	8.58
Cobalt-60	pCi/L	0	4	0.00	–	–	0.00	–
Neptunium-237	pCi/L	2	5	9.45	11.3	–	13.1	–
Plutonium-238	pCi/L	5	19	0.00	0.00555	0.00545	0.00940	0.0103
Plutonium-239, Plutonium-240	pCi/L	5	19	0.00515	0.0158	0.00990	0.0272	0.0245
Potassium-40	pCi/L	4	4	11.3	32.3	24.3	57.2	56.1
Radium-226	pCi/L	4	6	0.22	0.610	0.286	0.904	0.890
Sodium-22	pCi/L	0	4	0.00	–	–	0.00	–
Strontium-90	pCi/L	8	20	0.00350	0.111	0.0797	0.233	0.166
Tritium	pCi/L	7	18	0.00	154	148	303	263
Uranium-234	pCi/L	16	19	0.0855	0.251	0.0616	0.457	0.281
Uranium-235, Uranium-236	pCi/L	5	19	0.0265	0.0421	0.00838	0.0543	0.0495
Uranium-238	pCi/L	15	19	0.0205	0.0858	0.0442	0.176	0.108
Uranium (calculated)	µg/L	19	19	0.0114	0.311	0.131	0.670	0.370
Uranium (measured)	µg/L	6	6	0.0200	0.251	0.199	0.547	0.410
Gross Alpha	pCi/L	5	16	0.173	0.727	0.521	1.32	1.18
Gross Beta	pCi/L	14	16	0.800	1.49	0.355	2.34	1.67
Gross Gamma	pCi/L	3	14	52.3	83.7	21.9	99.2	108

UCL = upper confidence limit, pCi/L = picocurie per liter, µg/L = microgram per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–14 Radiochemical Statistical Analysis of Groundwater – Other Springs [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	6	13	0.0168	0.0328	0.0199	0.0908	0.0487
Cesium-137	pCi/L	2	13	0.0435	1.07	–	2.09	–
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	2	–	12.7	–	–	–
Plutonium-238	pCi/L	2	13	0.0131	0.0155	–	0.0179	–
Plutonium-239, Plutonium-240	pCi/L	4	13	0.00477	0.0164	0.0134	0.0259	0.0296
Potassium-40	pCi/L	1	2	–	41.4	–	–	–
Radium-226	pCi/L	2	2	0.118	0.144	–	0.170	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	5	10	0.198	45.6	40.1	115	80.7

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Tritium	pCi/L	2	12	455	286	–	455	–
Uranium-234	pCi/L	12	13	0.378	0.957	0.280	1.16	1.12
Uranium-235, Uranium-236	pCi/L	11	13	0.0107	0.0472	0.0221	0.14	0.0602
Uranium-238	pCi/L	12	13	0.0279	0.446	0.180	0.540	0.548
Uranium (calculated)	µg/L	13	13	0.0662	1.09	0.131	2.13	1.16
Uranium (measured)	µg/L	1	1	–	0.119	–	–	–
Gross Alpha	pCi/L	10	13	1.02	1.93	0.347	3.88	2.14
Gross Beta	pCi/L	11	13	2.40	42.0	41.9	228	66.7
Gross Gamma	pCi/L	0	8	0.00	–	–	0.00	–
Upper Los Alamos Canyon (includes DP Canyon) [b]								
Americium-241	pCi/L	3	3	0.0250	0.0590	0.0450	0.0908	0.110
Cesium-137	pCi/L	1	3	–	0.0435	–	–	–
Cobalt-60	pCi/L	0	0	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	0	0.00	–	–	0.00	–
Plutonium-238	pCi/L	2	3	0.0131	0.0155	–	0.0179	–
Plutonium-239, Plutonium-240	pCi/L	3	3	0.00716	0.0169	0.0127	0.0259	0.0313
Potassium-40	pCi/L	0	0	0.00	–	–	0.00	–
Radium-226	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	0	0.00	–	–	0.00	–
Strontium-90	pCi/L	3	3	60.5	87.3	37.8	115	130
Tritium	pCi/L	1	2	–	455	–	–	–
Uranium-234	pCi/L	3	3	0.378	0.411	0.0113	0.428	0.424
Uranium-235, Uranium-236	pCi/L	3	3	0.0107	0.0172	0.000636	0.0245	0.0179
Uranium-238	pCi/L	3	3	0.0279	0.0568	0.0404	0.0854	0.103
Uranium (calculated)	µg/L	3	3	0.0900	0.176	0.122	0.262	0.314
Uranium (measured)	µg/L	1	1	–	0.119	–	–	–
Gross Alpha	pCi/L	2	3	2.43	3.16	–	3.88	–
Gross Beta	pCi/L	3	3	123	172	69.3	228	250
Gross Gamma	pCi/L	0	1	0.00	–	–	0.00	–

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–15 Radiochemical Statistical Analysis of Groundwater – Perched Groundwater System in Volcanics [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	15	47	0.00530	0.0211	0.00478	0.0340	0.0235
Cesium-137	pCi/L	8	47	0.575	2.17	1.92	6.4	3.50
Cobalt-60	pCi/L	0	12	0.00	–	–	0.00	–
Neptunium-237	pCi/L	2	12	5.79	7.45	–	9.11	–
Plutonium-238	pCi/L	18	63	0.00	0.0104	0.0108	0.0180	0.0154
Plutonium-239, Plutonium-240	pCi/L	17	63	0.00	0.0143	0.00794	0.0206	0.0181
Potassium-40	pCi/L	10	12	9.37	31.6	15.4	59.4	41.2
Radium-226	pCi/L	2	11	0.14	0.336	–	0.532	–
Sodium-22	pCi/L	2	12	2.77	3.82	–	4.86	–
Strontium-90	pCi/L	25	61	0.0506	0.262	0.112	1.69	0.306
Tritium	pCi/L	3	46	52.8	75.4	8.80	85.5	85.3
Uranium-234	pCi/L	36	42	0.0218	4.78	1.22	13.0	5.17
Uranium-235, Uranium-236	pCi/L	31	45	0.0109	0.237	0.0953	0.707	0.271
Uranium-238	pCi/L	36	45	0.0224	2.64	0.814	8.23	2.91
Uranium (calculated)	µg/L	40	42	0.0172	7.12	0.916	24.8	7.41
Uranium (measured)	µg/L	15	15	0.0200	2.43	4.40	15.3	4.66
Gross Alpha	pCi/L	30	45	0.324	6.78	3.60	19.7	8.06
Gross Beta	pCi/L	35	45	1.05	5.26	2.36	42.6	6.04
Gross Gamma	pCi/L	8	36	60.7	135	43.9	281	165
Water Canyon (includes Canyon del Valle, Potrillo, and Fence Canyons) [b]								
Americium-241	pCi/L	4	8	0.0127	0.0194	0.00312	0.0220	0.0225
Cesium-137	pCi/L	1	8	–	4.25	–	–	–
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	2	–	5.79	–	–	–
Plutonium-238	pCi/L	2	8	0.00689	0.0124	–	0.0180	–
Plutonium-239, Plutonium-240	pCi/L	3	8	0.0138	0.0181	0.00357	0.0206	0.0221
Potassium-40	pCi/L	2	2	22.7	38.3	–	53.9	–
Radium-226	pCi/L	0	2	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	5	9	0.134	0.198	0.0740	0.392	0.263
Tritium	pCi/L	0	9	0.00	–	–	0.00	–
Uranium-234	pCi/L	5	6	0.0314	0.105	0.0690	0.255	0.165
Uranium-235, Uranium-236	pCi/L	4	8	0.0109	0.0206	0.00336	0.0293	0.0239
Uranium-238	pCi/L	6	8	0.0224	0.0566	0.0449	0.166	0.0925
Uranium (calculated)	µg/L	6	6	0.0235	0.148	0.152	0.497	0.270
Uranium (measured)	µg/L	11	11	0.0200	0.418	0.300	0.727	0.595
Gross Alpha	pCi/L	3	8	0.849	1.41	0.774	1.96	2.29

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	7	8	1.05	7.01	9.88	42.6	14.3
Gross Gamma	pCi/L	1	6	–	101	–	–	–
San Ildefonso Pueblo [b]								
Americium-241	pCi/L	11	39	0.00530	0.0219	0.00875	0.0340	0.0271
Cesium-137	pCi/L	7	39	0.575	2.26	2.09	6.40	3.81
Cobalt-60	pCi/L	0	10	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	10	–	9.11	–	–	–
Plutonium-238	pCi/L	16	55	0.00	0.00249	0.00350	0.00992	0.00420
Plutonium-239, Plutonium-240	pCi/L	14	55	0.00	0.0104	0.00931	0.0170	0.0153
Potassium-40	pCi/L	8	10	9.37	30.0	14.8	59.4	40.2
Radium-226	pCi/L	2	9	0.140	0.336	–	0.532	–
Sodium-22	pCi/L	2	10	2.77	3.82	–	4.86	–
Strontium-90	pCi/L	20	52	0.0506	0.247	0.121	1.69	0.300
Tritium	pCi/L	3	37	52.8	75.4	8.80	85.5	85.3
Uranium-234	pCi/L	31	36	0.0218	5.43	0.809	13.0	5.71
Uranium-235, Uranium-236	pCi/L	27	37	0.0207	0.259	0.0797	0.707	0.289
Uranium-238	pCi/L	30	37	0.0882	3.10	0.643	8.23	3.33
Uranium (calculated)	µg/L	34	36	0.0172	8.44	1.78	24.8	9.04
Uranium (measured)	µg/L	4	4	1.03	7.98	5.83	15.3	13.7
Gross Alpha	pCi/L	27	37	0.324	7.38	3.72	19.7	8.78
Gross Beta	pCi/L	28	37	1.47	4.59	1.63	16.2	5.19
Gross Gamma	pCi/L	7	30	60.7	142	47.7	281	177

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–16 Radiochemical Statistical Analysis of Groundwater – Intermediate Perched Groundwater Systems Pueblo/Los Alamos/Sandia Canyon Area Perched Systems in Conglomerates and Basalt [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	3	6	0.0154	0.0197	0.00696	0.0277	0.0275
Cesium-137	pCi/L	1	5	–	6.58	–		–
Cobalt-60	pCi/L	0	1	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	1	0.00	–	–	0.00	–
Plutonium-238	pCi/L	2	6	0.00	0.00705	–	0.0141	–
Plutonium-239, Plutonium-240	pCi/L	2	7	0.0333	0.0359	–	0.0385	–
Potassium-40	pCi/L	1	1	–	69.8	–	–	–
Radium-226	pCi/L	2	2	0.230	0.498	–	0.765	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/L	2	6	0.0929	0.178	–	0.263	–
Tritium	pCi/L	2	9	78.7	594	–	1110	–
Uranium-234	pCi/L	5	5	0.0463	0.921	0.553	1.56	1.41
Uranium-235, Uranium-236	pCi/L	4	5	0.0193	0.0962	0.0509	0.153	0.146
Uranium-238	pCi/L	4	5	0.0342	0.720	0.275	1.01	0.990
Uranium (calculated)	µg/L	5	5	0.00	1.84	1.09	3.08	2.79
Uranium (measured)	µg/L	3	3	0.0200	1.98	1.69	2.97	3.89
Gross Alpha	pCi/L	2	5	2.30	2.75	–	3.20	–
Gross Beta	pCi/L	4	5	1.45	8.98	1.85	12.6	10.8
Gross Gamma	pCi/L	2	3	79.0	94.0	–	109	–

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–17 Radiochemical Statistical Analysis of Groundwater – Regional Aquifer Wells Hydrogeologic Characterization Wells [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	17	93	0.0116	0.0271	0.0107	0.0392	0.0322
Cesium-137	pCi/L	12	97	0.251	3.82	1.29	7.39	4.55
Cobalt-60	pCi/L	6	38	0.304	3.17	2.20	6.48	4.93
Neptunium-237	pCi/L	6	38	8.16	15.4	9.62	30.1	23.1
Plutonium-238	pCi/L	3	94	0.00560	0.0103	0.00219	0.0118	0.0127
Plutonium-239, Plutonium-240	pCi/L	5	94	0.0112	0.125	0.123	0.601	0.234
Potassium-40	pCi/L	29	38	3.25	40.4	29.9	105	51.3
Radium-226	pCi/L	27	36	0.137	0.311	0.161	0.752	0.372
Sodium-22	pCi/L	2	38	1.87	5.715	–	9.56	–
Strontium-90	pCi/L	31	92	0.0776	0.155	0.0195	0.282	0.162
Tritium	pCi/L	21	64	63.4	158	22.0	523	167
Uranium-234	pCi/L	57	92	0.00870	0.315	0.106	1.13	0.342
Uranium-235, Uranium-236	pCi/L	42	93	0.0158	0.0401	0.00590	0.164	0.0419
Uranium-238	pCi/L	54	93	0.0102	0.178	0.0358	0.630	0.188
Uranium (calculated)	µg/L	79	92	0.00603	0.380	0.0979	1.92	0.401
Uranium (measured)	µg/L	35	35	0.02	0.481	0.638	2.03	0.692
Gross Alpha	pCi/L	34	91	0.268	1.75	0.836	13.5	2.03
Gross Beta	pCi/L	56	91	0.504	3.80	1.05	23.9	4.07
Gross Gamma	pCi/L	34	101	45.6	144	85.9	879	172
Upper Los Alamos Canyon (includes DP Canyon) [b]								
Americium-241	pCi/L	5	26	0.0185	0.0248	0.00690	0.0359	0.0309
Cesium-137	pCi/L	6	29	0.251	3.87	2.55	7.39	5.91

Measured Radiochemical		2001 through 2004						
		Detected	**Analyzed**	**Minimum**	**Mean**	**Standard Deviation**	**Maximum**	**95 Percent UCL**
Cobalt-60	pCi/L	2	11	5	5.74	–	6.48	–
Neptunium-237	pCi/L	1	11	–	25.1	–	–	–
Plutonium-238	pCi/L	3	24	0.00560	0.0103	0.00219	0.0118	0.0127
Plutonium-239, Plutonium-240	pCi/L	2	24	0.0112	0.0311	–	0.051	–
Potassium-40	pCi/L	9	11	6.41	23.4	11.7	42.9	31.0
Radium-226	pCi/L	7	10	0.143	0.314	0.120	0.543	0.403
Sodium-22	pCi/L	1	11	–	9.56	–	–	–
Strontium-90	pCi/L	9	25	0.091	0.155	0.0449	0.278	0.184
Tritium	pCi/L	12	17	63.4	169	18.2	348	179
Uranium-234	pCi/L	16	24	0.0359	0.245	0.153	1.13	0.320
Uranium-235, Uranium-236	pCi/L	14	25	0.016	0.0373	0.0148	0.124	0.0451
Uranium-238	pCi/L	16	25	0.024	0.144	0.0889	0.52	0.188
Uranium (calculated)	µg/L	20	24	0.0186	0.351	0.190	1.58	0.434
Uranium (measured)	µg/L	7	7	0.02	0.461	0.623	1.8	0.923
Gross Alpha	pCi/L	13	27	0.268	1.95	1.48	13.5	2.76
Gross Beta	pCi/L	19	27	1.08	4.31	1.77	23.9	5.11
Gross Gamma	pCi/L	6	29	45.6	117	39.2	243	148
Sandia Canyon [b]								
Americium-241	pCi/L	2	23	0.0211	0.0232	–	0.0253	–
Cesium-137	pCi/L	1	21	–	4.83	–	–	–
Cobalt-60	pCi/L	2	10	2.40	2.40	–	2.40	–
Neptunium-237	pCi/L	5	10	8.16	13.4	9.35	30.1	21.6
Plutonium-238	pCi/L	0	23	0	0	0.00	–	–
Plutonium-239, Plutonium-240	pCi/L	0	23	0	0	0.00	–	–
Potassium-40	pCi/L	8	10	11	56.5	34.0	105	80.1
Radium-226	pCi/L	8	10	0.137	0.329	0.196	0.745	0.465
Sodium-22	pCi/L	0	10	0.00	–	–	0.00	–
Strontium-90	pCi/L	9	23	0.0776	0.140	0.0446	0.247	0.169
Tritium	pCi/L	4	18	110	111	0	112	–
Uranium-234	pCi/L	12	23	0.0156	0.545	0.206	1.07	0.662
Uranium-235, Uranium-236	pCi/L	9	23	0.0167	0.0549	0.0140	0.164	0.0641
Uranium-238	pCi/L	11	23	0.0215	0.307	0.0382	0.63	0.330
Uranium (calculated)	µg/L	17	23	0.00603	0.654	0.154	1.92	0.728
Uranium (measured)	µg/L	8	8	0.0410	0.531	0.665	1.64	0.991
Gross Alpha	pCi/L	8	21	0.614	1.26	0.350	2.49	1.50
Gross Beta	pCi/L	13	21	1.32	2.51	0.1911	3.98	2.61
Gross Gamma	pCi/L	10	23	46.3	102.4	47.2	220	132
Pajarito Canyon (includes Twomile and Threemile Canyons) [b]								
Americium-241	pCi/L	10	36	0.0116	0.0263	0.0112	0.0392	0.0333
Cesium-137	pCi/L	5	39	1.24	3.06	1.64	7.29	4.50
Cobalt-60	pCi/L	2	12	0.304	1.37	–	2.44	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Neptunium-237	pCi/L	0	12	0.00	–	–	0.00	–
Plutonium-238	pCi/L	0	37	0.00	–	–	0.00	–
Plutonium-239, Plutonium-240	pCi/L	2	37	0.0254	0.0258	–	0.0261	–
Potassium-40	pCi/L	10	12	3.25	42.4	32.7	103	62.7
Radium-226	pCi/L	9	11	0.149	0.329	0.185	0.752	0.450
Sodium-22	pCi/L	1	12	–	1.87	–	–	–
Strontium-90	pCi/L	8	35	0.0988	0.175	0.0417	0.282	0.204
Tritium	pCi/L	3	21	67.7	187	153	523	360
Uranium-234	pCi/L	21	37	0.00870	0.302	0.0891	0.911	0.340
Uranium-235, Uranium-236	pCi/L	15	37	0.0158	0.0332	0.00333	0.0834	0.0349
Uranium-238	pCi/L	19	37	0.0102	0.175	0.00464	0.547	0.177
Uranium (calculated)	µg/L	34	37	0.0101	0.309	0.102	1.64	0.343
Uranium (measured)	µg/L	16	16	0.0200	0.493	0.746	2.03	0.858
Gross Alpha	pCi/L	11	35	1.08	1.95	0.657	4.99	2.34
Gross Beta	pCi/L	18	35	1.18	4.70	0.884	10.3	5.11
Gross Gamma	pCi/L	15	40	70.5	164	98.7	879	214
Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey) [b]								
Americium-241	pCi/L	0	7	0.00	–	–	0.00	–
Cesium-137	pCi/L	0	7	0.00	–	–	0.00	–
Cobalt-60	pCi/L	0	4	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	4	0.00	–	–	0.00	–
Plutonium-238	pCi/L	0	9	0.00	–	–	0.00	–
Plutonium-239, Plutonium-240	pCi/L	1	9	–	0.601	–	–	–
Potassium-40	pCi/L	2	4	14.5	42.6	–	70.6	–
Radium-226	pCi/L	3	4	0.162	0.206	0.0573	0.271	0.271
Sodium-22	pCi/L	0	4	0.00	–	–	0.00	–
Strontium-90	pCi/L	5	8	0.0788	0.158	0.0384	0.232	0.192
Tritium	pCi/L	2	7	88.4	105	–	122	–
Uranium-234	pCi/L	7	7	0.241	0.264	0.00401	0.299	0.267
Uranium-235, Uranium-236	pCi/L	4	7	0.0281	0.0437	0.00318	0.0637	0.0468
Uranium-238	pCi/L	7	7	0.103	0.135	0.0222	0.165	0.151
Uranium (calculated)	µg/L	7	7	0.320	0.416	0.0644	0.500	0.464
Uranium (measured)	µg/L	4	4	0.315	0.366	0.066	0.463	0.431
Gross Alpha	pCi/L	1	7	–	0.647	–	–	–
Gross Beta	pCi/L	5	7	0.504	1.15	0.205	1.58	1.32
Gross Gamma	pCi/L	3	8	55.5	95.8	35.4	122	136

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–18 Radiochemical Statistical Analysis of Groundwater – Water Supply Wells [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	16	51	0.00331	0.0383	0.0344	0.157	0.0551
Cesium-137	pCi/L	7	53	0.322	3.38	4.20	15.2	6.49
Cobalt-60	pCi/L	1	13	–	1.76	–	–	–
Neptunium-237	pCi/L	4	13	2.02	10.6	5.94	15.6	16.4
Plutonium-238	pCi/L	12	47	0.00401	0.0119	0.00144	0.0187	0.0127
Plutonium-239, Plutonium-240	pCi/L	12	47	0.00	0.0167	0.0136	0.0308	0.0244
Potassium-40	pCi/L	10	13	0.470	23.4	14.5	40.0	32.4
Radium-226	pCi/L	9	13	0.123	0.25	0.114	0.479	0.324
Sodium-22	pCi/L	0	13	0.00	–	–	0.00	–
Strontium-90	pCi/L	50	172	0.0353	0.0935	0.0283	0.272	0.101
Tritium	pCi/L	11	59	60.8	204	180	874	311
Uranium-234	pCi/L	46	47	0.213	0.532	0.113	1.25	0.564
Uranium-235, Uranium-236	pCi/L	32	47	0.00490	0.0495	0.0204	0.142	0.0566
Uranium-238	pCi/L	46	47	0.0173	0.211	0.119	0.561	0.245
Uranium (calculated)	µg/L	47	47	0.0248	0.841	0.0937	1.78	0.868
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	29	62	0.528	1.18	0.134	2.33	1.23
Gross Beta	pCi/L	55	62	1.32	3.56	0.758	8.06	3.76
Gross Gamma	pCi/L	12	34	48.4	115	38.5	355	136
Pueblo Canyon (includes Acid Canyons) [b]								
Americium-241	pCi/L	3	9	0.0221	0.0738	0.0667	0.121	0.149
Cesium-137	pCi/L	0	9	0.00	–	–	0.00	–
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	2	–	2.02	–	–	–
Plutonium-238	pCi/L	3	8	0.0124	0.0157	0.00302	0.0183	0.0192
Plutonium-239, Plutonium-240	pCi/L	4	8	0.00220	0.0109	0.00653	0.0155	0.0173
Potassium-40	pCi/L	2	2	3.30	17.1	–	30.8	–
Radium-226	pCi/L	1	2	–	0.123	–	–	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	7	30	0.0597	0.0746	0.00793	0.104	0.0805
Tritium	pCi/L	2	9	60.8	79.7	–	98.5	–
Uranium-234	pCi/L	8	8	0.516	0.813	0.182	1.04	0.940
Uranium-235, Uranium-236	pCi/L	4	8	0.0947	0.127	0.0167	0.142	0.144
Uranium-238	pCi/L	8	8	0.0284	0.303	0.234	0.503	0.465
Uranium (calculated)	µg/L	8	8	0.740	1.31	0.201	1.56	1.45
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	8	10	0.691	1.46	0.529	2.05	1.83
Gross Beta	pCi/L	10	10	2.46	3.64	0.903	6.10	4.20

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Gamma	pCi/L	1	4	–	116	–	–	–
Sandia Canyon [b]								
Americium-241	pCi/L	3	8	0.00331	0.0226	0.0208	0.0373	0.0461
Cesium-137	pCi/L	1	10	–	0.322	–	–	–
Cobalt-60	pCi/L	1	2	–	1.76	–	–	–
Neptunium-237	pCi/L	1	2	–	11.8	–	–	–
Plutonium-238	pCi/L	2	7	0.0101	0.0104	–	0.0106	–
Plutonium-239, Plutonium-240	pCi/L	3	7	0.00	0.00775	0.0110	0.0159	0.0202
Potassium-40	pCi/L	1	2	–	10.1	–	–	–
Radium-226	pCi/L	1	2	–	0.234	–	–	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/L	9	30	0.0495	0.106	0.0521	0.178	0.140
Tritium	pCi/L	1	11	–	96.4	–	–	–
Uranium-234	pCi/L	7	7	0.595	0.923	0.128	1.25	1.02
Uranium-235, Uranium-236	pCi/L	5	7	0.0474	0.0747	0.0201	0.125	0.0923
Uranium-238	pCi/L	7	7	0.0391	0.281	0.203	0.561	0.431
Uranium (calculated)	µg/L	7	7	0.896	1.28	0.123	1.78	1.37
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	6	11	0.696	1.71	0.580	2.33	2.17
Gross Beta	pCi/L	9	11	2.47	5.14	1.59	8.06	6.18
Gross Gamma	pCi/L	3	5	81.7	167	73.1	355	249
Pajarito Canyon (includes Twomile and Threemile Canyons) [b]								
Americium-241	pCi/L	3	3	0.0157	0.0314	0.00824	0.0588	0.0407
Cesium-137	pCi/L	1	3	–	1.53	–	–	–
Cobalt-60	pCi/L	0	0	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	0	0.00	–	–	0.00	–
Plutonium-238	pCi/L	1	2	–	0.00950	–	–	–
Plutonium-239, Plutonium-240	pCi/L	1	2	–	0.00279	–	–	–
Potassium-40	pCi/L	0	0	0.00	–	–	0.00	–
Radium-226	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	0	0.00	–	–	0.00	–
Strontium-90	pCi/L	5	14	0.0729	0.0997	0.00750	0.110	0.106
Tritium	pCi/L	0	5	0.00	–	–	0.00	–
Uranium-234	pCi/L	2	2	0.222	0.240	–	0.257	–
Uranium-235, Uranium-236	pCi/L	1	2	–	0.0183	–	–	–
Uranium-238	pCi/L	2	2	0.0173	0.0583	–	0.0992	–
Uranium (calculated)	µg/L	2	2	0.304	0.312	–	0.320	–
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	1	3	–	1.03	–	–	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Beta	pCi/L	2	3	2.44	3.00	–	3.55	–
Gross Gamma	pCi/L	0	1	0.00	–	–	0.00	–
Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey) [b]								
Americium-241	pCi/L	2	6	0.0120	0.0845	–	0.157	–
Cesium-137	pCi/L	3	6	0.0205	5.76	8.24	15.2	15.1
Cobalt-60	pCi/L	0	1	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	1	0.00	–	–	0.00	–
Plutonium-238	pCi/L	1	5	–	0.0168	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	5	0.00	–	–	0.00	–
Potassium-40	pCi/L	0	1	0.00	–	–	0.00	–
Radium-226	pCi/L	1	1	–	0.23	–	–	–
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/L	5	18	0.0849	0.159	0.0622	0.224	0.214
Tritium	pCi/L	0	7	0.00	–	–	0.00	–
Uranium-234	pCi/L	5	5	0.213	0.302	0.0833	0.387	0.375
Uranium-235, Uranium-236	pCi/L	3	5	0.0347	0.0390	0.000530	0.0440	0.0396
Uranium-238	pCi/L	5	5	0.0188	0.110	0.0799	0.169	0.180
Uranium (calculated)	µg/L	5	5	0.370	0.461	0.0533	0.521	0.507
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	1	6	–	0.665	–	–	–
Gross Beta	pCi/L	6	6	1.90	3.39	1.41	6.03	4.52
Gross Gamma	pCi/L	1	3	–	90.5	–	–	–
Guaje Canyon (includes Barrancas and Rendija Canyons) [b]								
Americium-241	pCi/L	5	24	0.00609	0.0180	0.000486	0.0317	0.0184
Cesium-137	pCi/L	2	24	1.61	2.79	–	3.97	–
Cobalt-60	pCi/L	0	7	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	7	–	13.0	–	–	–
Plutonium-238	pCi/L	5	24	0.00401	0.0131	0.00794	0.0187	0.0200
Plutonium-239, Plutonium-240	pCi/L	4	24	0.00	0.0168	0.0197	0.0308	0.0362
Potassium-40	pCi/L	6	7	0.470	26.4	15.1	40.0	38.5
Radium-226	pCi/L	6	7	0.139	0.277	0.128	0.479	0.380
Sodium-22	pCi/L	0	7	0.00	–	–	0.00	–
Strontium-90	pCi/L	23	78	0.0353	0.0913	0.0301	0.272	0.104
Tritium	pCi/L	8	25	67.8	257	255	874	434
Uranium-234	pCi/L	23	24	0.254	0.396	0.0110	0.594	0.401
Uranium-235, Uranium-236	pCi/L	18	24	0.0049	0.0381	0.0105	0.0684	0.0430
Uranium-238	pCi/L	23	24	0.0194	0.179	0.102	0.346	0.221
Uranium (calculated)	µg/L	24	24	0.0248	0.661	0.0737	1.05	0.690
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Gross Alpha	pCi/L	13	31	0.528	0.827	0.286	1.48	0.983
Gross Beta	pCi/L	27	31	1.32	2.93	0.671	6.25	3.18
Gross Gamma	pCi/L	6	20	48.4	90.7	22.1	123	108

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
[b] Italicized subheadings are individual areas contributing to main heading.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–19 Radiochemical Statistical Analysis of Groundwater – Santa Fe Water Supply Wells [a]

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Americium-241	pCi/L	1	15	–	0.0111	–	–	–
Cesium-137	pCi/L	13	25	0.0182	3.44	3.81	6.60	5.51
Cobalt-60	pCi/L	2	3	1.41	1.64	–	1.87	–
Neptunium-237	pCi/L	2	3	9.84	10.3	–	10.8	–
Plutonium-238	pCi/L	1	15	–	0.00420	–	–	–
Plutonium-239, Plutonium-240	pCi/L	2	15	0.00	0.00455	–	0.00910	–
Potassium-40	pCi/L	2	3	15.9	25.6	–	35.3	–
Radium-226	pCi/L	3	5	0.557	1.70	1.02	2.51	2.86
Sodium-22	pCi/L	1	3	–	1.59	–	–	–
Strontium-90	pCi/L	10	32	0.0809	0.147	0.0468	0.226	0.176
Tritium	pCi/L	4	14	0.125	54.3	47.0	84.1	100
Uranium-234	pCi/L	43	44	0.00475	22.6	20.4	97.2	28.7
Uranium-235, Uranium-236	pCi/L	34	37	0.00288	1.58	1.41	7.79	2.05
Uranium-238	pCi/L	21	23	2.03	24.6	19.8	84.8	33.1
Uranium (calculated)	µg/L	21	22	1.49×10^{-6}	70.3	53.0	255	93.0
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	13	14	9.98	38.3	38.7	192	59.3
Gross Beta	pCi/L	13	14	0.167	11.0	6.01	51.5	14.3
Gross Gamma	pCi/L	0	13	0.00	–	–	0.00	–

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Main heading as indicated in Table F–1.
Source: LANL 2005.

Table F–20 Radiochemical Statistical Analysis of Sediment from 2001 through 2004

Measured Radiochemical		*2001 through 2004*						
		Detected	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
REGIONAL STATIONS								
Americium-241	pCi/g	65	76	0.000800	0.0137	0.00404	0.116	0.0147
Cesium-137	pCi/g	72	73	0.0154	0.196	0.0966	1.09	0.219
Cobalt-60	pCi/L	0	10	0.00	–	–	0.00	–
Neptunium-237	pCi/L	10	10	0.0961	0.571	0.344	1.09	0.784
Plutonium-238	pCi/g	41	77	0.00	0.00689	0.00399	0.118	0.00812
Plutonium-239, Plutonium-240	pCi/g	51	77	0.0011	0.0309	0.0181	0.450	0.0358
Potassium-40	pCi/L	10	10	13.8	19.0	4.36	29.8	21.7
Sodium-22	pCi/L	0	10	0.00	–	–	0.00	–
Strontium-90	pCi/g	52	78	0.00410	0.0967	0.0269	0.247	0.104
Tritium	pCi/L	5	6	28.4	161	176	465	315
Tritium	pCi/g	21	35	0.00360	15.3	30.1	80.6	28.2
Uranium-234	pCi/g	76	76	0.282	0.821	0.0580	1.74	0.834
Uranium-235, Uranium-236	pCi/g	73	76	0.00780	0.0742	0.0130	0.174	0.0772
Uranium-238	pCi/g	76	76	0.295	0.810	0.0829	1.65	0.829
Uranium (calculated)	µg/g	52	52	0.100	1.69	1.25	4.48	2.03
Gross Alpha	pCi/g	75	75	4.23	13.2	1.30	30.9	13.5
Gross Beta	pCi/g	75	75	12.2	23.9	0.647	36.7	24.0
Gross Gamma	pCi/g	31	31	4.04	8.30	1.25	25.8	8.74
PERIMETER STATIONS								
Americium-241	pCi/g	110	137	0.00160	0.275	0.484	12.2	0.365
Cesium-137	pCi/g	132	139	0.00370	0.302	0.148	11.1	0.327
Cobalt-60	pCi/L	2	34	0.0240	0.0366	–	0.0492	–
Neptunium-237	pCi/L	34	34	0.0910	0.514	0.288	1.12	0.611
Plutonium-238	pCi/g	66	136	0.00120	0.151	0.286	5.96	0.220
Plutonium-239, Plutonium-240	pCi/g	106	136	0.00120	0.808	0.731	9.86	0.947
Potassium-40	pCi/L	34	34	13.7	23.7	5.09	32.9	25.5
Sodium-22	pCi/L	3	34	0.0236	0.0329	0.00838	0.0398	0.0424
Strontium-90	pCi/g	99	139	0.000800	0.210	0.173	3.24	0.244
Tritium	pCi/L	2	8	85.6	441	–	797	–
Tritium	pCi/g	46	126	0.00250	80.6	161	2300	127
Uranium-234	pCi/g	135	135	0.0498	0.858	0.0646	2.67	0.869
Uranium-235, Uranium-236	pCi/g	124	135	0.00220	0.0649	0.0130	0.338	0.0672
Uranium-238	pCi/g	135	135	0.0558	0.823	0.0537	2.14	0.832
Uranium (calculated)	µg/g	103	103	0.0900	1.76	1.32	6.42	2.01
Gross Alpha	pCi/g	138	138	2.00	11.8	1.55	33.7	12.1
Gross Beta	pCi/g	138	138	15.2	29.7	1.87	63.3	30.0
Gross Gamma	pCi/g	66	66	1.40	8.66	0.854	15.7	8.87
ONSITE STATIONS								
Americium-241	pCi/g	281	318	0.00160	0.678	0.153	13.7	0.696
Cesium-137	pCi/g	304	309	0.00460	1.41	0.552	28.6	1.48
Cobalt-60	pCi/L	9	81	0.0210	0.0579	0.0423	0.137	0.0855
Neptunium-237	pCi/L	81	81	0.157	0.699	0.304	1.70	0.765

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Plutonium-238	pCi/g	219	315	0.00	0.408	0.108	11.5	0.422
Plutonium-239, Plutonium-240	pCi/g	274	315	0.00140	0.680	0.0995	13.4	0.692
Potassium-40	pCi/L	81	81	18.1	27.9	2.98	34.8	28.6
Sodium-22	pCi/L	9	81	0.0204	0.0271	0.00711	0.0430	0.0318
Strontium-90	pCi/g	250	313	0.00250	0.269	0.139	3.24	0.286
Tritium	pCi/L	28	30	54.7	1618	2148	9500	2413
Tritium	pCi/g	187	275	0.000100	274	547	9930	352
Uranium-234	pCi/g	313	313	0.0420	0.867	0.0813	2.37	0.876
Uranium-235, Uranium-236	pCi/g	308	313	0.00310	0.0716	0.0323	0.414	0.0752
Uranium-238	pCi/g	313	313	0.0373	0.897	0.0886	2.49	0.906
Uranium (calculated)	µg/g	228	228	0.110	2.03	1.52	7.51	2.23
Gross Alpha	pCi/g	307	307	0.447	16.0	2.20	59.3	16.2
Gross Beta	pCi/g	308	308	6.64	36.6	2.43	74.3	36.8
Gross Gamma	pCi/g	141	141	1.01	12.3	1.46	145	12.6
CANYONS								
Guaje Canyon [a]								
Americium-241	pCi/g	10	13	0.00620	0.0166	0.00706	0.0391	0.0210
Cesium-137	pCi/g	13	14	0.0133	0.314	0.243	0.883	0.446
Cobalt-60	pCi/L	0	5	0.00	–	–	0.00	–
Neptunium-237	pCi/L	5	5	0.354	0.748	0.329	1.12	1.04
Plutonium-238	pCi/g	9	13	0.00150	0.00807	0.00363	0.0206	0.0104
Plutonium-239, Plutonium-240	pCi/g	9	13	0.00140	0.0169	0.0111	0.0361	0.0242
Potassium-40	pCi/L	5	5	24.3	27.3	3.36	31.1	30.2
Sodium-22	pCi/L	0	4	0.00	–	–	0.00	–
Strontium-90	pCi/g	10	14	0.0476	0.163	0.0475	0.396	0.192
Tritium	pCi/L	1	1	–	797	–	–	–
Tritium	pCi/g	3	7	0.0136	26.9	38.0	53.7	69.8
Uranium-234	pCi/g	13	13	0.563	1.15	0.301	2.01	1.32
Uranium-235, Uranium-236	pCi/g	12	13	0.0472	0.112	0.0520	0.338	0.141
Uranium-238	pCi/g	13	13	0.623	1.15	0.238	1.75	1.28
Uranium (calculated)	µg/g	10	10	0.230	2.20	1.65	3.80	3.22
Gross Alpha	pCi/g	13	13	6.24	14.7	2.88	23	16.3
Gross Beta	pCi/g	13	13	24.1	31.4	3.44	37.7	33.2
Gross Gamma	pCi/g	6	6	8.90	11.0	1.70	15.7	12.3
Bayo Canyon [a]								
Americium-241	pCi/g	7	10	0.0047	0.0151	0.0124	0.0490	0.0242
Cesium-137	pCi/g	8	10	0.0119	0.0436	0.00626	0.0895	0.0479
Cobalt-60	pCi/L	0	3	0.00	–	–	0.00	–
Neptunium-237	pCi/L	3	3	0.383	0.466	0.0722	0.514	0.548
Plutonium-238	pCi/g	1	10	–	0.00520	–	–	–
Plutonium-239, Plutonium-240	pCi/g	4	10	0.00120	0.00787	0.00665	0.0145	0.0144
Potassium-40	pCi/L	3	3	24.5	26.0	2.00	28.3	28.3
Sodium-22	pCi/L	1	3	–	0.0242	–	–	–
Strontium-90	pCi/g	6	9	0.000800	0.0540	0.0462	0.170	0.0910

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Tritium	pCi/L	1	1	–	510	–	–	–
Tritium	pCi/g	4	7	0.00250	46.4	80.2	139	125
Uranium-234	pCi/g	10	10	0.625	0.918	0.256	1.33	1.08
Uranium-235, Uranium-236	pCi/g	10	10	0.0312	0.0695	0.0319	0.118	0.0892
Uranium-238	pCi/g	10	10	0.597	0.924	0.252	1.41	1.08
Uranium (calculated)	µg/g	8	8	0.220	2.27	1.81	4.23	3.52
Gross Alpha	pCi/g	9	9	5.78	10.2	3.30	16.8	12.4
Gross Beta	pCi/g	9	9	23.0	29.7	4.87	36.5	32.9
Gross Gamma	pCi/g	6	6	7.80	10.4	0.556	13.6	10.8
Pueblo Canyon [b]								
Americium-241	pCi/g	29	30	0.00430	0.0975	0.0428	0.405	0.113
Cesium-137	pCi/g	30	32	0.0473	0.441	0.368	2.11	0.573
Cobalt-60	pCi/L	0	8	0.00	–	–	0.00	–
Neptunium-237	pCi/L	8	8	0.261	0.686	0.260	1.06	0.866
Plutonium-238	pCi/g	17	30	0.00250	0.0117	0.00465	0.0321	0.0139
Plutonium-239, Plutonium-240	pCi/g	30	30	0.00740	2.01	1.06	7.96	2.39
Potassium-40	pCi/L	8	8	26	28.8	1.67	31.1	29.9
Sodium-22	pCi/L	0	8	0.00	–	–	0.00	–
Strontium-90	pCi/g	25	29	0.0209	0.145	0.0478	0.386	0.163
Tritium	pCi/L	0	0	0.00	–	–	0.00	–
Tritium	pCi/g	14	29	0.00570	71.6	143	544	146
Uranium-234	pCi/g	30	30	0.343	1.03	0.255	2.32	1.12
Uranium-235, Uranium-236	pCi/g	30	30	0.0118	0.0785	0.0204	0.149	0.0858
Uranium-238	pCi/g	30	30	0.391	0.948	0.0885	2.03	0.980
Uranium (calculated)	µg/g	23	23	0.13	1.93	1.39	4.46	2.50
Gross Alpha	pCi/g	31	31	3.13	14.5	3.42	28.1	15.7
Gross Beta	pCi/g	31	31	23.5	32.1	3.15	43	33.2
Gross Gamma	pCi/g	16	16	7.46	10.2	0.00606	12.6	10.2
Los Alamos Canyon (includes Bayo, Acid, Pueblo, DP Canyons) [b]								
Americium-241	pCi/g	44	51	0.00530	0.0870	0.0171	0.376	0.0920
Cesium-137	pCi/g	49	49	0.0225	0.506	0.182	1.96	0.557
Cobalt-60	pCi/L	0	12	0.00	–	–	0.00	–
Neptunium-237	pCi/L	12	12	0.321	0.677	0.203	1.15	0.792
Plutonium-238	pCi/g	33	51	0.00	0.0124	0.00408	0.0532	0.0138
Plutonium-239, Plutonium-240	pCi/g	49	51	0.00410	0.200	0.0877	1.26	0.224
Potassium-40	pCi/L	12	12	23.6	26.9	2.28	30.5	28.2
Sodium-22	pCi/L	0	12	0.00	–	–	0.00	–
Strontium-90	pCi/g	40	52	0.0123	0.424	0.348	3.24	0.532
Tritium	pCi/L	0	2	0.00	–	–	0.00	–
Tritium	pCi/g	40	49	0.00160	171	341	3030	276
Uranium-234	pCi/g	50	50	0.334	0.804	0.105	1.39	0.833
Uranium-235, Uranium-236	pCi/g	49	50	0.00310	0.0524	0.0140	0.106	0.0563
Uranium-238	pCi/g	50	50	0.338	0.771	0.100	1.48	0.799
Uranium (calculated)	µg/g	38	38	0.160	1.56	1.12	4.29	1.92

Measured Radiochemical		2001 through 2004						
		Detected	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Alpha	pCi/g	51	51	4.05	11.9	2.45	29.9	12.6
Gross Beta	pCi/g	51	51	16.9	33.8	4.06	49.5	34.9
Gross Gamma	pCi/g	24	24	5.00	8.70	0.0784	14.4	8.74
Sandia Canyon [b]								
Americium-241	pCi/g	21	27	0.00160	0.0140	0.00552	0.0217	0.0164
Cesium-137	pCi/g	21	26	0.00370	0.0472	0.0168	0.139	0.0544
Cobalt-60	pCi/L	2	7	0.024	0.0273	–	0.0305	–
Neptunium-237	pCi/L	7	7	0.223	0.700	0.487	1.7	1.06
Plutonium-238	pCi/g	16	27	0.00150	0.0125	0.00708	0.0435	0.0160
Plutonium-239, Plutonium-240	pCi/g	19	27	0.00200	0.0148	0.00285	0.0429	0.0161
Potassium-40	pCi/L	7	7	23.5	28.1	4.01	34.8	31.1
Sodium-22	pCi/L	1	7	–	0.0227	–	–	–
Strontium-90	pCi/g	13	24	0.00390	0.0663	0.0276	0.157	0.0813
Tritium	pCi/L	3	4	55.7	99.9	40.8	136	146
Tritium	pCi/g	12	23	0.00510	241	482	1270	514
Uranium-234	pCi/g	27	27	0.0498	0.818	0.404	2.37	0.971
Uranium-235, Uranium-236	pCi/g	25	27	0.0120	0.0747	0.0441	0.246	0.0920
Uranium-238	pCi/g	27	27	0.0558	0.790	0.411	2.49	0.945
Uranium (calculated)	µg/g	19	19	0.14	2.16	1.70	7.51	2.92
Gross Alpha	pCi/g	24	24	0.447	11.1	3.14	23.0	12.4
Gross Beta	pCi/g	24	24	6.64	32.4	4.57	52.9	34.2
Gross Gamma	pCi/g	16	16	6.57	9.14	0.162	15.8	9.22
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey) [b]								
Americium-241	pCi/g	68	75	0.00350	2.08	1.50	13.7	2.43
Cesium-137	pCi/g	72	74	0.00470	4.34	3.50	28.6	5.15
Cobalt-60	pCi/L	6	20	0.0229	0.0740	0.0438	0.137	0.109
Neptunium-237	pCi/L	20	20	0.162	0.621	0.315	1.57	0.759
Plutonium-238	pCi/g	60	75	0.00150	1.08	0.715	11.5	1.26
Plutonium-239, Plutonium-240	pCi/g	63	75	0.00140	1.85	1.30	9.86	2.18
Potassium-40	pCi/L	20	20	22.1	28.85	2.80	33.8	30.1
Sodium-22	pCi/L	5	20	0.0204	0.0265	0.00480	0.0324	0.0307
Strontium-90	pCi/g	62	73	0.00430	0.460	0.341	2.64	0.545
Tritium	pCi/L	7	7	226	1631	1208	3030	2526
Tritium	pCi/g	35	64	0.00110	376	751	9930	624
Uranium-234	pCi/g	75	75	0.287	0.855	0.130	1.91	0.884
Uranium-235, Uranium-236	pCi/g	74	75	0.0033	0.0754	0.0493	0.414	0.0867
Uranium-238	pCi/g	75	75	0.247	0.863	0.136	2.16	0.894
Uranium (calculated)	µg/g	54	54	0.130	1.95	1.54	6.51	2.36
Gross Alpha	pCi/g	72	72	2.64	20.6	3.89	59.3	21.5
Gross Beta	pCi/g	72	72	21.4	43.7	3.07	74.3	44.4
Gross Gamma	pCi/g	34	34	5.76	20.9	4.86	145	22.5
Cañada del Buey Canyon [c]								
Americium-241	pCi/g	6	7	0.0062	0.0159	0.00449	0.0261	0.0195
Cesium-137	pCi/g	8	8	0.017	0.118	0.0760	0.293	0.171

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	2	2	0.393	0.636	–	0.879	–
Plutonium-238	pCi/g	5	7	0.00	0.0580	0.0720	0.140	0.121
Plutonium-239, Plutonium-240	pCi/g	7	7	0.0019	0.0219	0.0105	0.0502	0.0297
Potassium-40	pCi/L	2	2	28.5	30.0	–	31.5	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–
Strontium-90	pCi/g	7	8	0.0203	0.0500	0.0240	0.0960	0.0678
Tritium	pCi/L	1	1	–	1010	–	–	–
Tritium	pCi/g	6	6	0.0001	236	471	943	613
Uranium-234	pCi/g	7	7	0.787	1.01	0.0940	1.39	1.08
Uranium-235, Uranium-236	pCi/g	7	7	0.0273	0.0757	0.0498	0.154	0.113
Uranium-238	pCi/g	7	7	0.748	0.968	0.131	1.44	1.07
Uranium (calculated)	µg/g	5	5	0.27	2.23	1.72	4.35	3.73
Gross Alpha	pCi/g	8	8	13.3	17.6	2.51	23.3	19.3
Gross Beta	pCi/g	8	8	15.8	34.6	4.12	48.3	37.5
Gross Gamma	pCi/g	3	3	8.56	9.41	1.20	10.6	10.8
Pajarito Canyon (includes Twomile, Threemile Canyons) [b]								
Americium-241	pCi/g	77	81	0.00220	0.133	0.116	3.08	0.159
Cesium-137	pCi/g	81	82	0.00460	0.413	0.143	4.43	0.444
Cobalt-60	pCi/L	1	20	–	0.0492	–	–	–
Neptunium-237	pCi/L	20	20	0.252	0.706	0.351	1.59	0.859
Plutonium-238	pCi/g	65	81	0.00160	0.113	0.0593	1.31	0.128
Plutonium-239, Plutonium-240	pCi/g	74	81	0.00170	0.260	0.134	3.81	0.290
Potassium-40	pCi/L	20	20	21.1	28.1	3.40	33.4	29.6
Sodium-22	pCi/L	1	20	–	0.0430	–	–	–
Strontium-90	pCi/g	66	82	0.00860	0.162	0.0811	1.14	0.182
Tritium	pCi/L	14	15	54.7	2276	2726	9500	3704
Tritium	pCi/g	48	64	0.00340	376	751	9930	588
Uranium-234	pCi/g	81	81	0.310	0.930	0.0921	1.69	0.950
Uranium-235, Uranium-236	pCi/g	79	81	0.00220	0.0727	0.0319	0.189	0.0797
Uranium-238	pCi/g	81	81	0.221	0.938	0.0923	1.86	0.958
Uranium (calculated)	µg/g	58	58	0.130	2.11	1.61	5.53	2.52
Gross Alpha	pCi/g	81	81	2.37	16.3	1.52	34.4	16.7
Gross Beta	pCi/g	81	81	17.9	37.6	2.48	52.6	38.1
Gross Gamma	pCi/g	28	28	5.13	10.5	0.327	18.1	10.7
Potrilllo Canyon [c]								
Americium-241	pCi/g	4	6	0.00510	0.0113	0.00422	0.0143	0.0154
Cesium-137	pCi/g	6	6	0.0795	0.133	0.0559	0.207	0.178
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	2	2	0.541	0.648	–	0.755	–
Plutonium-238	pCi/g	2	6	0.00120	0.00255	–	0.00390	–
Plutonium-239, Plutonium-240	pCi/g	3	6	0.00330	0.0126	0.0128	0.0272	0.0271
Potassium-40	pCi/L	2	2	28.3	29.2	–	30.1	–
Sodium-22	pCi/L	0	2	0.00	–	–	0.00	–

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Strontium-90	pCi/g	3	5	0.0226	0.0819	0.0515	0.116	0.140
Tritium	pCi/L	0	0	0.00	–	–	0.00	–
Tritium	pCi/g	2	5	0.196	0.424	–	0.651	–
Uranium-234	pCi/g	6	6	0.364	0.763	0.295	1.09	0.999
Uranium-235, Uranium-236	pCi/g	6	6	0.0329	0.0666	0.0374	0.140	0.0965
Uranium-238	pCi/g	6	6	0.419	0.792	0.276	1.10	1.01
Uranium (calculated)	µg/g	5	5	0.33	1.44	1.17	2.72	2.47
Gross Alpha	pCi/g	5	5	11.9	11.4	5.50	16.3	16.2
Gross Beta	pCi/g	6	6	18.2	31.8	11.9	45.2	41.4
Gross Gamma	pCi/g	3	3	1.48	6.66	2.51	8.43	9.49
Water Canyon (includes Cañon de Valle, Potrillo, Fence, Indio Canyons) [b]								
Americium-241	pCi/g	77	88	0.00160	0.0380	0.0196	0.239	0.0424
Cesium-137	pCi/g	85	85	0.00700	0.275	0.0529	1.14	0.286
Cobalt-60	pCi/L	1	21	–	0.021	–	–	–
Neptunium-237	pCi/L	21	21	0.091	0.707	0.306	1.33	0.837
Plutonium-238	pCi/g	47	86	0.00	0.0106	0.00977	0.166	0.0134
Plutonium-239, Plutonium-240	pCi/g	74	86	0.00170	0.0740	0.0324	0.721	0.0814
Potassium-40	pCi/L	21	21	18.1	26.0	3.39	32.9	27.5
Sodium-22	pCi/L	3	21	0.0216	0.0323	0.00950	0.0398	0.0430
Strontium-90	pCi/g	72	87	0.00560	0.109	0.0290	0.375	0.116
Tritium	pCi/L	2	3	82.5	95.75	–	109	–
Tritium	pCi/g	53	88	0.000300	82.1	163	541	126
Uranium-234	pCi/g	86	86	0.351	0.786	0.0655	1.59	0.800
Uranium-235, Uranium-236	pCi/g	84	86	0.00450	0.0619	0.0194	0.170	0.0660
Uranium-238	pCi/g	86	86	0.288	0.874	0.107	2.01	0.896
Uranium (calculated)	µg/g	64	64	0.11	2.01	1.49	6.04	2.37
Gross Alpha	pCi/g	88	88	2.91	13.4	2.54	26.9	13.9
Gross Beta	pCi/g	88	88	8.22	32.1	2.88	50.5	32.7
Gross Gamma	pCi/g	39	39	5.91	8.85	0.266	12.0	8.94
Ancho Canyon [b]								
Americium-241	pCi/g	12	18	0.00400	0.0123	0.00359	0.0230	0.0143
Cesium-137	pCi/g	16	16	0.0126	0.113	0.0543	0.327	0.140
Cobalt-60	pCi/L	0	3	0.00	–	–	0.00	–
Neptunium-237	pCi/L	3	3	0.157	0.356	0.188	0.53	0.568
Plutonium-238	pCi/g	9	18	0.00120	0.00451	0.00233	0.00560	0.00603
Plutonium-239, Plutonium-240	pCi/g	13	18	0.00350	0.0164	0.0106	0.0946	0.0221
Potassium-40	pCi/L	3	3	25.4	27.1	2.39	29.8	29.8
Sodium-22	pCi/L	0	3	0.00	–	–	0.00	–
Strontium-90	pCi/g	13	19	0.00510	0.110	0.0457	0.346	0.134
Tritium	pCi/L	1	2	–	85.6	–	–	–
Tritium	pCi/g	10	15	0.000200	163	325	1610	365
Uranium-234	pCi/g	17	17	0.281	0.659	0.150	1.27	0.731
Uranium-235, Uranium-236	pCi/g	16	17	0.00800	0.0496	0.0168	0.0876	0.0578
Uranium-238	pCi/g	17	17	0.225	0.717	0.197	1.60	0.811

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (calculated)	µg/g	12	12	0.09	1.49	1.07	3.78	2.10
Gross Alpha	pCi/g	16	16	1.70	8.82	2.96	14.0	10.3
Gross Beta	pCi/g	16	16	12.4	27.6	5.90	38.3	30.5
Gross Gamma	pCi/g	9	9	1.40	7.04	0.0392	9.94	7.07
***Chaquehui Canyon* [a]**								
Americium-241	pCi/g	3	3	0.00260	0.00937	0.00587	0.0130	0.0160
Cesium-137	pCi/g	3	3	0.182	0.373	0.323	0.746	0.739
Cobalt-60	pCi/L	0	1	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	1	–	0.956	–	–	–
Plutonium-238	pCi/g	2	3	0.00280	0.00580	–	0.00880	–
Plutonium-239, Plutonium-240	pCi/g	2	3	0.0161	0.0178	–	0.0195	–
Potassium-40	pCi/L	1	1	–	13.7	–	–	–
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/g	2	3	0.199	0.236	–	0.272	–
Tritium	pCi/L	0	0	0.00	–	–	0.00	–
Tritium	pCi/g	1	3	–	2300	–	–	–
Uranium-234	pCi/g	3	3	1.13	1.72	0.831	2.67	2.66
Uranium-235, Uranium-236	pCi/g	3	3	0.0578	0.0855	0.0430	0.135	0.134
Uranium-238	pCi/g	3	3	1.09	1.50	0.509	2.07	2.08
Uranium (calculated)	µg/g	3	3	0.34	3.27	2.94	6.21	6.59
Gross Alpha	pCi/g	3	3	13.8	21.3	6.58	26.1	28.7
Gross Beta	pCi/g	3	3	28.6	34.8	7.34	42.9	43.1
Gross Gamma	pCi/g	1	1	–	9.11	–	–	–
***Frijoles Canyon* [b]**								
Americium-241	pCi/g	14	18	0.00380	3.06	6.09	0.0511	6.25
Cesium-137	pCi/g	18	18	0.0566	1.18	1.72	11.1	1.97
Cobalt-60	pCi/L	0	2	0.00	–	–	0.00	–
Neptunium-237	pCi/L	2	2	0.312	0.601	–	0.889	–
Plutonium-238	pCi/g	6	17	0.00190	1.50	2.97	5.96	3.88
Plutonium-239, Plutonium-240	pCi/g	15	17	0.00190	2.48	4.92	9.86	4.97
Potassium-40	pCi/L	2	2	17.6	23.4	–	29.2	–
Sodium-22	pCi/L	1	2	–	0.0236	–	–	–
Strontium-90	pCi/g	14	17	0.00730	0.885	1.57	3.24	1.71
Tritium	pCi/L	0	1	0.00	–	–	0.00	–
Tritium	pCi/g	4	16	0.0314	96.4	166	484	259
Uranium-234	pCi/g	17	17	0.376	1.09	0.332	2.10	1.24
Uranium-235, Uranium-236	pCi/g	16	17	0.0121	0.0713	0.0228	0.130	0.0825
Uranium-238	pCi/g	17	17	0.430	1.08	0.297	2.14	1.22
Uranium (calculated)	µg/g	12	12	0.180	2.25	1.99	6.42	3.38
Gross Alpha	pCi/g	18	18	9.44	15.1	1.42	21.7	15.7
Gross Beta	pCi/g	18	18	18.4	31.6	5.91	44.2	34.4
Gross Gamma	pCi/g	9	9	1.46	9.48	2.71	13.2	11.2
***Fence Canyon* [c]**								
Americium-241	pCi/g	6	7	0.00620	0.0153	0.00706	0.0323	0.0209

Measured Radiochemical		***2001 through 2004***						
		Detected	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Cesium-137	pCi/g	7	7	0.0613	0.250	0.217	0.574	0.410
Cobalt-60	pCi/L	1	3	–	0.0256	–	–	–
Neptunium-237	pCi/L	3	3	0.600	0.767	0.255	1.06	1.06
Plutonium-238	pCi/g	3	7	0.00320	0.00367	0.000723	0.00450	0.00449
Plutonium-239, Plutonium-240	pCi/g	4	7	0.00700	0.0185	0.0108	0.0303	0.0291
Potassium-40	pCi/L	3	3	26.3	26.8	0.462	27.1	27.4
Sodium-22	pCi/L	0	3	0.00	–	–	0.00	–
Strontium-90	pCi/g	4	7	0.0124	0.0969	0.0671	0.185	0.163
Tritium	pCi/L	0	0	0.00	–	–	0.00	–
Tritium	pCi/g	2	5	0.0610	2.58	–	5.10	–
Uranium-234	pCi/g	7	7	0.683	0.974	0.0701	1.12	1.03
Uranium-235, Uranium-236	pCi/g	7	7	0.0553	0.0864	0.0452	0.199	0.120
Uranium-238	pCi/g	7	7	0.743	1.01	0.0576	1.27	1.05
Uranium (calculated)	µg/g	6	6	0.320	2.14	1.57	3.80	3.40
Gross Alpha	pCi/g	7	7	4.86	18.1	9.97	28.1	25.5
Gross Beta	pCi/g	7	7	20.7	32.3	8.98	42.8	39.0
Gross Gamma	pCi/g	3	3	1.01	8.75	3.74	11.4	13.0
Indio Canyon [c]								
Americium-241	pCi/g	2	4	0.0107	0.0188	–	0.0268	–
Cesium-137	pCi/g	4	4	0.0911	0.167	0.0596	0.235	0.225
Cobalt-60	pCi/L	0	1	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	1	–	0.277	–	–	–
Plutonium-238	pCi/g	1	4	–	0.00230	–	–	–
Plutonium-239, Plutonium-240	pCi/g	4	4	0.00240	0.0159	0.0107	0.0253	0.0263
Potassium-40	pCi/L	1	1	–	25.2	–	–	–
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/g	4	5	0.00250	0.0850	0.0894	0.180	0.173
Tritium	pCi/L	0	0	0.00	–	–	0.00	–
Tritium	pCi/g	2	3	0.0870	0.215	–	0.342	–
Uranium-234	pCi/g	4	4	0.517	0.867	0.317	1.22	1.18
Uranium-235, Uranium-236	pCi/g	4	4	0.0358	0.0732	0.0552	0.155	0.127
Uranium-238	pCi/g	4	4	0.501	0.909	0.347	1.27	1.25
Uranium (calculated)	µg/g	3	3	0.240	1.86	1.83	3.84	3.93
Gross Alpha	pCi/g	4	4	3.76	11.8	7.90	18.7	19.6
Gross Beta	pCi/g	4	4	18.5	32.6	10.6	43.2	43.0
Gross Gamma	pCi/g	2	2	7.21	8.56	–	9.90	–

UCL = upper confidence limit, pCi/L = picocuries per liter, pCi/g = picocuries per gram, µg/g = micrograms per gram.
[a] Perimeter Stations.
[b] Both Onsite and Perimeter Stations.
[c] Onsite Stations.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–21 Radiochemical Statistical Analysis of Surface Water or Storm Water Runoff

Measured Radiochemical		*2001 through 2004*						
		Detected	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
REGIONAL STATIONS								
Americium-241	pCi/L	6	21	0.00270	0.0433	0.0455	0.116	0.0797
Cesium-137	pCi/L	4	18	0.54	2.70	1.43	3.75	4.10
Cobalt-60	pCi/L	0	6	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	6	0.00	–	–	0.00	–
Plutonium-238	pCi/L	7	22	0.002	0.0165	0.0182	0.0489	0.0300
Plutonium-239, Plutonium-240	pCi/L	5	22	0.0567	0.528	0.368	1.00	0.851
Potassium-40	pCi/L	4	6	34.4	63	27. 5	90.2	90.0
Radium-226	pCi/L	3	5	0.245	1.77	2.55	4.72	4.66
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	1	6	–	2.51	–	–	–
Strontium-90	pCi/L	11	21	0.132	0.265	0.188	0.694	0.376
Tritium	pCi/L	4	17	74.8	126	23.1	199	149
Uranium-234	pCi/L	23	23	0.529	10.4	15.9	108	16.9
Uranium-235, Uranium-236	pCi/L	22	23	0.0250	0.902	1.45	9.55	1.51
Uranium-238	pCi/L	23	23	0.285	10.3	16.7	111	17.2
Uranium (calculated)	µg/L	13	13	0	3.04	2.78	12.5	4.56
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	21	21	2.3	22.5	30.7	235	35.7
Gross Beta	pCi/L	21	21	1.38	41.9	59.1	298	67.1
Gross Gamma	pCi/L	6	16	77.8	244	224	499	423
PERIMETER STATIONS								
Americium-241	pCi/L	59	97	0.00	0.569	0.654	8.46	0.735
Cesium-137	pCi/L	33	80	0.00	5.94	1.95	15.8	6.60
Cobalt-60	pCi/L	3	16	0.517	1.60	0.978	2.42	2.71
Neptunium-237	pCi/L	6	16	2.67	9.33	5.91	18.1	14.1
Plutonium-238	pCi/L	42	95	0.00	0.383	0.506	3.57	0.535
Plutonium-239, Plutonium-240	pCi/L	51	96	0.00	1.94	2.20	39.4	2.54
Potassium-40	pCi/L	13	16	15.6	76.3	67.6	229	113
Radium-226	pCi/L	4	8	0.161	0.385	0.196	0.6	0.577
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	2	16	1.87	3.00	–	4.13	–
Strontium-90	pCi/L	71	85	0.0622	4.61	3.58	26.8	5.44
Tritium	pCi/L	20	55	58.3	127	23.2	268	138
Uranium-234	pCi/L	83	90	0.0379	19.4	15.1	354	22.7
Uranium-235, Uranium-236	pCi/L	66	89	0.00	1.26	0.903	15.2	1.48
Uranium-238	pCi/L	81	89	0.0194	17.9	14.1	334	21.0
Uranium (calculated)	µg/L	100	101	0.00	11.1	10.2	137	13.1
Uranium (measured)	µg/L	25	25	0.0300	3.16	9.79	48.3	6.99

Measured Radiochemical		***2001 through 2004***						
		Detected	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Gross Alpha	pCi/L	68	86	0.506	282	168	3070	322
Gross Beta	pCi/L	79	85	0.636	412	245	5370	466
Gross Gamma	pCi/L	17	51	66.0	211	173	1110	293
ONSITE STATIONS								
Americium-241	pCi/L	245	330	0.00	14.6	25.3	583	17.7
Cesium-137	pCi/L	118	295	0.00	12.8	6.48	99.1	13.9
Cobalt-60	pCi/L	13	92	1.96	4.14	2.76	11.3	5.64
Neptunium-237	pCi/L	21	91	1.98	10.1	5.90	24.8	12.6
Plutonium-238	pCi/L	205	319	0.00	16.2	30.9	685	20.4
Plutonium-239, Plutonium-240	pCi/L	216	319	0.00	12.1	19.1	608	14.6
Potassium-40	pCi/L	88	90	1.26	77.4	106	709	99.7
Radium-226	pCi/L	10	13	0.123	0.306	0.144	0.566	0.395
Radium-228	pCi/L	4	6	0.481	0.757	0.291	1.06	1.04
Sodium-22	pCi/L	3	92	1.87	3.18	1.23	4.32	4.58
Strontium-90	pCi/L	216	296	0.0516	3.79	1.32	71.9	3.97
Tritium	pCi/L	135	236	50.9	354	155	12900	380
Uranium-234	pCi/L	273	297	0.0132	7.60	2.63	149	7.91
Uranium-235, Uranium-236	pCi/L	204	305	0.00	0.673	0.280	7.28	0.712
Uranium-238	pCi/L	280	307	0.0150	7.70	2.24	147	7.97
Uranium (calculated)	µg/L	404	412	0.00	7.22	5.36	190	7.74
Uranium (measured)	µg/L	225	225	0.0300	4.51	12.7	93.4	6.17
Gross Alpha	pCi/L	235	292	0.193	150	29.0	1800	154
Gross Beta	pCi/L	272	286	0.809	171	76.7	3160	181
Gross Gamma	pCi/L	42	106	55.2	186	92.5	1990	214
CANYONS								
Guaje Canyon [b]								
Americium-241	pCi/L	19	29	0.0180	0.437	0.226	1.52	0.539
Cesium-137	pCi/L	18	27	0	8.11	2.77	15.8	9.39
Cobalt-60	pCi/L	0	1	0.00	–	–	0.00	–
Neptunium-237	pCi/L	0	1	0.00	–	–	0.00	–
Plutonium-238	pCi/L	9	29	0.0650	0.243	0.204	0.699	0.377
Plutonium-239, Plutonium-240	pCi/L	17	29	0.0121	1.55	1.36	3.93	2.20
Potassium-40	pCi/L	1	1	–	25.9	–	–	–
Radium-226	pCi/L	2	2	0.486	0.543	–	0.6	–
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/L	27	28	0.212	10.2	2.69	26.8	11.2
Tritium	pCi/L	6	14	84.3	151	24.2	268	171
Uranium-234	pCi/L	30	31	0.0390	35.3	28.3	354	45.4
Uranium-235, Uranium-236	pCi/L	26	30	0.00	1.95	1.43	15.2	2.50
Uranium-238	pCi/L	28	30	0.0334	32.3	25.8	334	41.9
Uranium (calculated)	µg/L	26	26	0.113	16.6	18.2	137	23.6

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	24	28	0.900	430	420	3070	598
Gross Beta	pCi/L	27	27	2.29	542	617	5370	775
Gross Gamma	pCi/L	7	17	85.2	334	205	1110	486
Los Alamos Canyon (includes Bayo, Acid, Pueblo, DP Canyons) [c]								
Americium-241	pCi/L	72	87	0.00	1.18	1.08	16.1	1.43
Cesium-137	pCi/L	39	81	0.00	6.16	4.46	32.7	7.56
Cobalt-60	pCi/L	3	30	2.70	3.12	0.556	3.74	3.74
Neptunium-237	pCi/L	10	30	3.41	8.48	3.63	13.3	10.7
Plutonium-238	pCi/L	57	84	0.00	0.175	0.0917	1.40	0.199
Plutonium-239, Plutonium-240	pCi/L	66	84	0.0100	3.82	2.88	85.3	4.51
Potassium-40	pCi/L	30	30	3.27	67.8	61.0	248	89.6
Radium-226	pCi/L	2	2	0.277	0.410	–	0.542	–
Radium-228	pCi/L	1	2	–	0.481	–	–	–
Sodium-22	pCi/L	1	30	–	3.35	–	–	–
Strontium-90	pCi/L	66	80	0.0946	5.22	5.31	50.1	6.50
Tritium	pCi/L	37	65	50.9	140	64.9	546	161
Uranium-234	pCi/L	73	81	0.0590	7.58	6.65	149	9.11
Uranium-235, Uranium-236	pCi/L	66	81	0.00820	0.557	0.430	7.28	0.660
Uranium-238	pCi/L	72	81	0.0220	7.46	6.85	147	9.04
Uranium (calculated)	µg/L	129	130	0.0200	8.68	5.64	102	9.65
Uranium (measured)	µg/L	66	66	0.0300	2.71	4.43	21.6	3.78
Gross Alpha	pCi/L	69	81	0.575	122	146	1800	157
Gross Beta	pCi/L	76	81	1.58	171	210	3010	218
Gross Gamma	pCi/L	3	12	96.3	132	30.8	151	167
Pajarito Canyon (includes Twomile, Threemile Canyons) [c]								
Americium-241	pCi/L	85	134	0.0073	0.646	0.595	10.1	0.773
Cesium-137	pCi/L	40	113	1.21	6.46	3.53	46.8	7.56
Cobalt-60	pCi/L	7	37	0.764	5.64	4.09	10.7	8.67
Neptunium-237	pCi/L	11	36	2.67	10.1	6.01	24.8	13.7
Plutonium-238	pCi/L	81	131	0.00	0.160	0.147	0.985	0.192
Plutonium-239, Plutonium-240	pCi/L	79	131	0.00480	1.20	1.15	7.65	1.45
Potassium-40	pCi/L	34	36	5.49	82.0	120.1	709	122
Radium-226	pCi/L	5	8	0.14	0.312	0.160	0.566	0.453
Radium-228	pCi/L	4	4	0.537	1.67	1.10	2.83	2.76
Sodium-22	pCi/L	3	37	1.87	3.22	1.24	4.32	4.63
Strontium-90	pCi/L	86	120	0.0516	2.69	2.25	71.9	3.17
Tritium	pCi/L	54	84	62.9	261	46.5	1980	274
Uranium-234	pCi/L	107	119	0.0132	9.01	5.23	67.8	10.0
Uranium-235, Uranium-236	pCi/L	73	125	0.00	0.868	0.549	6.41	0.994
Uranium-238	pCi/L	118	126	0.0210	8.82	4.30	83.3	9.60
Uranium (calculated)	µg/L	133	134	0.00	8.39	10.8	249	10.2

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (measured)	µg/L	87	87	0.0300	7.83	29.2	238	14.0
Gross Alpha	pCi/L	91	115	0.315	145	96.1	1630	165
Gross Beta	pCi/L	105	110	0.809	174	139	3160	201
Gross Gamma	pCi/L	23	44	55.0	139	62.4	430	165
Water Canyon (includes Cañon de Valle, Potrillo, Fence, Indio Canyons) [c]								
Americium-241	pCi/L	44	53	0.00	0.117	0.0821	1.18	0.141
Cesium-137	pCi/L	20	46	0.00	5.55	2.75	15.0	6.76
Cobalt-60	pCi/L	2	9	1.86	1.92	–	1.98	–
Neptunium-237	pCi/L	0	9	0.00	–	–	0.00	–
Plutonium-238	pCi/L	30	50	0.00	0.101	0.0579	0.549	0.122
Plutonium-239, Plutonium-240	pCi/L	36	50	0.00	0.362	0.308	3.15	0.463
Potassium-40	pCi/L	9	9	1.26	163	197	511	292
Radium-226	pCi/L	1	1	–	0.245	–	–	–
Radium-228	pCi/L	1	2	–	1.06	–	–	–
Sodium-22	pCi/L	0	9	0.00	–	–	0.00	–
Strontium-90	pCi/L	41	46	0.140	2.80	1.94	16.9	3.39
Tritium	pCi/L	10	31	106	157	18.9	231	168
Uranium-234	pCi/L	43	48	0.0486	16.2	8.42	79.0	18.8
Uranium-235, Uranium-236	pCi/L	34	48	0.00900	1.09	0.537	4.86	1.27
Uranium-238	pCi/L	43	48	0.0194	19.8	13.2	82.1	23.8
Uranium (calculated)	µg/L	62	64	0.00	18.3	21.1	190	23.6
Uranium (measured)	µg/L	46	46	0.0250	13.0	25.9	93.4	20.5
Gross Alpha	pCi/L	40	46	0.463	179	94.2	1660	209
Gross Beta	pCi/L	43	46	1.26	283	156	2990	330
Gross Gamma	pCi/L	6	17	93.1	135	32.1	170	161.1
Mortandad Canyon (includes Ten Site Canyon, Cañada del Buey) [a]								
Americium-241	pCi/L	54	67	0.00930	32.3	55.1	583	47.0
Cesium-137	pCi/L	21	53	0.22	28.0	26.8	99.1	39.4
Cobalt-60	pCi/L	2	14	0.517	1.79	–	3.07	–
Neptunium-237	pCi/L	5	14	1.98	10.1	7.38	18.1	16.6
Plutonium-238	pCi/L	44	62	0.00	39.1	72.4	685	60.5
Plutonium-239, Plutonium-240	pCi/L	43	63	0.00	27.0	49.8	608	41.9
Potassium-40	pCi/L	13	14	4.93	77.9	68.9	229	115
Radium-226	pCi/L	1	1	–	0.123	–	–	–
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	2	14	1.87	3.00	–	4.13	–
Strontium-90	pCi/L	29	55	0.169	1.15	0.640	4.25	1.38
Tritium	pCi/L	27	47	73.4	1134	875	12900	1464
Uranium-234	pCi/L	48	52	0.0227	3.38	4.89	55.0	4.76
Uranium-235, Uranium-236	pCi/L	35	54	0.00	0.324	0.488	4.60	0.486
Uranium-238	pCi/L	51	55	0.0150	3.19	4.49	67.2	4.42
Uranium (calculated)	µg/L	63	67	0.0180	4.11	4.01	45.8	5.10

Measured Radiochemical		2001 through 2004						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Uranium (measured)	µg/L	36	36	0.0790	3.37	8.34	48.3	6.10
Gross Alpha	pCi/L	39	52	0.193	148	143	979	193
Gross Beta	pCi/L	47	51	1.60	109	106	1400	140
Gross Gamma	pCi/L	10	23	90.1	334	280	1990	507
Ancho Canyon [a]								
Americium-241	pCi/L	1	3	–	0.0166	–	–	–
Cesium-137	pCi/L	1	2	–	2.93	–	–	–
Cobalt-60	pCi/L	1	1	–	2.42	–	–	–
Neptunium-237	pCi/L	1	1	–	13.9	–	–	–
Plutonium-238	pCi/L	1	3	–	0.0127	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	3	0.00	–	–	0.00	–
Potassium-40	pCi/L	1	1	–	43.2	–	–	–
Radium-226	pCi/L	0	1	0.00	–	–	0.00	–
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	1	0.00	–	–	0.00	–
Strontium-90	pCi/L	0	2	0.00	–	–	0.00	–
Tritium	pCi/L	0	3	0.00	–	–	0.00	–
Uranium-234	pCi/L	3	3	0.0610	0.113	0.0465	0.146	0.166
Uranium-235, Uranium-236	pCi/L	0	3	0.00	–	–	0.00	–
Uranium-238	pCi/L	3	3	0.0366	0.0498	0.00283	0.067	0.0530
Uranium (calculated)	µg/L	4	4	0.0900	12.6	18.2	33.5	30.4
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	1	3	–	1.19	–	–	–
Gross Beta	pCi/L	1	3	–	2.17	–	–	–
Gross Gamma	pCi/L	1	2	–	78.3	–	–	–
Frijoles Canyon [a]								
Americium-241	pCi/L	1	8	–	0.0260	–	–	–
Cesium-137	pCi/L	0	7	0.00	–	–	0.00	–
Cobalt-60	pCi/L	0	3	0.00	–	–	0.00	–
Neptunium-237	pCi/L	1	3	–	9.02	–	–	–
Plutonium-238	pCi/L	1	8	–	0.00260	–	–	–
Plutonium-239, Plutonium-240	pCi/L	0	8	0.00	–	–	0.00	–
Potassium-40	pCi/L	1	3	–	15.6	–	–	–
Radium-226	pCi/L	1	3	–	0.161	–	–	–
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	3	0.00	–	–	0.00	–
Strontium-90	pCi/L	4	8	0.0622	0.726	0.939	3.63	1.65
Tritium	pCi/L	3	9	58.3	76.8	16.0	87.3	94.9
Uranium-234	pCi/L	6	7	0.0379	0.102	0.0540	0.204	0.145
Uranium-235, Uranium-236	pCi/L	2	7	0.0456	0.0512	–	0.0568	–
Uranium-238	pCi/L	6	7	0.0272	0.0398	0.00223	0.0502	0.0416
Uranium (calculated)	µg/L	4	4	0.0829	0.137	0.0404	0.170	0.176

Measured Radiochemical		2001 through 2004						
		Detected	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Uranium (measured)	µg/L	0	0	0.00	–	–	0.00	–
Gross Alpha	pCi/L	4	8	0.548	1.597	0.0877	2.77	1.68
Gross Beta	pCi/L	7	8	0.636	2.33	0.756	4.25	2.89
Gross Gamma	pCi/L	2	7	66.0	79.3		92.6	
Sandia Canyon [a]								
Americium-241	pCi/L	14	28	0.00950	0.0420	0.0159	0.111	0.0503
Cesium-137	pCi/L	6	29	1.82	3.85	2.40	9.61	5.77
Cobalt-60	pCi/L	2	11	1.96	3.80	5.63	5.63	11.6
Neptunium-237	pCi/L	2	11	5.82	13.96	22.1	22.1	44.6
Plutonium-238	pCi/L	12	29	0.00	0.0466	0.0189	0.0972	0.0572
Plutonium-239, Plutonium-240	pCi/L	8	29	0.0197	0.0861	0.0381	0.331	0.112
Potassium-40	pCi/L	11	11	7.59	47.3	87.1	87.1	98.8
Radium-226	pCi/L	1	2	–	0.176	–	–	–
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	11	0.00	–	–	0.00	–
Strontium-90	pCi/L	14	27	0.0900	0.208	0.0922	0.792	0.256
Tritium	pCi/L	16	30	54.4	108	17.8	203	117
Uranium-234	pCi/L	28	29	0.0220	1.65	1.25	13.0	2.11
Uranium-235, Uranium-236	pCi/L	17	29	0.0187	0.149	0.141	1.56	0.216
Uranium-238	pCi/L	24	29	0.0447	1.74	1.34	14.8	2.28
Uranium (calculated)	µg/L	56	56	0.0180	1.86	1.39	17.7	2.23
Uranium (measured)	µg/L	39	39	0.040	0.998	4	4	2.25
Gross Alpha	pCi/L	21	27	0.428	53.4	74.7	877	85.4
Gross Beta	pCi/L	27	27	3.41	34.1	21.7	212	42.2
Gross Gamma	pCi/L	4	20	83.6	165	68.0	343	232
Pueblo Canyon [a]								
Americium-241	pCi/L	19	31	0.0171	0.653	0.486	4.46	0.871
Cesium-137	pCi/L	10	29	1.70	5.52	1.96	10.9	6.73
Cobalt-60	pCi/L	3	14	2.41	5.43	5.08	11.3	11.2
Neptunium-237	pCi/L	2	14	3.61	7.705	–	11.8	–
Plutonium-238	pCi/L	18	30	0	0.0788	0.0822	0.443	0.117
Plutonium-239, Plutonium-240	pCi/L	23	30	0.0088	6.98	6.59	88.7	9.68
Potassium-40	pCi/L	13	13	16.5	60.5	30.9	108	77.3
Radium-226	pCi/L	2	3	0.276	0.307	–	0.338	–
Radium-228	pCi/L	0	0	0.00	–	–	0.00	–
Sodium-22	pCi/L	0	14	0.00	–	–	0.00	–
Strontium-90	pCi/L	26	28	0.224	1.83	1.21	11.6	2.30
Tritium	pCi/L	9	21	75	132	4.14	219	135
Uranium-234	pCi/L	26	29	0.0381	5.59	4.95	50.8	7.49
Uranium-235, Uranium-236	pCi/L	22	29	0.0246	0.447	0.379	2.96	0.605
Uranium-238	pCi/L	26	29	0.0658	5.61	4.97	50.4	7.52
Uranium (calculated)	µg/L	38	39	0.00426	6.61	1.81	42.9	7.18

Measured Radiochemical		*2001 through 2004*						
		Detected	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
Uranium (measured)	µg/L	27	27	0.03	2.24	3.66	11.5	3.62
Gross Alpha	pCi/L	23	28	0.61	111	4.12	533	113
Gross Beta	pCi/L	27	28	1.54	170	10.2	914	174
Gross Gamma	pCi/L	7	18	73.2	192.1	165.9	820	315

UCL = upper confidence limit, pCi/L = picocuries per liter, µg/L = micrograms per liter.
[a] Onsite Stations.
[b] Perimeter Stations.
[c] Both Onsite and Perimeter Stations.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–22 Radiochemical Statistical Analysis of Soil Composite from 2001 through 2003

Measured Radiochemical		*2001 through 2003*						
		Detected	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
REGIONAL STATIONS								
Americium-241	pCi/g	10	10	0.00	0.00410	0.00202	0.00930	0.00535
Cesium-137	pCi/g	10	10	0.0600	0.257	0.105	0.650	0.322
Plutonium-238	pCi/g	5	5	0.00	0.00190	0.00185	0.00420	0.00352
Plutonium-239, 240	pCi/g	10	10	0.00100	0.00978	0.00550	0.0290	0.0132
Strontium-90	pCi/g	10	10	0.0500	0.156	0.0406	0.260	0.181
Tritium	pCi/g	10	10	0.00	0.273	0.237	0.940	0.419
Uranium-234	pCi/g	7	7	0.550	0.729	0.154	1.20	0.843
Uranium-235	pCi/g	7	7	0.0330	0.0562	0.000766	0.0770	0.0568
Uranium-238	pCi/g	7	7	0.590	0.740	0.0949	1.20	0.811
Uranium (calculated)	µg/L	6	6	1.70	2.20	0.240	2.70	2.39
Gross Alpha	pCi/g	6	6	3.70	4.48	0.778	6.10	5.11
Gross Beta	pCi/g	6	6	3.70	4.55	0.497	5.01	4.95
Gross Gamma	pCi/g	6	6	6.00	7.33	0.471	8.00	7.71
PERIMETER STATIONS								
Americium-241	pCi/g	29	29	0.00100	0.0116	0.00278	0.0580	0.0126
Cesium-137	pCi/g	30	30	0.0900	0.337	0.0231	0.840	0.346
Plutonium-238	pCi/g	24	24	0.00	0.00298	0.00149	0.0110	0.00358
Plutonium-239, 240	pCi/g	30	30	0.00800	0.0591	0.0225	0.530	0.0671
Strontium-90	pCi/g	29	29	0.0100	0.174	0.00813	0.450	0.177
Tritium	pCi/g	25	25	0.0100	0.822	0.551	3.00	1.04
Uranium-234	pCi/g	20	20	0.600	1.12	0.0226	2.25	1.13
Uranium-235	pCi/g	20	20	0.0330	0.0813	0.0175	0.188	0.0890
Uranium-238	pCi/g	20	20	0.540	1.12	0.107	2.32	1.17
Uranium (calculated)	µg/L	20	20	2.10	3.93	0.463	9.30	4.14
Gross Alpha	pCi/g	20	20	1.93	5.41	0.268	7.90	5.53
Gross Beta	pCi/g	20	20	2.38	4.91	0.601	7.70	5.17
Gross Gamma	pCi/g	20	20	9.00	11.3	0.283	20.0	11.4
ONSITE STATIONS								
Americium-241	pCi/g	36	36	0.00200	0.0150	0.00801	0.200	0.0176
Cesium-137	pCi/g	36	36	0.0300	0.345	0.0606	0.900	0.365
Plutonium-238	pCi/g	32	32	0.00	0.00230	0.000176	0.00600	0.00236
Plutonium-239, 240	pCi/g	36	36	0.00200	0.0563	0.0324	0.800	0.0669

Measured Radiochemical		2001 through 2003						
		Detected	Analyzed	Minimum	Mean	Standard Deviation	Maximum	95 Percent UCL
Strontium-90	pCi/g	34	34	0.00	0.142	0.0379	0.380	0.154
Tritium	pCi/L	36	36	0.100	0.907	0.724	4.00	1.14
Uranium-234	pCi/g	24	24	0.750	1.08	0.0430	1.80	1.10
Uranium-235	pCi/g	24	24	0.0440	0.0691	0.00271	0.152	0.0702
Uranium-238	pCi/g	24	24	0.770	1.15	0.0348	1.87	1.17
Uranium (calculated)	µg/L	24	24	2.41	3.51	0.175	6.00	3.58
Gross Alpha	pCi/g	24	24	3.59	5.54	0.346	8.10	5.68
Gross Beta	pCi/g	24	24	2.90	4.70	0.0884	8.10	4.74
Gross Gamma	pCi/g	24	24	10.0	11.6	0.589	14.0	11.8

UCL = upper confidence limit, pCi/g = picocuries per gram, pCi/L = picocuries per liter, µg/L = micrograms per liter.
Sources: LANL 2002, 2004a, 2004b, 2005.

Table F–23 presents EPA and EPA equivalent maximum contaminant levels (Title 40 of the *Code of Federal Regulations*, Part 141 [40 CFR 141]) for comparison between the groundwater, surface water or storm water runoff concentrations presented in the above tables. Maximum contaminant levels only apply to drinking water systems.

Table F–23 Benchmark Concentrations for Analyzed Radionuclides for Groundwater, Surface Water or Storm Water 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]
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 141).
[c] EPA maximum contaminant levels equivalent. 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 ongoing Environmental Monitoring Program also includes chemicals, which are periodically measured at stations onsite, at the perimeter, and in the region around LANL. Perchlorate is a chemical of particular interest and has a high propensity to enter the groundwater. Perchlorate is a chemical used in rocket solid propellant, fireworks, lubricating oils, rubber manufacturing, paint production, aluminum refining, leather tanning, explosives, match manufacturing, air bag inflators, fabrics, and dye fixers. It 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 maximum contaminant level or maximum contaminant level goal for perchlorate in drinking water. However, the EPA has established a No Observed Effect Level (NOEL) of 23 parts per billion or 23 micrograms per liter for perchlorate, based on a NOEL of 0.0007 milligram or kilogram per day for a 154-pound (70-kilogram) adult consuming 0.53 gallons (2 liters) of water per day. 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 2004, a total of 204 detectable sample measurements were made of perchlorate in groundwater at these stations. The statistical analysis of these measurements was collated and is presented in **Table F–24**. Measured mean values of perchlorate at most LANL locations were below both the EPA NOEL and New Mexico SAL. Only Mortandad and Pueblo Canyons exceeded the New Mexico limit, and only Mortandad Canyon exceeded the EPA NOEL (USACHPPM 2006, EPA 2006, NAS 2005).

Table F–24 Perchlorate Statistical Analysis of Groundwater from 2002 through 2004 (micrograms per liter)

Location	*Detected*	*Analyzed*	*Minimum*	*Mean*	*Standard Deviation*	*Maximum*	*95 Percent UCL*
2002							
Upper Los Alamos Canyon (includes DP Canyon)	22	22	0.958	1.36	0.194	1.45	1.44
Sandia Canyon	25	25	0.400	1.34	0.370	2.17	1.49
Pajarito Canyon (includes Twomile and Threemile Canyons)	18	18	1.45	1.45	0.0	1.45	1.45
Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey)	41	41	0.300	36.0	51.2	143	51.6
Pueblo Canyon (includes Acid Canyons)	24	24	0.801	1.44	0.501	3.00	1.65
Ancho Canyon	4	4	0.958	0.958	0.00	0.958	–
Guaje Canyon (includes Barrancas and Rendija Canyons)	11	11	1.45	1.45	0.0	1.45	1.45
Water Canyon (includes Canyon del Valle, Potrillo, and Fence Canyons)	14	14	1.45	1.45	0.0	1.45	1.45
White Rock Canyon	53	53	0.801	1.89	2.06	12.0	2.45
2003							
Upper Los Alamos Canyon (includes DP Canyon)	3	3	0.370	0.385	0.0127	0.393	0.399
Sandia Canyon	5	5	0.381	0.425	0.0446	0.500	0.464
Pajarito Canyon (includes Twomile and Threemile Canyons)	2	2	0.293	0.295	–	0.296	–
Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey)	38	38	0.301	26.1	33.2	148	36.6
Pueblo Canyon (includes Acid Canyons)	14	14	1.61	2.70	0.737	4.34	3.09

Location	***Detected***	***Analyzed***	***Minimum***	***Mean***	***Standard Deviation***	***Maximum***	***95 Percent UCL***
Ancho Canyon	0	0	–	–	–	–	–
Guaje Canyon (includes Barrancas and Rendija Canyons)	5	5	0.271	0.336	0.0433	0.377	0.374
Water Canyon (includes Canyon del Valle, Potrillo, and Fence Canyons)	0	0	–	–	–	–	–
White Rock Canyon	17	17	0.232	0.423	0.132	0.661	0.485
2004							
Upper Los Alamos Canyon (includes DP Canyon)	29	29	0.0500	0.349	0.260	1.04	0.444
Sandia Canyon	15	15	0.0500	0.344	0.155	0.500	0.422
Pajarito Canyon (includes Twomile and Threemile Canyons)	22	22	0.0500	0.289	0.241	1.09	0.390
Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey)	48	48	0.200	30.1	31.6	99.1	39.1
Pueblo Canyon (includes Acid Canyons)	11	11	0.0969	2.06	1.00	2.97	2.66
Ancho Canyon	4	4	0.0500	0.173	0.0876	0.249	0.258
Guaje Canyon (includes Barrancas and Rendija Canyons)	11	11	0.0500	0.323	0.103	0.434	0.384
Water Canyon (includes Canyon del Valle, Potrillo, and Fence Canyons)	6	6	0.0500	0.436	0.299	0.645	0.676
White Rock Canyon	58	58	0.0500	0.347	0.198	0.854	0.398
2002 through 2004							
Upper Los Alamos Canyon (includes DP Canyon)	54	54	0.0500	0.698	0.574	1.45	0.851
Sandia Canyon	45	45	0.0500	0.704	0.556	2.17	0.867
Pajarito Canyon (includes Twomile and Threemile Canyons)	42	42	0.0500	0.678	0.669	1.45	0.880
Mortandad Canyon (includes Ten Site Canyon and Cañada del Buey)	127	127	0.200	30.7	4.95	148	31.6
Pueblo Canyon (includes Acid Canyons)	49	49	0.0969	2.07	0.629	4.34	2.25
Ancho Canyon	8	8	0.0500	0.565	0.555	0.958	0.950
Guaje Canyon (includes Barrancas and Rendija Canyons)	27	27	0.0500	0.703	0.647	1.45	0.947
Water Canyon (includes Canyon del Valle, Potrillo, and Fence Canyons)	20	20	0.0500	0.943	0.717	1.45	1.26
White Rock Canyon	128	128	0.0500	0.887	0.871	12.0	1.04

UCL = upper confidence limit.
Sources: LANL 2002, 2004a, 2004b, 2005.

F.4 References

ANL (Argonne National Laboratory), 2005a, "Human Health Fact Sheet – Americium," Available at http://www.ead.anl.gov/pub/doc/americium.pdf, August.

ANL (Argonne National Laboratory), 2005b, "Human Health Fact Sheet – Plutonium," Available at http://www.ead.anl.gov/pub/doc/plutonum.pdf, August.

ANL (Argonne National Laboratory), 2005c, "Human Health Fact Sheet – Cesium," Available at http://www.ead.anl.gov/pub/doc/cesium.pdf, August.

ANL (Argonne National Laboratory), 2005d, "Human Health Fact Sheet – Strontium," Available at http://www.ead.anl.gov/pub/doc/strontium.pdf, August.

ANL (Argonne National Laboratory), 2005e, "Human Health Fact Sheet – Tritium," Available at http://www.ead.anl.gov/pub/doc/tritium.pdf, August.

EPA (U.S. Environmental Protection Agency), 2006, "Integrated Risk Information System - Perchlorate and Perchlorate Salts," Available at http://www.epa.gov/iris/subst/1007.htm, February 13.

LANL (Los Alamos National Laboratory), 2001, *Derivation and Use of Radionuclide Screening Levels*, LA-UR-01-990, Los Alamos, New Mexico, March.

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, September.

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.

USACHPPM (U.S. Army Center for Health Promotion and Preventive Medicine), 2006, "Perchlorate in Drinking Water," Publication No. 31-003-0502, 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 *Draft 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) 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, as well as 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**.

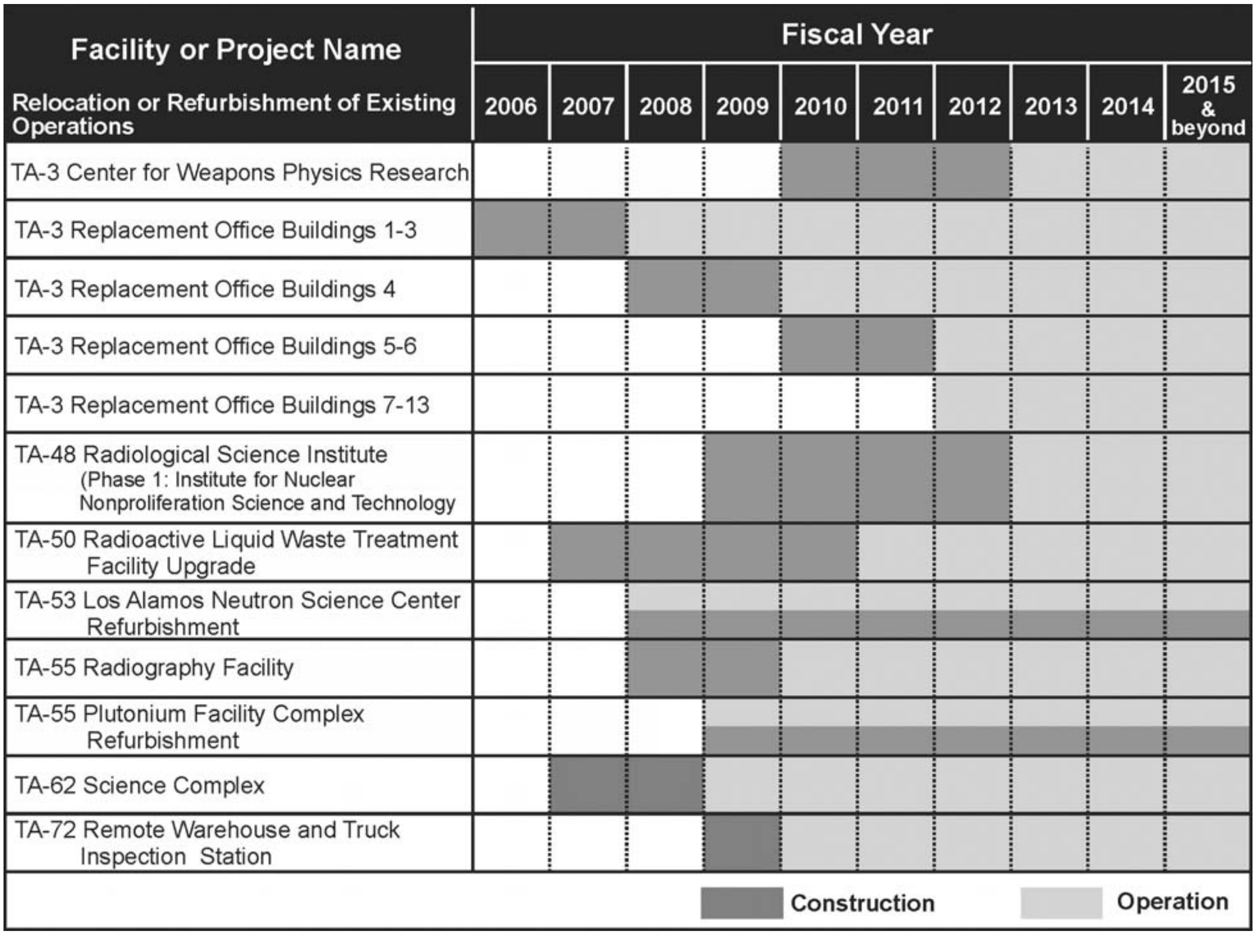


Figure G–1 Proposed Timeframes for Construction and Operation of Projects to Maintain Existing Los Alamos National Laboratory Operations and Capabilities

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 storm water 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 2002a) 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. 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 (LEED-NC) 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 2002) and LANL Sustainable Design Guide (LANL 2004f). 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 *LANL Wildland Fire Management Plan*, LA-UR-05-0286 (LANL 2005f). 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 storm water 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 storm water 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 storm water runoff may include storm water 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 impacts resulting from 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 Center for Weapons Physics Research 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. Further, 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 located at TA-8 requires 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 requires 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.

Center for Weapons Physics Research (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. Divisions that would have office space in the Center for Weapons Physics Research include the Computer and Computational Science, Physics, Theoretical, and Applied Physics Divisions. The Center for Weapons Physics Research 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 also 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 is currently performed in TA-8. This requires 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 must be used when the materials are transported, and a temporary material accountability area needs to be set up in TA-8 while the nondestructive examination procedures take place. These steps require significant security resources, making the process expensive, logistically difficult, and inefficient. NNSA proposes to establish 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. The proposed modern nondestructive examination radiography facility would be constructed within TA-55 as either a new building or a modification of the existing Building 55-41.

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 Center for Weapons Physics Research Construction and Operation Impact Assessment

This section provides an impact assessment for the construction and operation of a Center for Weapons Physics Research in TA-3 at LANL. Section G.1.1 provides background information on the construction project and a physical description of the Center for Weapons Physics

Research. Section G.1.2 provides a description of the proposed project to construct and operate a Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research (formerly referred to as the "Center for Stockpile Stewardship Research") 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research facility in a currently developed area of TA-3 (see **Figure G–2**). The Center for Weapons Physics Research 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 2006). The Center for Weapons Physics Research 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 three stories tall; three of the four buildings would be designated as classified buildings and require security controls and fencing (LANL 2006). 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 2006). The Center for Weapons Physics Research 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.

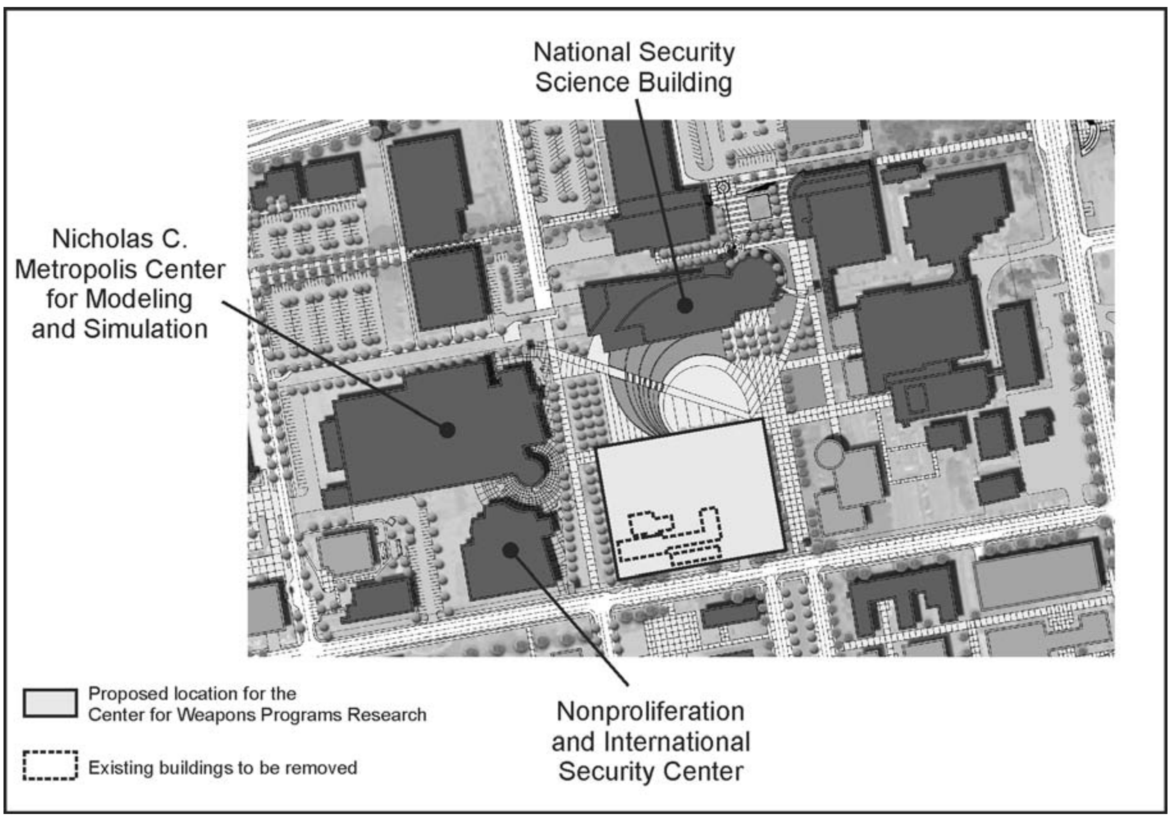


Figure G–2 Proposed Location for the Center for Weapons Physics Research

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 Center for Weapons Physics Research. The complex would include a clean room and vault space for classified weapons designers and would require a substantial amount of electricity (LANL 2006). 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 2006).

As shown in Figure G–2, construction and operation of the Center for Weapons Physics Research facility 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 Center for Weapons Physics Research 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. Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research. 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 will be 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 expected.
- *Water Resources* – The proposed site is located in an already-developed area of TA-3, and operations would not result in new discharges.
- *Ecological Resources* – 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 will be included in the impacts discussion.

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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research site, is less than 1 in 10,000 (LANL 2004c). To account for seismic risk, the Center for Weapons Physics Research would be designed and constructed in accordance with current DOE seismic standards and applicable building codes.

Construction Impacts—Approximately 499,000 cubic yards (382,000 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 storm water 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 of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were modeled for the site work and erection construction phases of the TA-3 Center for Weapons Physics Research'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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 for 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 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 85 (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—Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 containment structures, 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 297,000 person-hours to demolish the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 3 (DOE 2004) to 13 (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 Center for Weapons Physics Research 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 will be assessed for inclusion in the National Register of Historic Places in 2006. 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 Center for Weapons Physics Research 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 2.7 million gallons (10 million liters) of liquid fuels and 14.4 million gallons (53 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—Center for Weapons Physics Research 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 2006). 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 Center for Weapons Physics Research is expected 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, Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 minimal on an annual 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—Center for Weapons Physics Research 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 of hazardous materials are present within the proposed footprint of the Center for Weapons Physics Research site (LANL 2006). Should any suspect disposal site be disclosed during subsurface construction work, LANL's Environmental Restoration Project staff would review the site and stipulate procedures for working within that site area.

Operations Impacts—Solid waste generated during Center for Weapons Physics Research operations would be disposed of at the Los Alamos County Landfill or other appropriate solid waste landfill. The amount of waste generated during Center for Weapons Physics Research 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 205,000 cubic yards (157,030 cubic meters) of waste, including low-level waste, mixed low-level radioactive waste, hazardous waste, sanitary waste, and nonhazardous solid waste. DD&D would also generate about 311 cubic yards (about 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 8.5 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 Center for Weapons Physics Research Decontamination, Decommissioning, and Demolition Activities (cubic yards)

Low-Level Radioactive Waste	*Mixed Low-Level Radioactive Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
17,366	< 1	187,317	2	311

[a] Includes construction, demolition, and sanitary waste.
Note: To convert cubic yards to cubic meters, multiply by 0.76455.

For disposal of generated low-level 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 Area G Zone 4 capacity and disposal priorities.

Scenario 1. Under this scenario, NNSA would pursue offsite disposal of the low-level waste resulting from DD&D of the buildings and structures, including concrete, soil, steel, and personal protective equipment. Both the Nevada Test Site, a DOE waste disposal facility, and a commercial facility have the capacity to accept these quantities of waste. Under this scenario, there would be little reduction of LANL's remaining low-level waste radioactive disposal capacity at Area G in TA-54.

Scenario 2. Under this scenario for waste disposal, the low-level waste would be disposed of on site at Area G in TA-54. The current disposal site footprint has limited waste capacity, although expansion into Zone 4 is planned for 2006. The current footprint is expected to be adequate for the amount of low-level waste that would be generated by the DD&D activities. Implementing this scenario would reduce the remaining capacity at Area G.

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.

The generated demolition debris and sanitary waste could also 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 generates 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. The amount of waste generated would not be within the disposal capacity of the existing disposal facilities.

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 Center for Weapons Physics Research 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 Center for Weapons Physics Research 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 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 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 – Center for Weapons Physics Research

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, rem = roentgen equivalent man, TA = technical area.

Table G–3 presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities anticipated due to traffic accidents from both the collision and excess LCFs from exposure to releases of radioactivity. The analyses assumed that all generated 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 – Center for Weapons Physics Research

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	11,473	4.4	Not analyzed [c]	0.052
Nevada Test Site	11,473	7.0	1.4×10^{-7}	0.078
Commercial facility	11,473	6.7	1.0×10^{-7}	0.075

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported off site.
[b] Approximately 9 percent of shipments are radioactive wastes. The remaining waste includes 91 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 DOE'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 1999a). 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. Construction on the first three buildings given a Categorical Exclusion is scheduled to begin in fiscal year 2006. Construction on the remaining nine Replacement Office Buildings would be phased beginning in fiscal year 2008.

The Replacement Office Buildings would include construction of a three-story, 45,000-square-foot (4,200-square-meter) Los Alamos Site Office Building, which would house approximately 150 staff. 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.

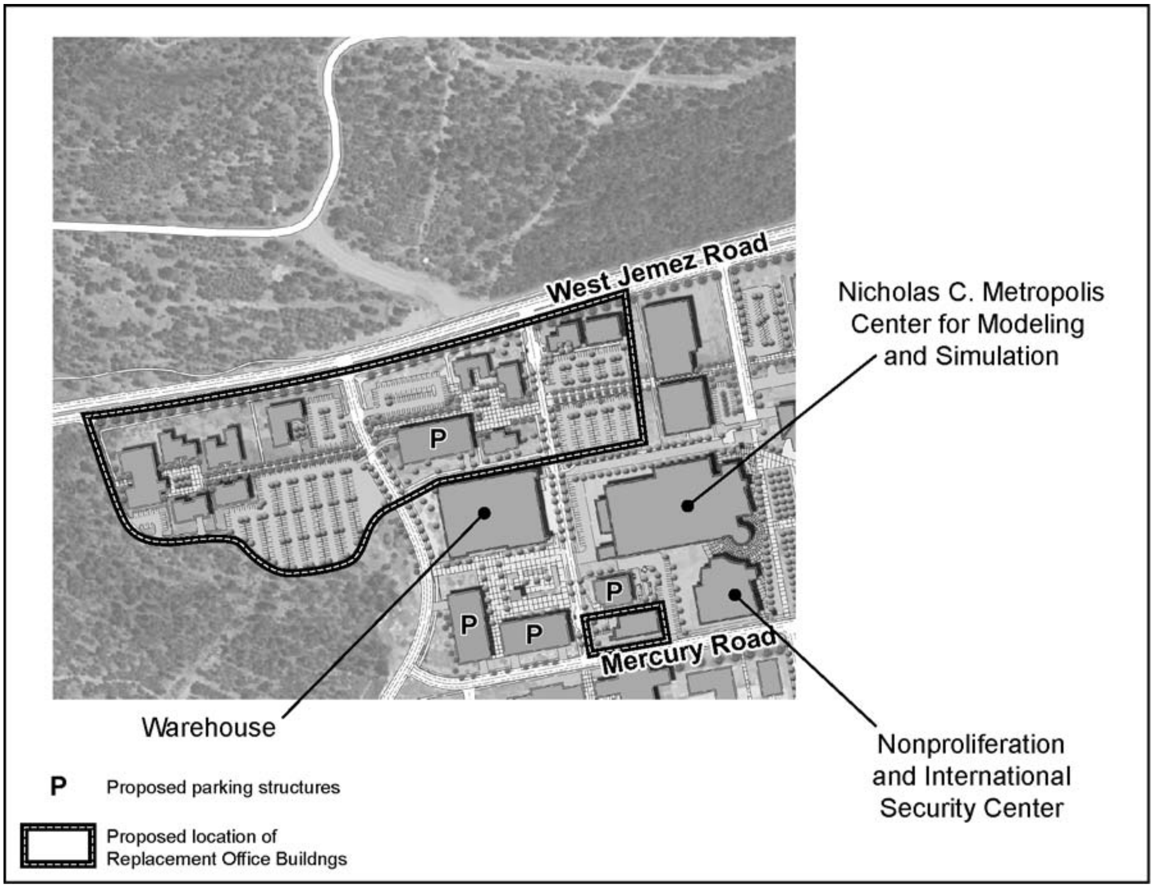


Figure G–3 Replacement Office Building Complex Proposed Layout

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 will be 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 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, and waste management.

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 storm water 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 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 storm water 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 storm water pollution prevention plan. Silt fences, hay bales, or other appropriate best management practices would be employed to minimize storm water transport of fine particulates (disturbed during construction) into surface water in the vicinity of TA-3.

Operations Impacts—There would be an increase in storm water 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 storm water 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 building erection phase. Estimated maximum PM_{10} concentrations are an annual average of 4.6 micrograms per cubic meter and a 24-hour average of 94.6 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 of 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. Criteria pollutant concentrations were not modeled for the demolition of buildings at TA-3, but would be less than for construction of the new facilities. Concentrations off site and along the roads to which the public has regular access would be below ambient air quality standards.

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 (*Pinus ponderosa* P. & C. Lawson) 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. The Replacement Office Building Complex would be constructed partially in the buffer zone. Thus, while direct impacts should not occur, construction has potential to disturb the Mexican spotted owl due to excess noise or light. If construction were to take place during the breeding season (March 1 through August 31), owls could be disturbed, and surveys would need to be undertaken to determine if they were present. If no Mexican spotted owls were found, there would be no restrictions on construction activities. However, if they were present, restrictions could be implemented to ensure that noise and lighting limits were met. 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; thus, these species also would not be adversely affected by the new facility (LANL 2000).

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 2.1 million gallons (7.9 million liters). Total water consumption is estimated to be 9.6 million gallons (37 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 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 1,800 cubic yards (1,400 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 2004e).

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 7 cubic yards (5 cubic meters) of 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 Area G. Because the estimated volume is small, no impacts on disposal capacity are expected.

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 2006). This project would also involve DD&D of 52 deteriorating structures (80 percent of LANL's radiological facilities) (LANL 2006). 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 2006). The existing radiological facilities were built in accordance with building codes and safety and security requirements that are now outdated (LANL 2006). 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.

G.3.2 Options Considered

The two options identified for the Radiological Sciences Institute are the No Action Option and proposed project option.

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 2006.

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 current applicable building codes and safety and security requirements are prohibitive and would provide only a limited lifespan to existing facilities. With No Action, 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.

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	Optic laboratories	24
46-31 (25%)	Test Building No. 2	Optic laboratories	3
46-158 (15%)	Laser-Induced Chemistry Laboratory	Optic laboratories	1
46-200 (50%)	Chemistry and Laser Laboratory	Chemistry laboratory	2
46-250	Analytical Chemistry	Chemistry laboratory	7
48-1	Isotope Separator 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 physics 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
			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 2006.

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 TA 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 (including rollup of various numbers of Security Category III and IV quantities) of materials.

- *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 of 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 that have measurable quantities of emissions or waste include those of the Sigma Complex (Buildings TA-3-66, TA-35, and TA-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), 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 (59,086 square meters) of building space located in six TAs (TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59) (LANL 2006). 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 (13,471 square meters), a reduction of about 50,000 net square feet (4,645 square meters) relative to the facilities to be replaced, and would house approximately 450 to 500 technical and support staff (LANL 2006).

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 *Relocation of Remaining TA-18 Operations and Decontamination, Decommissioning, and Demolition of TA-18 Buildings Impacts Assessment*. 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 will be included in the impacts discussion.

- *Environmental Justice* – The proposed project is mainly confined to already-developed areas, with no disproportionate human health impacts 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, environmental restoration, 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 the LANL Complex 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]	105,000 person-rem	~ 350 millirem	

MEI = maximally exposed individual, TA = technical area, rem = roentgen equivalent man.

[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 is 350 to 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.

Source: 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. To put these doses into perspective, comparisons with doses from natural background radiation and the regulatory limit of 10 millirem established in 40 CFR 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 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 anticipated 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 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 2006).

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 waste 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. No mixed transuranic waste is expected to be generated (LANL 2006).

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).

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.

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.

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, rem = roentgen equivalent man, 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

rem = roentgen equivalent man, LCF = latent cancer fatality.
[a] Increased risk of an LCF to an individual, assuming the accident occurs.

Table G–10 Radiological Accident Offsite Population and Worker Risks under the Radiological Sciences Institute Project No Action Option

Accident	Onsite Worker	Offsite Population	
	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	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	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

MEI = maximally exposed individual.
[a] Increased risk of an LCF to an individual per year.
[b] Offsite population size is approximately 300,000 persons.

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 LCFs for the MEI, 24.3 or 22 increased LCFs for the onsite worker population, 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, 0.058 LCFs for the onsite worker population, and 0.00049 increased risk of an LCF for a noninvolved worker located at a distance of 330 feet (100 meters) from the accident.

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.

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 hectares) are undeveloped (LANL 2006).

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 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—While 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. 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 at 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 1.97 million gallons [7.46 million liters] in 2004) associated with the Sigma Complex at TA-3 (LANL 2006). There is also one NPDES outfall (which discharged 1.19 million gallons [4.50 million liters] in 2004) 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 storm water pollution prevention plan to ensure that fine particulates created during construction would not be transported by storm water 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 2006), and the Chemistry and Metallurgy Research Building has one NPDES outfall (03A-021) (LANL 2006), 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 storm water runoff from the new facility because of the increase in impervious areas of buildings and parking lots. This may be offset by the decreased storm water 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 2006). 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 storm water runoff may be offset by the decreased storm water 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 2002 are reported in **Table G–11**. Emissions of toxic pollutants are based on chemical usage in the key areas. The toxic emissions reported in Table G–11 for TA-48 are for the Radiochemistry Site key area, as summarized in the *SWEIS Yearbook – 2002* (LANL 2003c). These emissions vary by year with the amounts of chemicals being used. **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 – 2002 (tons per year)

Pollutant	*Boiler BS-1*	*Boiler BS-2*	*Boiler BS-6*
Criteria Pollutants			
Carbon monoxide	0.343	0.343	0.459
Nitrogen oxides	0.408	0.408	0.547
Particulate matter	0.031	0.031	0.042
PM_{10}	0.031	0.031	0.042
$PM_{2.5}$	0.031	0.031	0.042
Sulfur oxides	0.002	0.002	0.003
Volatile organic compounds	0.022	0.022	0.030

PM_{10} and $PM_{2.5}$ = particulate matter with aerodynamic diameters of 10 and 2.5 micrometers, respectively, or less.
Source: LANL 2003c.

Table G–12 Nonradiological Air Pollutant Emissions at Technical Area 3 Machine Shops and Technical Area 18 – 2002 (tons per year)

Pollutant	*Machine Shop (TA-3)*	*TA-18 Pajarito Site*
Ethanol	0.000143	0
Isopropyl alcohol	0	0.00182
Nitric acid	0.00148	0

TA = technical area.
Source: LANL 2003c.

Radiological air emissions for 1999 – 2004 are presented in 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 1999b). 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} were greatest for the erection phase. Estimated maximum PM_{10} concentrations are an annual average of 2.9 micrograms per cubic meter and a 24-hour average of 40.4 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.

While 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 2006). To determine the extent and nature of any contamination, an assessment of the affected areas would be performed prior to commencing ground disturbance. 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 at TA-48 (LANL 2006). It would be necessary to characterize and define the contamination and its extent and assess its seriousness at these potential release sites. If the contamination poses 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.

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	1.66×10^{-5}
Beryllium-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]	1.55×10^{-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 represented by strontium-90 and yttrium-90 in equilibrium.
Source: Appendix C of this SWEIS.

Noise impacts of operation of the new Radiological Sciences Institute at TA-48 are expected to be similar to those of 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.

DD&D Impacts—DD&D of buildings at TA-3, TA-18, TA-35, TA-46, TA-48, and TA-59 replaced by new facilities at the Radiological Sciences Institute would result in temporary increases in air quality impacts of construction equipment, trucks, and employee vehicles. Criteria pollutant concentrations were not modeled for demolition of buildings at TA-48, but would be less than for 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 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 being replaced by new facilities at Radiological Sciences Institute 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 replaced by new facilities at the Radiological Sciences Institute 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 (*Pinus ponderosa* P. & C. Lawson) forest vegetation zone and those in TA-18 are in the piñon (*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 (Green et al. 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.

While there are no threatened or endangered species in the TA-48 area (LANL 2006), portions of the TA are located within both the core habitat and buffer zone of the Mexican spotted owl (*Strix occidentalis lucida*) for the Sandia-Mortandad Canyon Area of Environmental Interest. However, both 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 (*Haliaeetus leucocephalus*) and southwestern willow flycatcher (*Empidomax traillii extimus*) 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 core areas of the Los Alamos Canyon and Sandia-Mortandad Canyon Areas of Environmental Interest, respectively. However, all buildings to be removed are within developed portions of the TAs. In 2005, two Areas of Environmental Interest were occupied by the Mexican spotted owl. 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 hectares) of ponderosa pine forest at TA-48 and within the small area of TA-55 would be cleared (LANL 2006). 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 portions of TA-48 fall within the Sandia-Mortandad Canyon Mexican spotted owl Area of Environmental Interest, they do not include that part of the TA where the Radiological Sciences Institute would be constructed. However, a small portion of the Pajarito Canyon Area of Environmental Interest buffer zone (less than 2 acres [0.8 hectares]) could be disturbed by construction that takes place in the southeast corner of TA-48 and western edge of TA-55. The Mexican spotted owl is unlikely to be impacted. Because an Area of Environmental Interest is located nearby, construction has the potential to disturb the Mexican spotted owl due to excess noise or light. If construction were to take place during the breeding season (March 1 through August 31), owls could be disturbed, and surveys would need to be undertaken to determine if they were present. If none were found, there would be no restrictions on construction activities. However, if they were present, restrictions could be implemented to ensure that noise and lighting limits were met (LANL 2000). Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any part of TA-48; thus, these species also would not be adversely affected by the new facility. Because over 5 acres (2 hectares) would be disturbed by this project, DOE would consult with the U.S. Fish and Wildlife Service as required by the *LANL Threatened and Endangered Species Habitat Management Plan* prior to beginning of construction (LANL 2000, 2006). Mitigation measures determined necessary for the protection of habitat areas or individual species of concern would be implemented.

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.

Demolition of buildings and structures at TA-48 prior to construction of the new Radiological Sciences Institute would require mitigation such as described previously for construction and operation. Of those TAs that include buildings to be removed in connection with the new

Radiological Sciences Institute, only TA-3 and TA-35 fall within core areas of one of the site Areas of Environmental Interest. Because the buildings to be demolished are within developed portions of the Areas of Environmental Interest, habitat alteration is not restricted unless it impacts undeveloped occupied core areas (LANL 2000). If future surveys identified Mexican spotted owls within core areas of either of the Areas of Environmental Interest of concern (that is, the Los Alamos Canyon or Sandia-Mortandad Canyon Areas of Environmental Interest), mitigation measures such as implementing noise and lighting restrictions may be required and would be implemented.

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 the 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 of close to 300,000.

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]	150,000 person-rem	~ 350 millirem	–

MEI = maximally exposed individual, rem = roentgen equivalent man.

[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 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 is 350 to 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 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. As stated in Chapter 5 of this SWEIS, 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 Administrative Control Level of 2,000 millirem per year and ALARA (DOE 1999c).

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 a containment structure, 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 1999b). As noted in Section 4.8.3 of the SWEIS, traditional cultural properties are present throughout LANL and adjacent lands; however, specific features or locations are not identified to protect such sites (Knight and Masse 2001). Traditional cultural properties are not anticipated 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 4.3 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 would be staggered over an extended period of time. As a result, impacts of these activities on LANL's utility infrastructure would be minimal on an annual 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, 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. Other radioactive and chemical wastes are transferred to the Chemical and Radioactive Waste Management Facility. Low-level wastes are disposed of at TA-54 Area G; 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, Machine Shops, and those activities at TA-18 that may be transferred to TA-48.

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 transferred to the Chemical and Radioactive Waste Management Facility or to a centralized waste storage facility within the Radiological Sciences Institute, where wastes may be stored for less than 90 days. Low-level wastes would be disposed of at TA-54 Area G or at an offsite facility; all other radioactive and chemical wastes would be sent off site for treatment or disposal.

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* [b] *TA-3*
Transuranic waste (cubic yards)	Range	0 to 1	0 to 0	0 to 0	0 to 0
	Average	less than 1	0	0	0
Low-level radioactive waste (cubic yards)	Range	44 to 116	0 to 41	less than 1 to 264	15 to 409
	Average	77	16	115	93
Mixed low-level radioactive waste (cubic yards)	Range	less than 1 to 8	0 to 10	0 to 2	0 to less than 1
	Average	3	1	less than 1	less than 1
Chemical waste (pounds)	Range	3,336 to 410,357	62 to 6,894	1,936 to 71,423	344 to 58,365
	Average	82,556	1,896	18,184	13,924

TA = technical area.

[a] TA-18 waste data include the SHEBA cease operations and 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.

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 2006). 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 2006).

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 through the Chemical and Radioactive Waste

Management Facility. The large quantity of low-level radioactive waste may be disposed of on site 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.

Table G–17 Decontamination, Decommissioning, and Demolition of Waste Volumes for Buildings to be Replaced by the Radiological Sciences Institute

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste	92,980
Mixed low-level waste	1,014
Transuranic waste	1,143
Demolition debris	74,301
Sanitary	1,593
Hazardous waste with asbestos	597
Solid hazardous with organics	352
Solid hazardous with metals	355

DD&D = decontamination, decommissioning, and demolition.
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 DD&D wastes on the worker population and general public is 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	2.97	0.0018	0.92	0.00055
Offsite disposition	Nevada Test Site	30.1	0.018	8.57	0.0051
	Commercial Facility	29.1	0.017	8.35	0.0050

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes would be disposed of at the Waste Isolation Pilot Plant.

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–18, disposal 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 anticipated due to traffic accidents from both the collisions and excess LCFs from exposure to releases of radioactivity.

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	10,273	2.16	3.6×10^{-9}	0.03
Nevada Test Site	10,273	16.64	4.9×10^{-6}	0.17
Commercial facility	10,273	15.19	4.7×10^{-6}	0.15

LCF = latent cancer fatality, TA = technical area.
[a] All nonradiological wastes would be transported offsite.
[b] Transuranic wastes would be disposed of at the Waste Isolation Pilot Plant.
[c] Approximately 58 percent of shipments are radioactive wastes. The remaining waste includes 41 percent industrial and sanitary waste and about 1 percent asbestos and hazardous wastes.
Note: To convert kilometers to miles, multiply by 0.6214.

The analyses assumed that all generated 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.

Environmental Restoration

NNSA is working with Federal and state regulatory authorities to address compliance and cleanup obligations arising from its past operations at LANL. NNSA is engaged in several activities to bring its operations into full regulatory compliance. These activities are set forth in negotiated agreements that contain schedules for achieving compliance with applicable requirements and financial penalties for nonachievement of agreed-upon milestones.

Although not listed on the National Priorities List, LANL adheres to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines for environmental restoration projects that involve certain hazardous substances not covered by the Resource Conservation and Recovery Act (RCRA). LANL's environmental restoration effort originally considered approximately 2,100 potential release sites at LANL (DOE 2002b). At the end of 1999, there remained 1,206 potential release sites requiring investigation or remediation and 118 buildings awaiting decontamination and decommissioning. Although there are many potential release sites, there is only one major Potential Release Site (48-001) that is of concern at TA-48. This area involves possible surface soil contamination from prior TA-48 stack emissions. Further investigation and any necessary remediation of this site would be completed under LANL's environmental restoration activities (DOE 2002b) and in accordance with LANL's Hazardous Waste Facility Permit.

Facility Accidents

Operations Impacts—Potential accidents that might occur at the proposed Radiological Sciences Institute 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) [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, rem = roentgen equivalent man, 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 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	Offsite Population	
	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	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	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	$< 7.9 \times 10^{-8}$	$< 7.7 \times 10^{-9}$	$< 3.4 \times 10^{-6}$

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.

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).

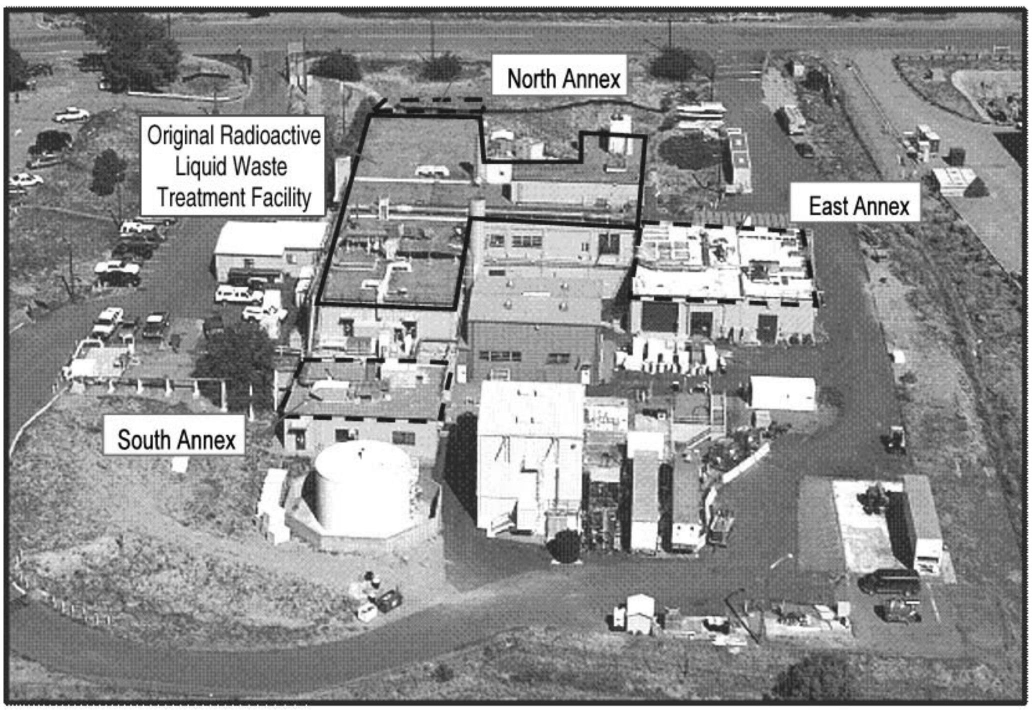


Figure G–4 Existing Radioactive Liquid Waste Treatment Facility

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.

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. The treatment facility returns the dried solids to TA-54. Drums of solidified transuranic waste from liquid treatment are stored at TA-54 pending shipment to the Waste Isolation Pilot Plant near Carlsbad, New Mexico; low-level radioactive waste is disposed of in the TA-54 material disposal area (MDA).

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.

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 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 basins or mechanical evaporation) may be incorporated as part of 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 the Waste Isolation Pilot Plant 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. 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. 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 waste and transuranic liquid waste treatment facilities to achieve greater reliability, redundancy, and flexibility. The new facility 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). NNSA would also modify low-level waste 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 basins 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 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.

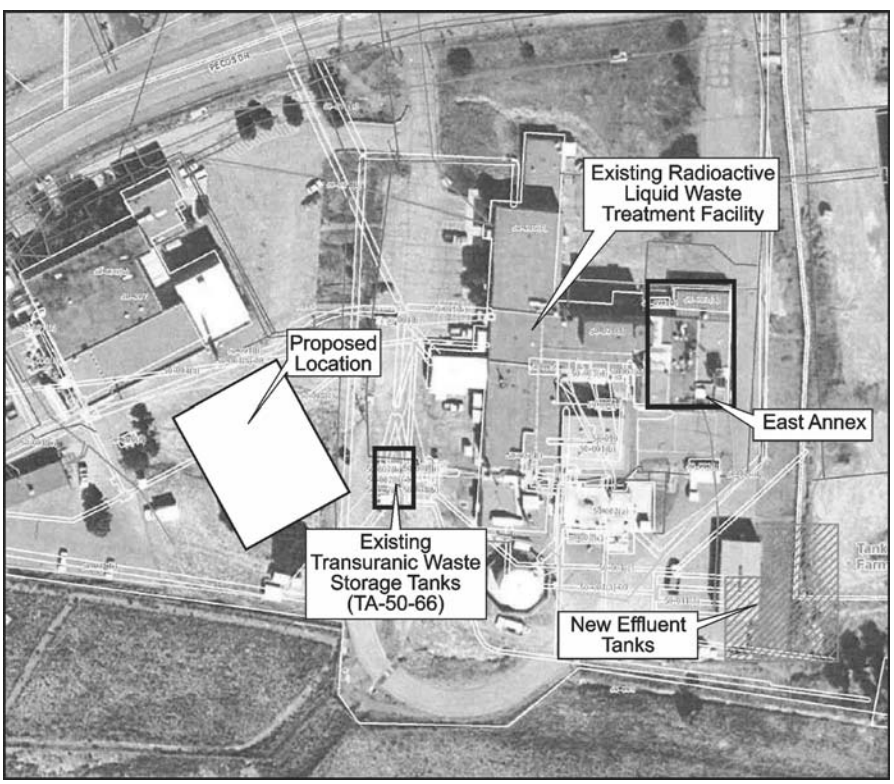


Figure G–6 Proposed Project Location

The proposed low-level 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 waste treatment process. This process would receive waste via pipeline from the low-level 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 2005g). In a typical year, the system could receive approximately 9.5 million gallons (36.0 million liters) per year of low-level waste. The proposed transuranic waste treatment process is shown in **Figure G–8**. The transuranic influent tanks can store approximately 25,438 gallons (96,293 liters) per year of transuranic acid wastewater and 8,970 gallons (33,955 liters) per year of transuranic caustic wastewater. Redundant tanks would handle overflows and drainage.

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 waste and one for transuranic waste (see **Figure G–9**). The new low-level 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, west 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 waste facility, it would contain processing areas, mechanical rooms, a control room, and access control areas. Additionally, either one of the auxiliary actions (evaporation basins or mechanical evaporation) described in Section G.4.2.5 may be added to this option.

The low-level waste facility would be located north of the existing Radioactive Liquid Waste Treatment Facility, thus necessitating 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 transuranic waste facility would be located near the point where the transuranic wastewater collection system enters TA-50, southwest of the existing Radioactive Liquid Waste Treatment 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 described for the proposed project. All other aspects of this option are the same as those of the proposed project (Option 1).

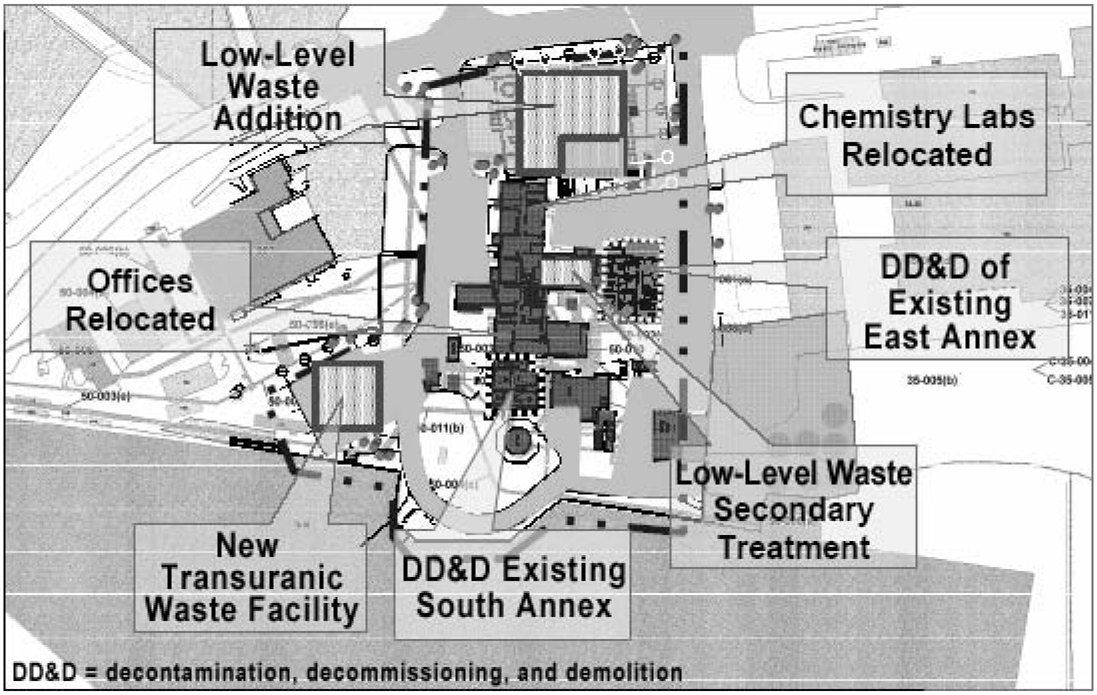


Figure G–9 Proposed Layout under the Two Liquid Waste Treatment Buildings Option

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 waste and transuranic waste treatment processes, as in Option 2. 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 waste treatment system.

Upon completion of the new facilities, the low-level 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 basins 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 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 first auxiliary action consists of constructing evaporation basins and allowing the wastewater to evaporate using passive solar energy. The evaporation basins could be constructed at a site located about a mile east of the Radioactive Liquid Waste Treatment Facility. 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. The auxiliary actions could be applied to any of the action options.

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 evaluated as part of each of the action options (Options 1, 2, and 3).

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 will be 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 expected.

Resource areas examined in this analysis include: land use, visual 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 water quality, 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 is not likely to meet more stringent discharge standards in the future. Construction impacts on particulate or radioactive emissions would not occur. There would be no effects on potential release sites, 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 waste influent (LANL 2005g). During that same period, solid low-level waste volumes ranged from 173 to 510 cubic yards (132 to 390 cubic meters) (LANL 2003b, 2004d, 2006). Under the No Action Option, low-level 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 waste is 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 waste generation was 488 cubic yards (373 cubic meters) (LANL 2003b, 2004d, 2006). If all pollution prevention measures and mission changes are implemented as scheduled, low-level waste influent volumes are expected to decrease slightly from current levels by about the year 2014 (LANL 2005g). Low-level 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 are a function of the influent volume and influent contamination concentrations. For the years 1998-2002, the Radioactive Liquid Waste Treatment Facility received on average 5,346 liters of caustic transuranic and 33,276 liters of acid transuranic influent. In that same period, the Radioactive Liquid Waste Treatment Facility produced approximately about 5 to 6 cubic meters of solid transuranic and mixed transuranic waste annually. Under the No Action Option, the transuranic influent is expected to approximately double once 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.

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 basins 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 basins 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 basins is implemented, the land use designation for the basin areas and along a portion of the pipeline would likely change from Reserve to Waste Management. The basins themselves would occupy approximately 4 acres (1.6 hectares), but a somewhat larger area would undergo a change in land use designation. Removing this land from the Reserve designation was not previously accounted for in the 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 basins 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 basins 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 basins 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 basins would result in a permanent change to the visual environment in the area near the border of TA-52 and TA-5. This change would also be noticeable as a break in the forest cover from higher areas to the west of LANL.

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 major radioactive MDA (MDA-C) is located immediately south of the existing Radioactive Liquid Waste Treatment Facility. NNSA would be implementing various environmental remediation measures for MDA-C and other potential release sites at TA-50 as part of the Compliance Order on Consent (Consent Order) entered into by NNSA, the University of California as the management and operating contractor, and the State of New Mexico (NMED 2005). Any new projects within an area affected by the Consent Order are responsible for appropriate management of contaminated materials within their area of impact. NNSA, through its management contractor, is responsible for other remediation activities in those potential release sites.

TA-50 is located 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 storm water, other water discharges, or wind.

Construction Impacts—Approximately 95,000 cubic yards (72,000 cubic meters) of soil and rock would be disturbed during building excavation. If construction of the evaporation basins and associated pipeline is also selected, an additional 80,000 cubic yards (61,000 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. 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 storm water 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 storm water 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, water quality is expected to improve due to improved processing and potentially more-stringent discharge requirements. If discharges are 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 partially 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 storm water 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 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.

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 basins 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—While construction of the Radioactive Liquid Waste Treatment Facility would not disturb any natural habitat, the evaporation ponds would disturb 4 acres (1.6 hectares) of primarily open field habitat. No direct effects on sensitive species habitat are expected as a result of construction. However, construction has the potential to disturb the Mexican spotted owl due to excess noise or light. If construction were to take place during the breeding season (March 1 through August 31) owls could be disturbed and surveys would be undertaken to determine if they were present or not. If no Mexican spotted owls were found there would be no restrictions on construction activities. However, if they were present restrictions could be implemented to ensure that noise and lighting limits were met. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include areas where the Radioactive Liquid Waste Treatment Facility or evaporation basins would be constructed; thus, these species would not be adversely affected by the proposed project (LANL 2000).

Operations and DD&D Impacts—No direct effects on sensitive species are expected as a result of Radioactive Liquid Waste Treatment Facility operations. If future effluent flow to Mortandad Canyon is reduced by recycling or evaporation, the extent of perennial and intermittent stream reaches and associated wetland and riparian habitat would potentially be adversely affected. This could reduce the abundance and diversity of prey species for the Mexican spotted owl.

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 ALARA radiological doses to workers.

Construction Impacts—Construction would have potential for affecting only worker health. Based on an estimated 317,000 projected person-hours and accident rates for construction at DOE sites and for the general construction industry, 4 to 13 recordable injuries and no fatalities could be expected from construction of the new treatment buildings and associated structures. If the evaporation basins were built, an additional 48,900 person-hours would be required, with a possibility of 1 (DOE 2004) to 2 (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. Worker health and safety 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 in the current Radioactive Liquid Waste Treatment Plant.

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 preestablished safety procedures. Based on an estimated 60,000 person-hours and construction accident rates, one to three 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 basins and the pipelines that would be needed to transfer treated effluent to the basins 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.

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. 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 195,000 gallons (737,000 liters) of liquid fuels and 1.0 million gallons (3.8 million liters) of water.

If evaporation basins were constructed, an additional 189,000 gallons (715,000 liters) of liquid fuels and 1.9 million gallons (7.2 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.

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 2004, the Radioactive Liquid Waste Treatment Facility produced approximately 211 pounds (95 kilograms) (LANL 2006) of chemical waste compared to about 4,850 pounds (2,200 kilograms) of chemical waste projected by the *1999 SWEIS* (DOE 1999b).

The Radioactive Liquid Waste Treatment Facility typically generated about 170 to 262 cubic yards (130 to 200 cubic meters) of solid low-level waste annually between 1998 and 2002 (LANL 2003b). In 2003, 510 cubic yards (390 cubic meters) of low-level waste were generated, and, in 2004, 464 cubic yards (355 cubic meters) were generated (LANL 2004d, 2005d). Less than 4 percent of the low-level waste volume was mixed low-level 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 3 cubic yards (2.3 cubic meters) of mixed transuranic waste during those 2 years (LANL 2004d, 2006).

Construction Impacts—Under Option 1, construction would generate about 4,800 cubic yards (3,670 cubic meters) of contaminated soil, which would be disposed at TA-54 or an appropriate permitted facility as low-level waste, and about 620 cubic yards (470 cubic meters) of construction waste, with some potentially recyclable materials (soil, vegetation, wood, etc.). Wash water from concrete trucks (less than 100 gallons [380 liters]) would be disposed in accordance with LANL requirements. Transitioning from the existing Radioactive Liquid Waste Treatment Facility would also produce one-time waste. Transition waste is estimated at less than 27 cubic yards (21 cubic meters) of low-level waste, and less than 20 cubic yards (15 cubic meters) of clean soil. An additional 2,640 gallons (10,000 liters) of clean water used for testing the new process would be processed through the existing Radioactive Liquid Waste Treatment Facility treatment system. All potentially recyclable materials would be characterized. If contaminated with radioactive materials or chemicals, they would be disposed at an appropriate permitted facility (LANL 2005h).

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 Section 5.9 of this SWEIS.

DD&D Impacts—Demolition of the East Annex and TA-50-66 would produce considerable low-level waste and some transuranic waste. Approximately 1,630 cubic yards (1,246 cubic meters) of low-level waste, of which about 40 cubic yards (31 cubic meters) may be categorized as mixed low-level waste, would be generated by demolition of these facilities. Up to 200 cubic yards (153 cubic meters) of roofing material may also contain asbestos and would be disposed as radioactively contaminated asbestos waste at a permitted offsite facility. Approximately 90 cubic yards (69 cubic meters) of transuranic waste and less than 0.7 cubic yards (1 cubic meter) of polychlorinated benzene-contaminated oil may also be generated by demolition (LANL 2005h). Standdown of the existing Radioactive Liquid Waste Treatment Facility would generate additional one-time wastes. The standdown would produce about 7,900 gallons (30,000 liters) of low-level waste sludge that would be drummed, solidified, and disposed at TA-54 and about 40 cubic yards (31 cubic meters) of used filters, membranes, and expendable supplies that would also be disposed at TA-54. About 130 gallons (500 liters) of transuranic sludge would also be drummed, solidified, and transferred to TA-54 for eventual disposal at the Waste Isolation Pilot Plant. Rinsing and flushing of the piping at the existing Radioactive Liquid Waste Treatment Facility would be treated at either the new or existing facility. Any remaining treated effluent would be released to the outfall in Mortandad Canyon.

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 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 from incident-free transportation of DD&D wastes on the worker population and general public is presented in **Table G–25**. 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.

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–25, disposal 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–25 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	0.24	0.00014	0075	0.000045
Offsite disposition	Nevada Test Site	2.0	0.0012	0.59	0.00035
	Commercial facility	1.94	0.0012	0.57	0.00034

rem = roentgen equivalent man, LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes would be disposed at the Waste Isolation Pilot Plant.

Table G–26 presents the impacts of traffic and radiological accidents. This table provides population risks in terms of fatalities anticipated due to traffic accidents from both the collisions and excess LCFs from exposure to releases of radioactivity. The analyses assumed that all generated nonradioactive wastes would be transported to offsite disposal facilities.

Because all estimated LCFs and traffic fatalities, as shown in Tables G–25 and G–26, 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–26 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	461	0.056	3.3×10^{-13}	0.00088
Nevada Test Site	461	1.04	5.2×10^{-8}	0.011
Commercial facility	461	0.94	3.9×10^{-8}	0.0095

LCF = latent cancer fatality, TA = technical area.

[a] All nonradiological wastes would be transported off site.

[b] Transuranic wastes would be disposed at the Waste Isolation Pilot Plant.

[c] Approximately 88 percent of shipments are radioactive wastes. The remaining waste includes 10 percent industrial and sanitary waste and about 2 percent asbestos and hazardous wastes.

Note: To convert kilometers to miles, multiply by 0.6214.

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 basins 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 basins 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 basins 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 basins would result in a permanent change to the visual environment in the area near the border of TA-52 and TA-5. This change would also be noticeable as a break in the forest cover from higher areas to the west of LANL.

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—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 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 greater under this option because more demolition is proposed under this option. However, erosion control measures specified in a storm water pollution prevention plan would be implemented to mitigate impacts of sediment movement by storm water. Water quality effects would be similar to those under Option 1.

Air Quality

DD&D Impacts—Nonradioactive emissions would be slightly greater under this option because the amount of demolition is greater. Other air quality impacts would be similar to those under Option 1.

Human Health

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 preestablished safety procedures. Based on estimated worker hours and construction accident rates, one to three recordable injuries could occur from DD&D (DOE 2004, BLS 2003).

Cultural Resources

Construction Impacts—Under this option, effects on cultural resources of construction would be minimal. The pipeline and basins would be sited to avoid impacts on nearby archaeological sites to the extent practical. However, if the pipeline alignment or the basins encroached on cultural sites, the sites would be fenced for avoidance or excavated.

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 – Construction of two new buildings would require more infrastructure resources than Option 1. Construction is estimated to require 425,000 gallons (1.6 million liters) of liquid fuels and 2.3 million gallons (8.6 million liters) of water. If evaporation basins are constructed, then similar impacts to those described in Option 1 for constructing the basins would occur. The existing LANL infrastructure would be capable of supporting Option 2 without exceeding site capacities.

Operations – Electricity and natural gas requirements would be slightly more than Option 1 since two new buildings would be operating. Two buildings would increase the use of utilities for lighting and heating as compared to Option 1.

DD&D – 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.

Waste Management

Waste types are expected to be similar to those under the proposed project. **Table G–27** provides the types and volumes of wastes generated during construction (contaminated soil and rubble volumes), transition, and demolition of buildings. Uncontaminated construction waste would be greater than that under the proposed project because two 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 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.

Table G–27 Decontamination, Decommissioning, and Demolition Contaminated Construction Waste Volumes – Two Liquid Waste Treatment Buildings Option

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste	7,000
Mixed low-level waste	140
Transuranic waste	210
Demolition debris	1,730
Sanitary	60
Hazardous waste with asbestos	210
Solid hazardous with organics	0
Solid hazardous with metals	0

DD&D = decontamination, decommissioning, and demolition.
Note: To convert cubic yards to cubic meters, multiply by 0.76456. All numbers were rounded.

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.

The concentrated waste stream from the Radioactive Liquid Waste Treatment Facility evaporator is currently transported by tanker truck to a treatment facility in Tennessee, a trip of about 1,400 miles (2,300 kilometers). Typically, about six shipments are made each year. Following treatment, the dried materials are placed in drums and returned to LANL for disposal.

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.

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 DD&D construction wastes to disposal locations on or off site are presented in **Tables G–28** and **G–29**.

The results in these two tables indicate that no traffic fatalities or excess LCFs are expected from transportation of generated wastes.

Table G–28 Incident-Free Transportation Impacts – Two Liquid Waste Treatment Buildings 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 disposal	LANL TA-54	0.24	0.00014	0.075	0.000045
Offsite disposal	Nevada Test Site	2.14	0.0013	0.63	0.00038
	Commercial facility	2.07	0.0012	061	0.00037

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed at the Waste Isolation Pilot Plant.

Table G–29 Transportation Incident Impacts – Two Liquid Waste Treatment Building Option

Low-level Waste Disposal Location [a]	Number of Shipments [b]	Distance Traveled (10^6 kilometers)	Accident Risks	
			Radiological (excess LCFs)	Traffic (fatalities)
LANL	539	0.08	3.3×10^{-10}	0.0011
Nevada Test Site	539	1.14	5.6×10^{-8}	0.012
Commercial facility	539	1.03	4.2×10^{-8}	0.011

LCF = latent cancer fatality.
[a] Transuranic waste is disposed at the Waste Isolation Pilot Plant.
[b] Approximately 81 percent of these are radioactive. The remaining waste includes 17 percent industrial and sanitary and about 2 percent asbestos and hazardous.
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

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 air- and waterborne contamination spread would be reduced.

Water Resources

Effects on water quality could be greater than those under the proposed project 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.

Human Health

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. The additional renovation and demolition activities would require additional labor hours (totaling 108,000 person-hours) resulting in the possibility of one to five recordable injuries (DOE 2004, BLS 2003).

Cultural Resources

DD&D Impacts—Under this option, additional adverse effects on cultural resources are expected. In addition to impacts addressed under the Two Liquid Waste Treatment Buildings Option, 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 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 – 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 504,000 gallons (1.9 million liters) of liquid fuels and 2.7 million gallons (10 million liters) of water. If evaporation basins are constructed, then similar impacts to those described in Option 1 for constructing the basins would occur. The existing LANL infrastructure would be capable of supporting Option 3 without exceeding site capacities.

Operations – 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 – 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.

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 the proposed project and Option 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–30** provides the types and volumes of wastes generated during construction (contaminated soil and rubble volumes), transition, and demolition of buildings.

Table G–30 Decontamination, Decommissioning, and Demolition Contaminated Construction Waste Volumes – Two Liquid Waste Treatment Buildings and Renovation Option

DD&D Waste Type	*Cubic Yards*
Low-level radioactive waste	11,400
Mixed low-level waste	220
Transuranic waste	300
Demolition debris	1,800
Sanitary	100
Hazardous waste with asbestos	211
Solid hazardous with organics	1
Solid hazardous with metals	0

DD&D = decontamination, decommissioning, and demolition.
Note: To convert cubic yards to cubic meters, multiply by 0.76456. Numbers may not sum correctly due to rounding.

Transportation

Traffic effects would be the same as under the proposed project, except that the disruption would be longer in duration due to the extended renovation and demolition activities. The benefit of eliminating interstate waste transport would be achieved under this option.

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 DD&D construction wastes to disposal locations onsite or offsite are presented in **Tables G–31** and **G–32**.

Table G–31 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	0.70	0.00042	0.22	0.00013
Offsite	Nevada Test Site	3.91	0.0024	1.16	0.00069
	Commercial facility	3.80	0.0023	1.13	0.00068

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed at the Waste Isolation Pilot Plant.

Table G–32 Transportation Incident Impacts – Two Liquid Waste Treatment Building and Renovation Option

Low-level Waste Disposal Location [a]	*Number of Shipments* [b]	*Distance Traveled (10^6 kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL	850	0.11	9.9×10^{-10}	0.0015
Nevada Test Site	850	1.85	9.2×10^{-8}	0.019
Commercial facility	850	1.68	6.9×10^{-8}	0.017

LCF = latent cancer fatality.
[a] Transuranic waste is disposed at the Waste Isolation Pilot Plant.
[b] Approximately 86 percent of these are radioactive. The remaining waste includes 13 percent industrial and sanitary, and about 1 percent asbestos and hazardous.

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 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 2005f):

- 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 as 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 at LANL (see **Figure G–10**). NNSA proposes activities that constitute a refurbishment of an existing, operating facility that would provide the same basic operational conditions as currently exist (LANL 2006). 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, in particular, is available and aids understanding the TA-53 affected environment and potential environmental consequences, it has been included.

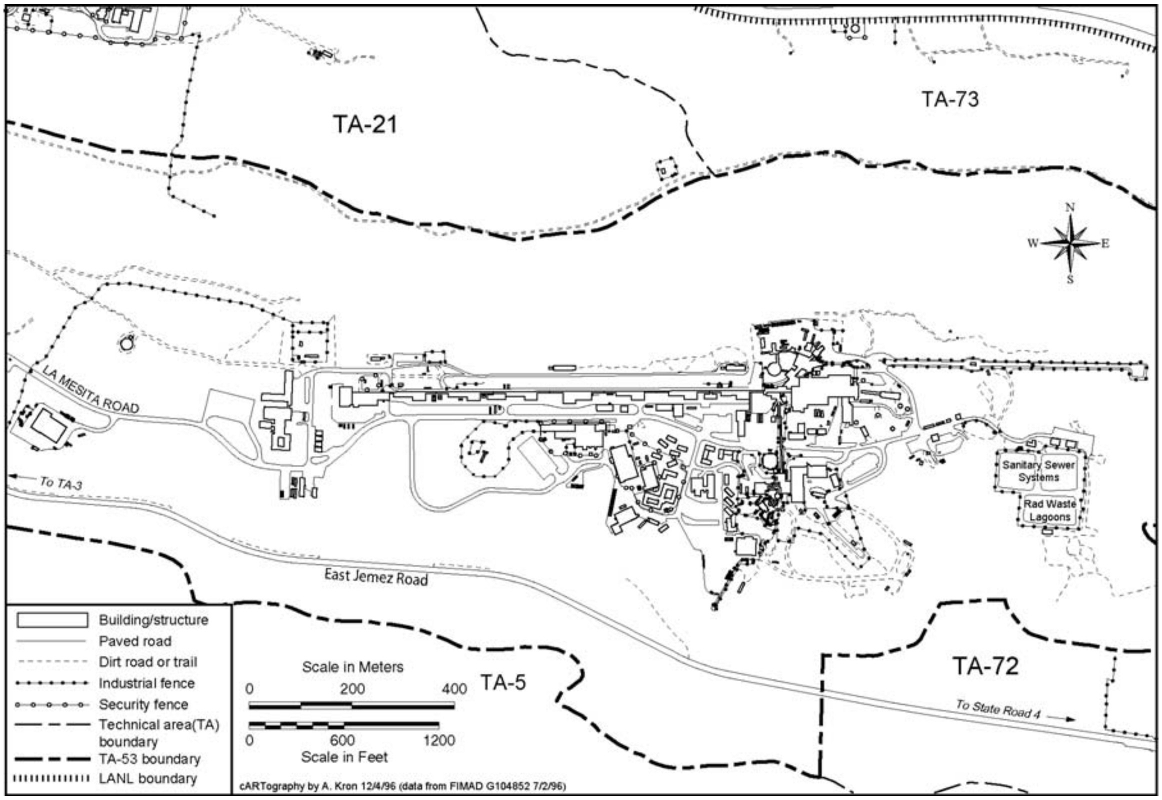


Figure G–10 Location of Los Alamos Neutron Science Center at Technical Area 53

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.
- *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 will be 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 expected.

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 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 activities proposed constitute a refurbishment of existing, operating facilities that would provide the same basic operational conditions as currently exist. The proposed project would be limited to the LANSCE Accelerator Complex and experimental facilities.

All work would be planned to occur during scheduled outages to minimize disruption to operations and would be conducted over the course of about 7 years (LANL 2006).

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, levels are still expected to remain below those that were forecast for the *1999 SWEIS* (DOE 1999b).

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, 2005d, 2006). 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 80 percent of the total LANL radiological air emissions during 2004 (LANL 2005e).

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 with portable equipment and handtools. 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 Section 5.4.2 of this SWEIS.

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, relatively high-energy gamma emitters, 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 1 million electron volts of gamma radiation as they decay, producing a potential short-term radiation exposure. Based on atmospheric modeling of actual releases and dose calculations, the dose to the MEI (at East Gate) from LANSCE in 2004 was 1.52 millirem. The total dose from all LANL operations to an individual at East Gate was approximately 1.68 millirem. This dose is well under the dose anticipated in the *1999 SWEIS* and its Record of Decision (ROD) (DOE 1999b) for LANSCE and LANL, under the EPA limit of 10 millirem per year, and less than 1 percent of the naturally occurring background radiation dose (LANL 2005e).

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, if any at all (LANL 2006). 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 within levels anticipated in the *1999 SWEIS* and its ROD.

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 used 413,392 megawatt-hours of electricity in fiscal year 2004, with LANSCE using 86,275 megawatt-hours. These values are well below the *1999 SWEIS* annual forecasts of 782,000 and 437,000, respectively (LANL 2005d). Full-power operation of the 800-million electron volt linear accelerator requires 21 megawatts of power from the LANL electric grid. Natural gas is consumed by boilers within TA-53 (11-32). However, no usage data is available. 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 2006). LANL used about 346 million gallons (1.3 billion liters) of water in fiscal year 2004 (LANL 2005d); LANSCE's current water use is not available. Nevertheless, recent 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 2006).

Construction Impacts—Requirements for utility infrastructure resources are expected to be negligible and well within the capacities of existing TA-53 utility systems (LANL 2006). 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 handtools, 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 described in Section 5.8.2.3 of this SWEIS. However, levels are still expected to remain below those forecast in the *1999 SWEIS* (DOE 1999b).

Waste Management

LANL generates chemical and radioactive wastes as a result of research, production, maintenance, construction, and remediation service activities. For 2004, waste quantities generated from operations at the key facilities were below *1999 SWEIS* projections for nearly all waste types (LANL 2005d). 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 basins. 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 2006). **Table G–33** presents the latest available waste generation data for TA-53 LANSCE operations.

Table G–33 Waste Generation from Existing Los Alamos Neutron Science Center Operations at Technical Area 53

Waste Type	*1999 SWEIS ROD Projection*	*2004 Generation*
Low-level radioactive waste (cubic yards per year)	1,420	3.4
Mixed low-level radioactive waste (cubic yards per year)	1	0
Chemical (pounds per year)	36,600	215,000 [a]

ROD = Record of Decision.
[a] This volume of waste was generated by 4 years' accumulation of metal under the DOE moratorium, which prevents commercial recycling of metal. This moratorium metal was shipped to Oak Ridge for evaluation and disposition.
Note: To convert pounds to kilograms, multiply by 0.45359; cubic yards to cubic meters, multiply by 0.76456.
Source: LANL 2005d.

Construction Impacts—LANSCE Refurbishment Project activities are expected to generate small quantities of low-level radioactive waste, mixed low-level waste, hazardous waste, and nonhazardous solid wastes. In particular, low-level radioactive and mixed low-level waste 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 in a fully compliant method that minimizes volume while minimizing exposure to workers. Liquid low-level 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 2006).

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 project options.

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 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 perimeter intrusion detection and assessment system 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. Some experimental low-energy nonnuclear radiography has been carried out at Building 55-41, located near Building 55-4 and within the PIDAS.

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 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

---

[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 different energy x rays.*

resources were not always readily available to safeguard the transportation and examinations. In addition, Building 8-23 requires extensive renovation to continue to function as a nuclear facility. LANL ceased the movement of nuclear items and components out of TA-55, and radiography for these materials was stopped. This prevents 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 TA-55 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 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 environmental impacts of locating the high-energy radiography capability at TA-55.

G.6.2 Options Considered

The four options identified for the TA-55 Radiography Facility are the No Action Option and three action options. Under the No Action Option, LANL would no longer be able to perform high-energy radiography. The three action options would implement the strategy for developing high-energy radiography capability within the PIDAS at TA-55. Under the first option, NNSA would construct a new radiography facility at TA-55 to accommodate high-energy radiography and other nondestructive examination activities. A second option is to demolish a portion of Building 55-41 and establish radiography capabilities in a newly built addition to the building. A third option is to renovate Building 55-41 for high-energy radiography.

G.6.2.1 No Action Option

Under the No Action Option, there would be no high-energy 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, and there would be no demolition, excavation, or construction activities at TA-55 associated with developing a high-energy radiography capability. Building 55-41 would continue to be used as office space and for nonnuclear storage, with space for temporary, very-low-level x-ray for nonnuclear items in the basement. No new structure would be built at TA-55 for high-energy radiography. As the structure ages, it would require additional maintenance. Under the No Action Option, the structure would be used long term until it fails.

G.6.2.2 Option 1: New Radiography Building Option

Under the New Radiography Building Option, NNSA would construct and operate a new facility at the site of Building 55-41 (see **Figure G–11**). The current support and administrative offices and bulk storage capacity would be temporarily moved to other sites within TA-55. Building 55-41, a 35,000-square-foot (3,150-square-meter) structure, would be totally demolished in preparation for construction of the new facility. The tunnel entrance would remain intact for possible future use. The new building would be constructed within the excavated space to maintain continuity with the tunnels that lead to Building 55-4. 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 remainder of the excavated area would be backfilled to existing grade using structural fill material. 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 Option 2: Hybrid Option

The Hybrid Option would require demolition of the high-bay portion of Building 55-41 and construction of a radiography facility on the site. The 2,500-square-foot (232-square-meter) high-bay vehicle enclosure and its foundation would be removed. The earthen berm above the below-grade portion of the building would be removed, if required. Radiography administrative functions to support the radiography facility would use approximately 6,000 square feet (557 square meters) of the remaining structure, and the existing administrative, support and storage functions would be reconfigured to accommodate the new uses. The Hybrid Option would include construction of a 400-square-foot (37-square-meter) accessory structure, which would contain the boiler for the facility. Access to the freight elevator, stairwells, and tunnel lobby in the basement would be maintained.

G.6.2.4 Option 3: Renovation Option

Under the Renovation Option, NNSA would modify portions of the basement of Building 55-41 to provide radiography capability at TA-55 for various items containing nuclear materials. About 1,000 square feet (232 square meters) of space in the basement would house the radiography examination area, while the remainder of the existing corridor would remain unchanged. The Renovation Option would also include construction of a 400-square-foot (37-square-meter) accessory structure, which would contain the boiler for the facility. Demolition of portions of (and construction of new) concrete walls and drywall partitions to reconfigure the area would be required. The existing heating, ventilation, and air conditioning; fire protection; plumbing; drainage; alarms; communications; security; and electrical systems would be reconfigured, upgraded, and remodeled to accommodate the changed purpose. There would be a new self-contained heating, ventilation, and air conditioning system for the nondestructive examination facility. The rest of the building would use the existing heating, ventilation, and air conditioning system.

When construction and demolition activities are completed, the modified two-story portion of the building would be classified as a "Performance Category 3"[2] facility. The remaining one-story portion would be classified as a "Performance Category 1"[3] facility. To meet these requirements, structural upgrades to the building may be required. Approximately 1,500 cubic yards (1,140 cubic meters) of soil would be removed from the exterior sides and a portion of the building roof to meet seismic requirements. The soil would be removed by either mechanical or manual means. This soil would be sampled and recycled or disposed appropriately through the LANL waste management program.

G.6.2.5 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 Purpose and Need.

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*

---

[2] *Performance Category 3: Design considerations for Performance Category 3 facilities are to limit facility damage as a result of design-basis natural phenomena events (such as earthquakes) so that hazardous materials can be controlled and confined, occupants are protected, and facility functioning is not interrupted.*

[3] *Performance Category 1: The primary design consideration for Performance Category 1 facilities is preventing major structural damage, collapse, or other failure that would endanger personnel (life safety). Repair or replacement of the facility or its systems after the hazard is not considered.*

Statement for the Proposed Relocation of TA-18 Capabilities and Materials (DOE 2002b) 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 are greater than for converting Building 55-41. Due to these limitations, this option was dismissed from further consideration in this document.

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) 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 in this document.

G.6.3 Affected Environment and Environmental Consequences

Chapter 3 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. Both Building 55-4 and Building 55-41 are located within the PIDAS. Nuclear components are manufactured and nuclear research and development is conducted in Building 55-4. Building 55-41 was originally designed for nuclear materials storage; however, the building has never been used for that purpose and no nuclear material has ever been brought into the building. It has since been modified for offices, warehouse storage, and temporary low-energy (nonnuclear) radiography support activities. The building consists of a high bay, a one-story service area, and a two-story (basement and first floor) area. The building is extensively shielded and is situated partially underground. The basement and first floor of the building are windowless and are constructed of concrete. This portion of the building consists of two long alleys. The one-story service area was designed to meet nonnuclear usage requirements. The two-story structure is bermed outside with soil on the top and sides.

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 options 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 and DD&D workers would be drawn from the pool of construction workers employed on various projects at LANL. Utility infrastructure resources needed for construction would be negligible for the proposed project and options and would have no incremental impact on site utility infrastructure.

- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-55, with no disproportionate human health impacts expected.

Resource areas examined in detail in this analysis include: geology and soils, air quality and noise, human health, cultural resources, waste management, transportation, and facility accidents.

G.6.3.1 No Action Option

Under the No Action Option, there would be no potential for injuries to demolition and construction workers from activities planned under the other options. 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 Building 55-41. Facilities at TA-8 and TA-55 could continue to be used in their current fashion. Transportation impacts due to road closures could continue.

Under this option, there would be no demolition, excavation, or construction activities. There would be no additional construction waste generated, and the construction and demolition debris waste shipments to landfills or recycling centers would not occur. There would be no generation of asbestos-containing material or any other hazardous waste that would require offsite disposal.

Under 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 action options would not occur.

There would be no earthen berm removal or construction and thus there would be no change in ambient air quality effects associated with implementing the No Action Option. The high-energy radiography capability would not be located in Building 55-41 or in a new building at TA-55. There would be no additional effects to consider.

G.6.3.2 Option 1: 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 and DD&D 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 storm water, 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 during demolition of Building 55-41 and construction of a new radiography building 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 demolition and 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 decibels A-weighted 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 decibels A-weighted 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.

DD&D Impacts—Demolition work in Building 55-41 could produce high noise levels resulting from removal of concrete walls or structures. Noise from construction equipment during demolition would be comparable to construction noise, as described above.

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. Members of the general public are not affected because access to Pajarito Road, and thence to 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 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). 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 demolition or construction workers; however, construction workers would be actively involved in potentially hazardous activities under this option. Demolition and 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 both demolition and 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 demolition and 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 not allow 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. Dose levels would be greatly reduced in adjacent rooms and throughout the rest of the building due to shielding. Work areas would be designed so workers in adjacent rooms would be shielded to ensure that exposures are kept to less than

20 millirem per week, and routine radiography operations would result in worker 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 ALARA worker doses. 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.

DD&D Impacts— Demolition and 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 demolition phase. Health and safety impacts for demolition activities would be similar to those that might be expected during construction activities. Based on an estimated 8,750 person-hours for DD&D of the 35,000-square-foot (3,150-square-meter) Building 55-41, no fatal accidents and no nonfatal injuries are expected to occur (DOE 2004, BLS 2003). The interior walls within the two-story portion of Building 55-41 are covered with peeling specially formulated placite paint, which would need to be removed by sandblasting. Removal of the placite paint would require appropriate personal protective equipment and respiratory equipment in accordance with applicable DOE and LANL procedures.

Cultural Resources

Under Option 1, a new Radiography Building would be built which would necessitate removal of the current building (Building 55-41). TA-55-41 is a potentially significant historic building that has yet to be assessed for National Register of Historic Places eligibility status. If determined to be eligible 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. The Advisory Council on Historic Preservation would be notified of the Memorandum of Agreement and would have an opportunity to comment.

Waste Management

DD&D Impacts—About 7,911 cubic yards (6,050 cubic meters) of solid waste would be generated during demolition of Building 55-41 and 48 cubic yards (37 cubic meters) construction of the new building. Construction and installation of the radiographic facility would incorporate, to the extent practical, recommendations that would be provided in the pollution prevention design assessment for this project. Construction and demolition debris would be minimized through recycling, reuse, or reselling, if the cost benefits, resources, and available technology permit. Material that cannot be recycled would be disposed 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. Hazardous wastes would be identified and removed from structures scheduled for demolition before general structural demolition could begin. No asbestos is known to be present within Building 55-41; if testing shows the presence of asbestos, it would be removed according to standard procedures for asbestos removal.

Placite paint, used on the walls, floor, and shelves in Building 55-41, also contains RCRA-listed toxicity characteristic constituents such as chromium, lead, and barium. However, analyses indicate that these elements are present in concentrations that are well below RCRA hazardous waste concentrations. Consequently, waste generated from the placite paint removal would not be considered RCRA-regulated hazardous waste and would be disposed in accordance with LANL waste management requirements at the Los Alamos County landfill or its replacement facility.

This option would include removal of the berm adjacent to Building 55-41. No potential release sites are known to be present at the proposed construction sites. The radiography project, in consultation with the Remediation Services Project, would perform characterization and confirmatory sampling to determine the soil disposition. If sampling and characterization indicate that the soil from the dirt berm is not contaminated, the soil could be used as fill material at TA-55 or elsewhere at LANL, or it could be staged on site at an approved material management area for future use at LANL.

Transportation

Operations Impacts—Under the New Radiography Building Option, nuclear items and components would be transported between Building 55-4 and Building 55-41. These buildings are both located 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 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} per year when realistically estimated or in excess of 10^{-6} 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, a high-energy radiography capability would be established in a new building constructed at the site of Building 55-41. The 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 was 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, less than a day, 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.6.3.3 Option 2: Hybrid Option

Under the Hybrid Option, impacts on air quality and noise, cultural resources, transportation, and accident risk would be similar to the New Radiography Building Option. Resource areas that differ from the New Radiography Building Option are detailed below.

Geology and Soils

Construction Impacts—Construction would require excavation of 9,500 cubic yards (7,300 cubic meters) of soils as well as 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. 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 storm water, other water discharges, or wind.

Human Health

Construction Impacts—The most common hazards associated with construction activities under the Hybrid Option would be similar to those of the New Radiography Facility Option. Based on an estimated 38,400 person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be none (DOE 2004) to approximately two (BLS 2003).

DD&D Impacts— Health and safety impacts of demolition activities would be similar but reduced in comparison to those expected under the New Facility Option. Based on an estimated 625 person-hours for DD&D of 2,500 square feet (232 square meters) of Building 55-41, no fatal accidents or nonfatal injuries would occur (DOE 2004, BLS 2003). The interior walls within the two-story portion of Building 55-41 are covered with specially formulated placite paint, which would need to be removed by sandblasting. Removal of the placite paint would require appropriate personal protective equipment and respiratory equipment in accordance with applicable DOE and LANL procedures.

Waste Management

Construction Impacts—Construction of the Hybrid Option would generate approximately 14 tons (13 metric tons) of construction waste, primarily construction debris and associated solid waste. Construction debris is not hazardous and may be disposed 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).

DD&D Impacts—The Hybrid Option would require managing and disposing wastes generated by demolition and construction activities. This option would also include removal of soil from dirt berms adjacent to Building 55-41. About 565 cubic yards (432 cubic meters) of solid waste would be generated during demolition of the high-bay area and construction of the new radiography section of Building 55-41. Construction debris would be handled and disposed of as described under the New Radiography Building Option.

G.6.3.4 Option 3: Renovation Option

Under the Renovation Option, impacts on air quality and noise, cultural resources, transportation, and accident risk would be similar to those of the New Radiography Building Option. Resource areas that differ from the New Radiography Building Option are detailed below.

Geology and Soils

Construction Impacts—Construction would require excavation of 2,100 cubic yards (1,600 cubic meters) of soils as well as 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. 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 storm water, other water discharges, or wind.

Human Health

Construction Impacts—The most common hazards associated with construction activities for the Renovation Option would be similar to those of the New Radiography Facility Option. Based on an estimated 16,800 person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be none to approximately one (DOE 2004, BLS 2003).

DD&D Impacts—Health and safety impacts of demolition activities would be similar but reduced in comparison to those expected under the Hybrid Option. Based on an estimated 250 person-hours for DD&D of 1,000 square feet (93 square meters) of Building 55-41, no fatal accidents or nonfatal injuries would occur (DOE 2004, BLS 2003). The interior walls within the two-story portion of Building 55-41 are covered with specially formulated placite paint, which would need to be removed by sandblasting. Removal of the placite paint would require appropriate personal protective equipment and respiratory equipment in accordance with applicable DOE and LANL procedures.

Waste Management

Construction Impacts—Construction would generate approximately 3 tons (3 metric tons) of construction waste, primarily construction debris and associated solid waste. Construction debris is not hazardous and may be disposed 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.

DD&D Impacts—The Renovation Option would require managing and disposing wastes generated by demolition and construction activities within Building 55-41 and removal of soil from the dirt berm adjacent to Building 55-41. Construction waste would be generated from construction and installation of the actual radiography facilities, including life safety upgrades to the building, and repair and upgrade of legacy structural deficiencies. Approximately 226 cubic yards (173 cubic meters) of construction and demolition debris would result from modification of the existing building. Wastes would be handled and disposed of as described under the New Radiography Building Option.

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 2006).

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 Condition: 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 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 their 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 if unreliability adversely impacts safety.

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. While 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 (confinement) 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
- Elevators
- Industrial waste
- 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
- FHAS blower system
- Steam system
- Positive pressure chilled water
- Acid waste system
- Bubbler bypass features
- Chlorine gas delivery system
- Remove selected gloveboxes from throughout the building
- Generator related to uninterrupted power supply
- 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 NTSF (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 are relatively minor in scope.

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 DOE 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:

- *Ecological Resources* – Located in an already-developed area of TA-55.
- *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 will be included in the impacts discussion.
- *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 DOE and, therefore, would not require any formal compliance consultation.
- *Environmental Justice* – The proposed project is confined to already-developed areas of TA-55, with no disproportionate human health impacts 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, 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 Option 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 the TA-55 Complex are designated Nuclear Materials Research and Development and Reserve (LANL 2003d). 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 activity 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 could be impacted by refurbishment project activities at TA-55. 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. 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 2004, discharges through this outfall totaled 2.72 million gallons (10.2 million liters) (LANL 2005d).

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 surfacewater 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 2006).

Air Quality and Noise

Estimates for selected toxic and hazardous air pollutant emissions from key LANL facilities were made in the *1999 SWEIS* (DOE 1999b) 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 2004d). **Table G–34** presents estimated toxic and hazardous air pollutant emissions for 2004 based on chemical usage at TA-55.

Table G–34 Toxic and Hazardous Pollutant Air Emissions from Existing Operations at Technical Area 55

Chemical and Form	*2004 Air Emissions (kilograms)*
Ammonium chloride (fume)	0.38
Chloroform	1.56
Ethanol	14.12
Hydrogen chloride	362.28
Hydrogen fluoride, as F	2.9
Hydrogen peroxide	12.31
Isobutane	0.16
Lead, elemental and inorganic compounds, as Pb	0.03
Methyl alcohol	0.28
Nitric acid	226.27
Oxalic acid	28.18
Phosphoric acid	0.32
Potassium hydroxide	122.96
Sulfuric acid	0.97

Note: To convert kilograms to pounds, multiply by 2.2046.
Source: LANL 2005d.

Radiological air emissions from operations at TA-55 in 2004 are described in Radiological Monitoring (Section 4.4.3.1). 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 with portable equipment and handtools. 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.

While 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. There are several small potential release sites at TA-55. 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 in support of improved regulatory compliance.

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 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 2004 (1.68 millirem) resulted from emissions out of 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 2004 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 2005d). 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 for any subproject (LANL 2006).

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 uses approximately 14,500 megawatt-hours of electricity annually. TA-55 uses natural gas to fire boilers and for other facility uses and is estimated to use approximately 45 million cubic feet (1.3 million cubic meters) annually. TA-55 water usage is not metered (DOE 2003).

Construction Impacts—Requirements for utility infrastructure resources, including electricity, fuels, and water, are expected to be negligible for most subprojects. Existing TA-55 utility systems would easily be capable of supporting project activities (LANL 2006). 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 handtools, spotlighting, and other construction equipment. This fuel would be procured from offsite sources and, therefore, would not be a limited resource. Total fuel consumption (mainly diesel fuel) is estimated to be about 25,000 gallons (94,700 liters). Up to 140,000 gallons (530,000 liters) of water over a period of 6 or more years may be required to support subproject activities. The existing TA-55 water supply infrastructure would be easily capable of handling this demand.

Operations Impacts—The proposed refurbishment activities are not intended to materially change TA-55 operations, and no net increase in utility infrastructure demands is expected 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 2004, waste quantities generated from operations at the key facilities were below *1999 SWEIS* ROD projections for nearly all waste types (LANL 2005d). **Table G–35** presents the latest available waste generation data for TA-55 operations.

Table G–35 Waste Generation from Existing Operations at Technical Area 55

Waste Type	*1999 SWEIS ROD Projection*	*2004 Generation*
Low-level radioactive waste (cubic yards per year)	986	247
Mixed low-level radioactive waste (cubic yards per year)	17	2
Transuranic waste (cubic yards per year)	310	18
Mixed transuranic waste (cubic yards per year)	133	30
Chemical (pounds per year)	18,500	17,200

ROD = Record of Decision.
Note: To convert cubic yards to cubic meters, multiply by 0.76455; pounds to kilograms, by 0.4536.
Source: LANL 2005d.

The Plutonium Facility has capabilities to treat, package, store, and transport the radioactive waste produced as part of 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 15- or 30-gallon (57- or 115-liter) drums or is packaged in waste boxes. Low-level wastes also is 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 TA-54 (LANL 2006).

Construction Impacts—Refurbishment project activities are expected to generate transuranic waste, low-level radioactive waste, mixed low-level 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–36**.

Table G–36 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)	1,292
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)	2,742

Note: To convert cubic yards to cubic meters, multiply by 0.7644; pounds to kilograms, multiply by 0.4536.
Source: LANL 2006.

Low-level wastes would consist mainly of personal protective equipment. 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 2006). 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) will 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–37**. 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–37, disposal 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–37 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	0.78	0.00047	0.25	0.00015
Offsite disposal	Nevada Test Site	1.31	0.00079	0.41	0.00024
	Commercial Facility	1.28	0.00077	0.40	0.00024

LCF = latent cancer fatality, TA = technical area.
[a] Transuranic waste would be disposed at the Waste Isolation Pilot Plant.

Table G–38 presents transportation impacts of traffic and radiological accidents. This table provides population risks from exposure to releases of radioactivity and fatalities anticipated due to traffic accidents collisions and excess LCFs. The analyses anticipated that, in the case of offsite disposition, all wastes generated by refurbishment activities would be transported to offsite disposal facilities.

Table G–38 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	282	0.11	1.1×10^{-9}	0.0013
Nevada Test Site	282	0.34	1.2×10^{-8}	0.0036
Commercial facility	282	0.32	9.0×10^{-9}	0.0033

LCF = latent cancer fatality, TA = technical area.

[a] Transuranic waste would be disposed of at the Waste Isolation Pilot Plant.

[b] All nonradiological wastes would be transported off site.

[c] Approximately 45 percent of these are radioactive. Others include 54 percent industrial and sanitary and about 1 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 proposed option locations for construction of the Science Complex. Section G.8.3 describes the affected environment and impacts of the No Action Option and the proposed project (construction and operations of the proposed Science Complex) at all of the option locations.

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.

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

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 (*Pinus ponderosa* P. & C. Lawson), and some piñon (*Pinus edulis* Engelm.)-juniper (*Juniperus monosperma* [Engelm.] Sarg.). 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 2006). 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 should 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.

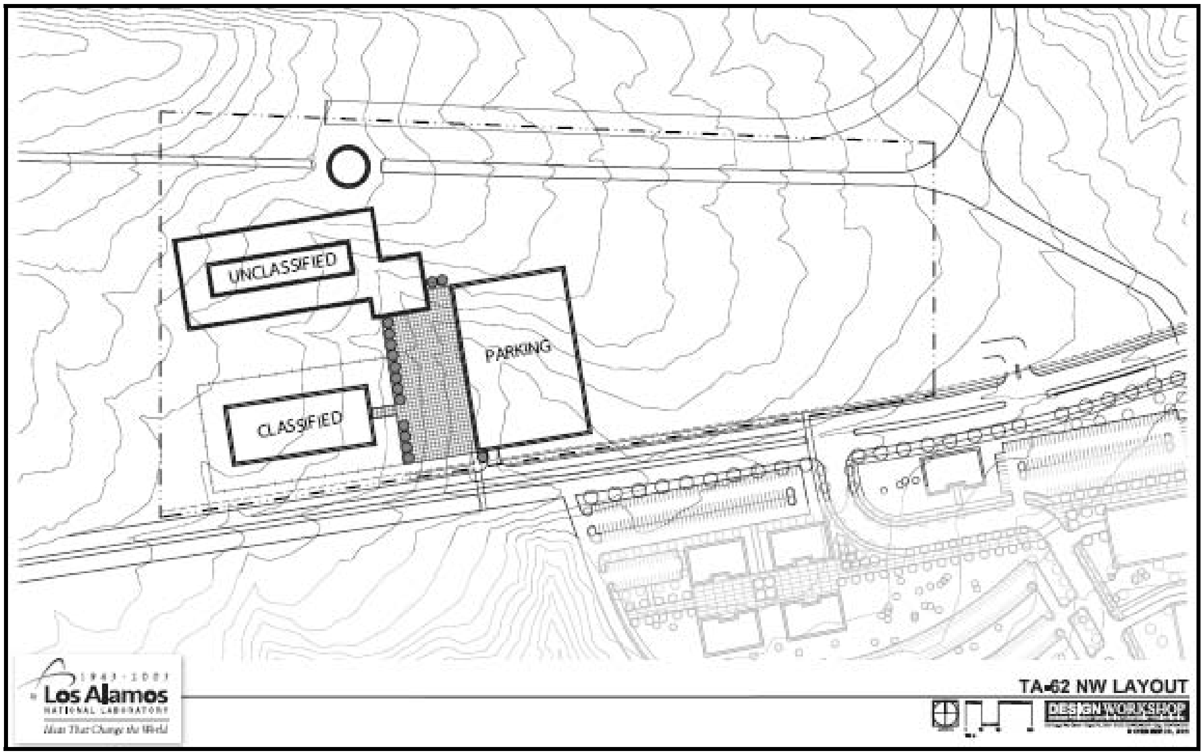


Figure G–12 Conceptual Layout of the Science Complex at the Northwest Technical Area 62 Site

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 should be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes should 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 piñon-juniper.

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 piñon-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 1500 and 10 CFR 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, that 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 alternate 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:

- *Human Health* – An accident analysis has been conducted that evaluates the potential for LANL operations to adversely impact human health at the Science Complex. This analysis is discussed in the Facility Accidents section for each option site.

- *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 will be included in the impacts discussions.

- *Environmental Justice* – The proposed project would entail no disproportionate human health impacts.

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, environmental restoration, 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 site options. Under the No Action Option, neither land tract would 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. Neither site would generate waste. 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

Land Resources—Land Use

Under the Northwest TA-62 Site option a site located immediately 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 and adjacent to 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, including the Mexican spotted owl, in the area 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 865,000 cubic yards (661,000 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 are 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.

DD&D Impacts—The proposed project includes DD&D activities of unspecified facilities with a footprint equivalent to new facility construction. The impact associated with DD&D of existing 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 the 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 Section 5.2 of this SWEIS) and in the vicinity of LANL. The volume of backfill would depend on the specific facility to be removed. 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

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 surfacewater 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 during this project. The potential for downstream siltation would be minor and temporary in nature. A storm water pollution prevention plan would be developed and implemented, including placement of best management practices to prevent erosion of disturbed soil by storm water runoff or other water discharges.

Under the current conceptual site layout plan (see Figure G–10) 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 storm water 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. Total emissions of criteria pollutants and other air emissions associated with of 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.

Effects of Science Complex construction on air quality would be negligible compared to potential annual air pollutant emissions from LANL as a whole. Soil disturbance during construction would result in small radiological air emissions, but would be controlled by best management practices 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 (*Strix occidentalis lucida*) (LANL 2006). Because of the potential for impact on the Mexican spotted owl habitat, formal compliance with the Endangered Species Act would be required and actions would need to be implemented, possibly including seasonal restrictions on construction, per the governing Federal agency providing construction oversight. Other state listed special status species would have a low probability of occurrence within the project area.

Guidance for Mexican spotted owl habitat alteration allows limited development of less than 5 acres (2 hectares) in buffer areas as long as it does not alter habitat in undeveloped core Area of Environmental Interest zones. Habitat alterations other than fuels management practices and utility corridor maintenance may not be allowed in undeveloped core areas (LANL 2000). The site plan for the Los Alamos Canyon Area of Environmental Interest states that the area is heavily developed and that any additional development within the Los Alamos Canyon Area of Environmental Interest is restricted to a few selected areas within the buffer zone (LANL 2000). Tree removal of less than 5 acres (2 hectares) during nonsensitive times of the year would be allowed. If restrictions cannot be met, a biological assessment must be conducted (LANL 2006). If construction for this option is planned in an undeveloped core area, it must be evaluated for Endangered Species Act compliance (LANL 2000).

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. Seasonal restrictions on construction may be imposed from March 1 to May 15 and possibly to August 31. If construction were to take place during the breeding season (March 1 through August 31) owls could be disturbed and surveys would need to be undertaken to determine if they were present. If none were found, there would be no restriction on project activities. However, if they were present, restrictions would be implemented to ensure that noise and lighting limits were met (LANL 2000).

Construction of the new buildings and parking structure would not impact wetlands, as none are located in or near the construction zone.

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.

Excess noise or light associated with operation of the Science Complex also has the potential to disturb the Mexican spotted owl. Restrictions could be implemented to ensure that noise and lighting limits were met (LANL 2000).

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 3.32 million person-hours to construct the new facilities, no fatal accidents would occur. Nonfatal injuries are estimated to be approximately 38 (DOE 2004) to 141 (BLS 2003).

Cultural Resources

Two archaeological sites are situated in the vicinity of the proposed Northwest TA-62 location, and both sites were determined to be eligible for the National Register of Historic Places. 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.

Construction Impacts—Two 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 both 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* (LANL 2005c) 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 4.7 million gallons (18 million liters) and total water consumption is estimated to be 24 million gallons (90 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 3,280 cubic yards (2,510 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. To mitigate non-construction related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access should be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes should be constructed on West Jemez Road approaching the site access.

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).

Environmental Restoration

There are no known potential release sites at this site near the Science Complex proposed layout.

Operations Impacts—Based on conceptual plans for this site, none of the proposed facility structures would be near any known potential release sites. Therefore, based on known potential release sites in the proposed Science Complex area at the Northwest TA-62 site, there are no likely environmental restoration concerns. Characterization of the site must be performed prior to land transfer or construction for liability purposes under RCRA. If any new potential release sites are discovered, they would need to be either avoided or remediated in accordance with applicable Federal and state requirements.

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 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 chance in 560,000 per year of occupancy. DD&D of the Chemistry and Metallurgy Research Building after about 2014 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 in detail 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 1999). 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 (LANL 2006). Other state-listed special status species would have a low probability of occurrence within the project area (LANL 2006). 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. The area is not within any Area of Environmental Interest for any federally listed threatened or endangered species (LANL 2006).

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.

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 and/or a qualified professional is consulted before work resumes. 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 (121.9 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.

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 are necessary to accommodate construction-related traffic volumes. To mitigate non-construction-related traffic increases, the four-lane cross section of West Jemez Road east of the proposed site access should be extended to the site access. Also, east- and westbound right- and left-turn deceleration lanes should be constructed on West Jemez Road approaching the site access.

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.

Environmental Restoration

There are no known potential release sites at the Research Park site. The closest potential release sites are located across West Jemez Road in TA-3 to the south, approximately 100 feet (30.5 meters) away from the Research Park site boundary.

Operations Impacts—None of the proposed structures would be impacted by potential release sites. Therefore, environmental restoration concerns are not anticipated under this option. Characterization of the site must be performed prior to land transfer and construction for liability purposes under RCRA. If any new potential release sites are discovered, they would need to be either avoided or remediated in accordance with applicable Federal and state requirements.

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 1 in 2,400 of developing an LCF. Taking into account the likelihood of the accident occurring, the risk of an LCF would be 1 chance in 240,000 per year of occupancy. Again, DD&D of the Chemistry and Metallurgy Research Building after about 2014 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 in detail 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 1999). 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 an approximately 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 the probability 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—Impacts and activities associated with DD&D of existing facilities would have the same impact 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 the 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 is 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 2006).

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 piñon-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 2006).

Construction Impacts—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 is more than 5 acres (2 hectares) (LANL 2006). Science Complex construction under the South TA-3 Site Option would also result in impacts generally similar to those addressed in Section G.8.3.2.

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.

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 and/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, which 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 could potentially impact adjacent drainages without proper installation of erosion control best management practices.

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 2002c). 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.

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).

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. 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.

Environmental Restoration

There are several potential release sites located on or near the northeast perimeter of the South TA-3 site. Potential Release Site 03-009(h), along the eastern perimeter of the site at the toe of the slope below and east of the existing parking lot, is a former concrete debris surface disposal area categorized by LANL "as administratively complete," with no suspected radiological contaminants of potential concern present (LANL 2006). Potential Release Site 03-009(e) lies on the northeast corner of the site perimeter and is a former fill area listed as administratively complete, with no suspected radiological or hazardous contaminants of potential concern. Potential Release Sites C-03-006 and 03-054(e) lie approximately 50 feet (15 meters) north of the northwest corner of the alternate site and are associated with a former radiological release from the Chemistry and Metallurgy Research Building, which flowed into storm water drains and was then released to the upper reaches of Mortandad Canyon. Contaminants of potential concern have been confirmed in this drainage at the headwaters of Mortandad Canyon, and LANL lists these potential release sites as “in progress”.

Operations Impacts—Although radiological and other contaminants of potential concern have been confirmed at Potential Release Sites C-03-006 and 03-054(e), the sites are located outside of the area anticipated to be disturbed by Science Complex construction and operation. The other potential release sites located within or along the project boundary are not expected to pose any health risks to human health, nor is the project expected to disturb these sites in the course of Science Complex construction and operation. Therefore, environmental restoration concerns are not anticipated with this option. Site characterization must be performed prior to land transfer and construction for liability purposes under RCRA. Science Complex drainage would be controlled so that it does not impact any existing potential release sites near the area. If any new potential release sites are discovered, they would need to be either avoided or remediated in accordance with applicable Federal and state requirements.

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 in 600 of developing an LCF. Taking into account the likelihood of the accident occurring, the risk of an LCF would be 1 chance in 60,000 per year of occupancy. Again, DD&D of the Chemistry and Metallurgy Research Building after about 2014 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 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 2006).

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 piñon-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.

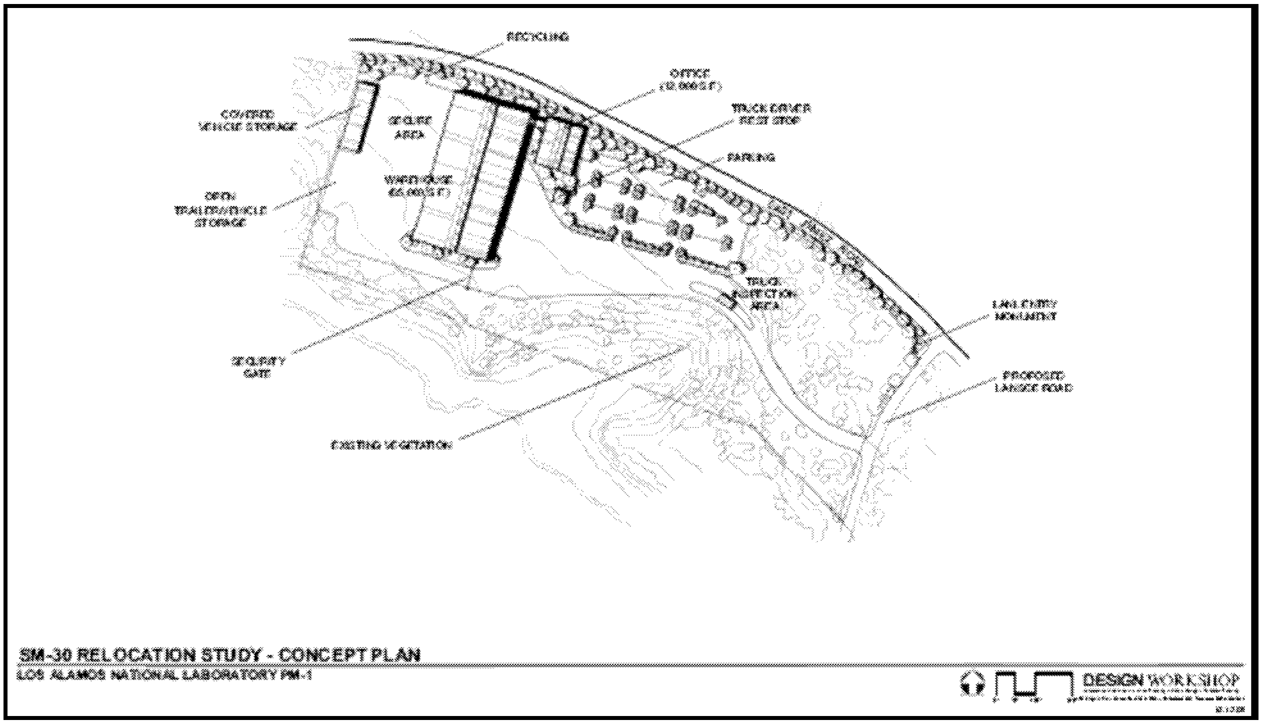


Figure G–13 Technical Area 72 Remote Warehouse and Truck Inspection Station Conceptual Layout

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.

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, then, 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 will be included in the impacts discussions.
- *Environmental Justice* – There would be no disproportionate impacts on populations as a result of the proposed Remote Warehouse and Truck Inspection Station.

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 of No Action, 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 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 pumping 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 storm water pollution prevention plan would be developed and implemented, including best management practices to prevent erosion of disturbed soil by storm water 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 storm water 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 piñon (*Pinus edulis* Engelm.)-juniper (*Juniperus monosperma* [Engelm.] Sarg.) woodland and ponderosa pine (*Pinus ponderosa* P. & C. Lawson) 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 (*Strix occidentalis lucida*), southwestern willow flycatcher (*Empidonax traillii extimus*), or the bald eagle (*Haliaeetus leucocephalus*). Other state-listed special status species would have a low probability of occurrence within the project area (LANL 2006). Furthermore, there are no wetlands or aquatic resources within the project area (Green et al. 2005).

Construction Impacts—The proposed project would result in clearing and grading approximately 4 acres (1.6 hectares) of ponderosa pine forest and piñon-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. If more than 5 acres (2 hectares) would be disturbed, a biological assessment would be conducted (LANL 2006).

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.

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 (LANL 2006). 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 do 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* would be implemented (LANL 2005c).

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 536,000 gallons (2 million liters) of liquid fuels and 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 disposed of at a permitted solid waste landfill.

Operations Impacts—Waste 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 are 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 1999b) 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 are bounded by the operational hazard analyses in the SWEIS.

G.10 References

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 for New Warehouse at Los Alamos National Laboratory*, LA-UR-04-1283, Los Alamos National Laboratory, New Mexico.

DOE (U.S. Department of Energy), 1996, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, DOE/EIS-0236, November 19.

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

DOE (U.S. Department of Energy), 1999c, *DOE Standard Radiological Control*, DOE-STD-1098-99, Office of Environment, Safety and Health, Washington DC, July.

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, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, DOE Standard 1020-2002, January, supersedes DOE-STD-1020-94, Washington, DC, April 1994.

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, Washington, DC, August.

DOE (U.S. Department of Energy), 2002c, *Environmental Assessment for the Proposed Construction and Operation of the Biosafety Level 3 Facility at LANL*, Office of Los Alamos Site Operations, February 26.

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, Washington, DC, November.

DOE (U.S. Department of Energy), 2004, *DOE and Contractor Facility Incident Rates,* Office of Environment, Safety, and Health, Washington, DC.

Gardner, J. N, A. Lavine, G. WoldeGabriel, D. J. Krier, D. Vaniman, F. Caporuscio, C. J. 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*, March.

Green C., L. McWhirter, E. Paulsgrove, and J. Wood, 2005, *Wetlands Delineation Report, Los Alamos National Laboratory*, Los Alamos, New Mexico, U.S. Army Corps of Engineers, Albuquerque, District, Albuquerque, New Mexico, October.

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, *Los Alamos National Laboratory Threatened and Endangered Species Habitat Management Plan, Overview*, 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*, Los Alamos National Laboratory, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2002, *Site + Architectural Design Principles*, LA-UR-01-5383, Los Alamos, New Mexico, January.

LANL (Los Alamos National Laboratory), 2003a, *Groundwater Annual Status Report for Fiscal Year 2002*, GPP-03-011, LA-UR-03-0244, Risk Reduction and Environmental Stewardship Groundwater Protection Program, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2003b, *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), 2003c, *Emissions Inventory Report Summary: Reporting Requirements for the New Mexico Administrative Code*, Title 20, Chapter 2, Part 73 (20.2.73 NMAC) for Calendar Year 2002, LA-14089-SR, Attachment A, November.

LANL (Los Alamos National Laboratory), 2003d, *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*, Los Alamos Neutron Science Center – Refurbishment, LA-UR-04-1350, May 21.

LANL (Los Alamos National Laboratory), 2004b, *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, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004f, *LANL Sustainable Design Guide*, LA-UR-02-6914, Los Alamos, New Mexico, December.

LANL (Los Alamos National Laboratory), 2005a, *2004 LANL Radionuclide Air Emissions Report*, LA-14233, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2005b, *LANSCE Refurbishment Project: Mission Need Statement, Non-Major System Acquisition Project*, LA-05-4040, Los Alamos, New Mexico, June 1.

LANL (Los Alamos National Laboratory), 2005c, *A Plan for the Management of the Cultural Heritage at Los Alamos National Laboratory*, LA-UR-04-8964, Ecology Group, Los Alamos, New Mexico, July.

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, Environmental Surveillance Program, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005f, *Los Alamos National Laboratory Wildland Fire Management Plan, Management Review Draft*, LA-UR-05-0286, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005g, Extract from the Radioactive Liquid Waste Treatment Facility (RLWTF) *Influent Boundary Condition Assessment* Revision 2.0, LA-UR-05-9001, November.

LANL (Los Alamos National Laboratory), 2005h, 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), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

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 the Proposed 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: Leadership in Energy and Environmental Design," 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 occur 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**.

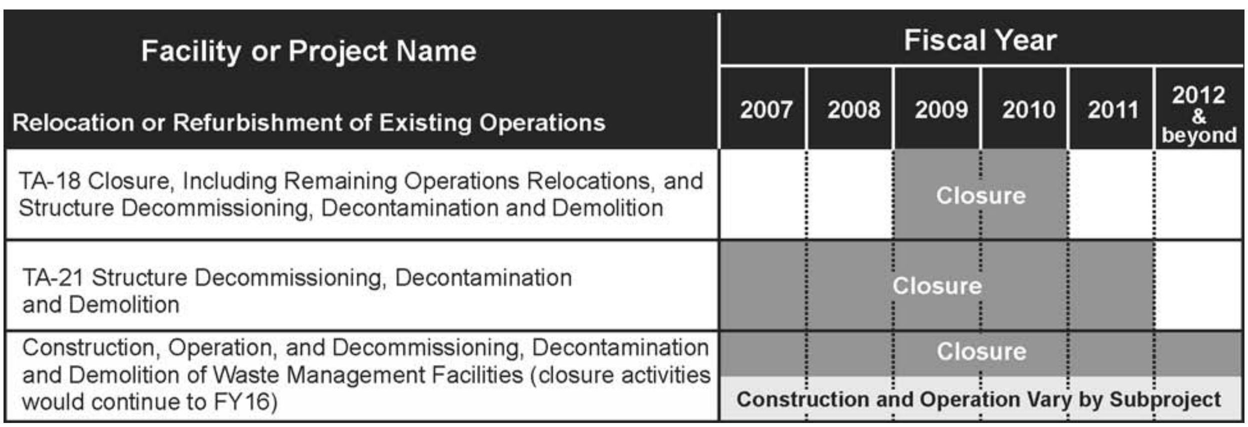


Figure H–1 Proposed Timeframes for Construction and Operation of Closure and Remediation Actions

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 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 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 landfill.

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.

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.

[1] This Security Category description refers to the required level of safeguards and security as established in DOE Order 474.1A and its manual, DOE M474.1-1B.

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 2005a). 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.

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 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 2002d). 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.

TA-18 Interim Operations. 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 sent to Y-12 disposition. The current planning assumptions for TA-18 operations are:

- TA-18 would continue to support limited Security Category III and IV capabilities through September 2008.
- TA-18 operations would cease at the end of September 2008, and the facility would be turned over for disposition.

During the 2005 through 2008 interim operations, 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 the SHEBA critical assembly to maintain the capabilities for training and criticality experiments. NNSA will analyze, through separate National Environmental Policy Act (NEPA) action, the relocation of SHEBA critical assembly 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.

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 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.

SPECIAL NUCLEAR MATERIALS SAFEGUARDS AND SECURITY

(DOE Manual 474.1-1B)

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).

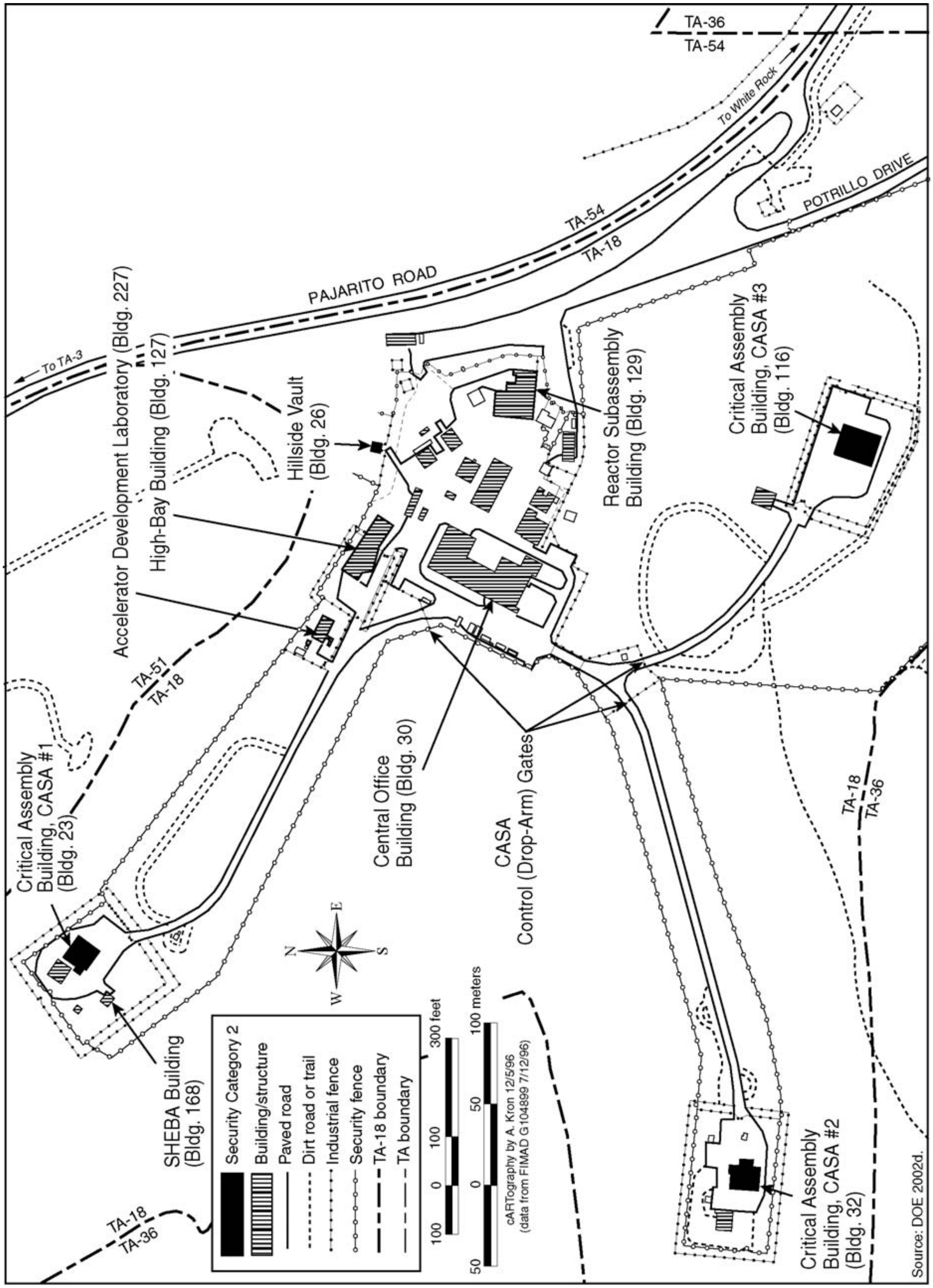


Figure H–2 Technical Area 18 Pajarito Site

A security fence surrounds each CASA. The following text describes the primary buildings being addressed in this project-specific analysis (DOE 2002d).

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 general-purpose criticality experiment remote critical assembly machines. These machines do 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 by 2010.

The SHEBA Building provides only a weatherproof shelter for critical assemblies. 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 127 can be used as a Material Access Area so that up to Security Category I quantities of special nuclear material can be temporarily brought into the building for experiments.

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

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 A) construct a new facility at TA-55; Option B) construct a new facility elsewhere at LANL (for example at TA-48); or Option C) 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 A) relocate the capabilities and materials to a facility near the Device Assembly Facility at the Nevada Test Site; or Option B) 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 locations offsite to LANL and therefore are not evaluated in this SWEIS.

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 meters) (DOE 2002d). 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 the following resource areas, a determination was made that no further analysis was necessary: environmental justice, socioeconomics, and infrastructure.

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 currently being analyzed as part of the Radiological Sciences Complex at TA-48 (see Appendix G). The environmental consequences presented in Appendix G would present an enveloping impact for relocating the remaining Security Category III and IV operational capabilities. This is because the impacts presented in the *TA-18 Relocation EIS* for Security Category III and IV materials and capabilities included other capabilities that would not be present (such as SHEBA) at TA-48 or at LANL. 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 2002d).

The generalized land use categories within which TA-18 is located are depicted in Figure 4–4 and include the Nuclear Materials Research and Development and Reserve (LANL 2003a). 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 2003a), 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 2002d).

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 2002d).

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 2002e).

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 protect 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 are not 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 2004b). Actual emissions vary by year with the amounts of chemicals being 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. No discernible effects on air quality would be expected to result from this action.

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 Piñon (*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 2002d); 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 (LANL 2000a).

There are no wetlands located within TA-18; however, nine wetlands have been delineated within Pajarito Canyon (TA-36) just to the east (Army Corps of Engineers 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 2002d).

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).

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 Piñon-Juniper Woodland community within which TA-18 is located. Temporary noises generated from demolition activities should attenuate to below Habitat Management Plan limits (80 decibels [db]) within a short distance from the construction site. 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.

The DD&D of buildings and structures at TA-18 has the potential to disturb the Mexican spotted owl due to excess noise or light. Direct loss of habitat would not occur, since all activities would take place within developed portions of the TA. However, if DD&D were to take place during the breeding season (March 1 through August 31), owls could be disturbed and surveys would need to be conducted to determine if owls were present. If none were found, there would be no restrictions on DD&D activities. However, if owls were present, restrictions could be implemented to ensure that noise and lighting limits were met (LANL 2000b). As noted above, TA-18 would undergo restoration following DD&D. The restoration of canyon habitat would benefit the Mexican spotted owl by creating additional habitat within the buffer zones of the Threemile Canyon Area of Environmental Interest.

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 (10 *Code of Federal Regulations* [CFR] 835), with an administrative control level of 2 rem (DOE 1999d). 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 DD&D labor hours and national construction safety statistics, the DD&D of the TA-18 structures could cause on the order of 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 2002d).

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.

Waste Management

The total amount of waste generated from the disposition of the buildings and structures is estimated to be 21,774 cubic yards (16,647 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.

- **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.

Table H–1 Estimated Waste Volumes (cubic yards)

Low Specific Activity Waste	*Mixed Low-Level Waste*	*Solid* [a]	*Hazardous*	*Asbestos*
4,624	5	17,055	36	54

[a] Includes construction, demolition, and sanitary waste.
Note: To convert waste volumes to cubic meters, multiply by 0.76456.

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. The estimated mixed low-level radioactive waste volume is small and could be handled and disposed of at LANL or transported offsite for disposal at a permitted facility.

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 and disposal 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 and disposal program.

The generated solid waste could also be managed at LANL or could be transported to a local 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 54 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.

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, 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 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	0.0009	5×10^{-7}	0.0002	1×10^{-7}
Offsite disposal	Nevada Test Site	0.38	2×10^{-4}	0.08	5×10^{-5}
	Commercial Facility	0.33	2×10^{-4}	0.07	4×10^{-5}

rem = roentgen equivalent man, 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 2002d). 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	1,225	0.41	Not applicable [c]	0.0049
Nevada Test Site	1,225	1.1	4.8×10^{-8}	0.012
Commercial Facility	1,225	1.0	3.6×10^{-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 solid waste management units[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 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.

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 solid waste management units in DP West and DP East, respectively.

[2] *"Solid waste management unit" means any discernible unit at which solid waste has been placed at any time, and from which the DOE 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 at which solid wastes have been routinely and systematically released; they do not include one-time spills (NMED 2005a).*

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.

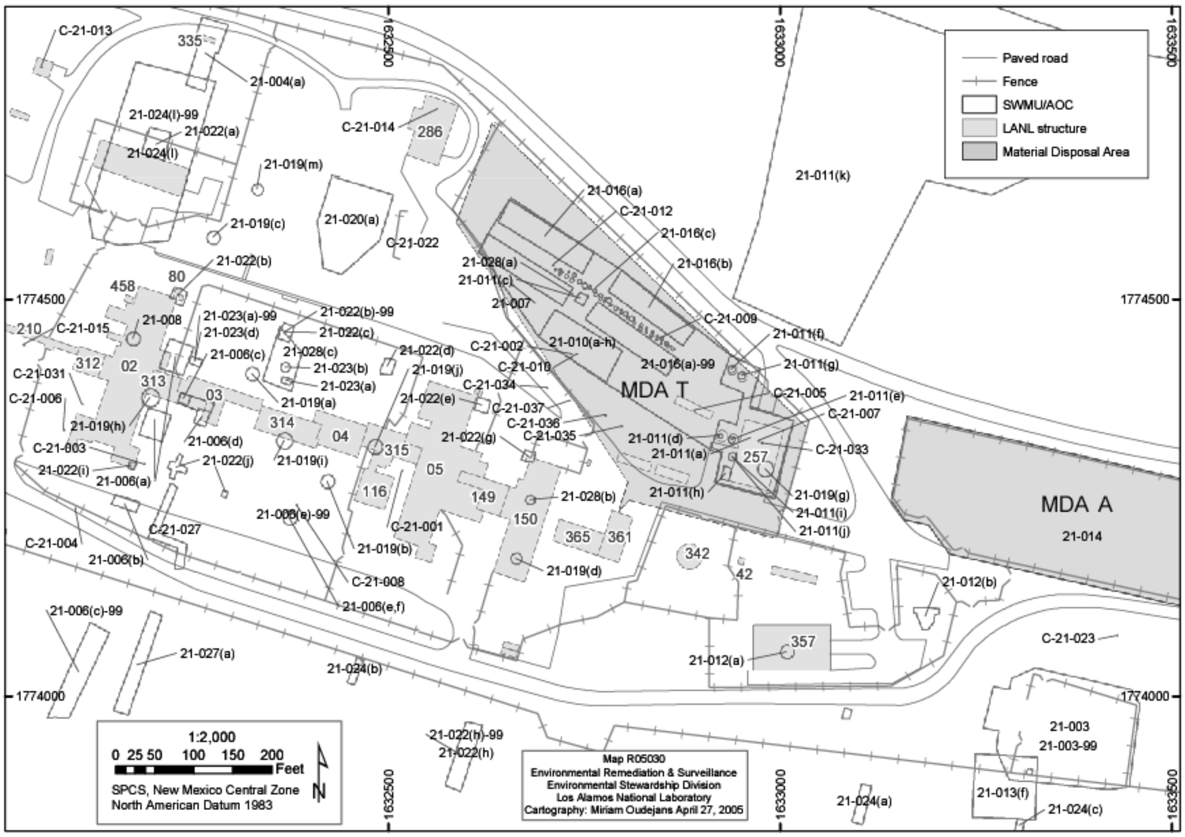


Figure H–3 Technical Area 21 Map of DP West Buildings and Solid Waste Management Units

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. Building 21-0210 is minimally contaminated and provides general office space. 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. Buildings 21-0150 and 21-210 are concrete column construction with exterior walls of concrete masonry unit construction (LANL 1999).

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 hazards to surveillance workers or environmental releases. 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

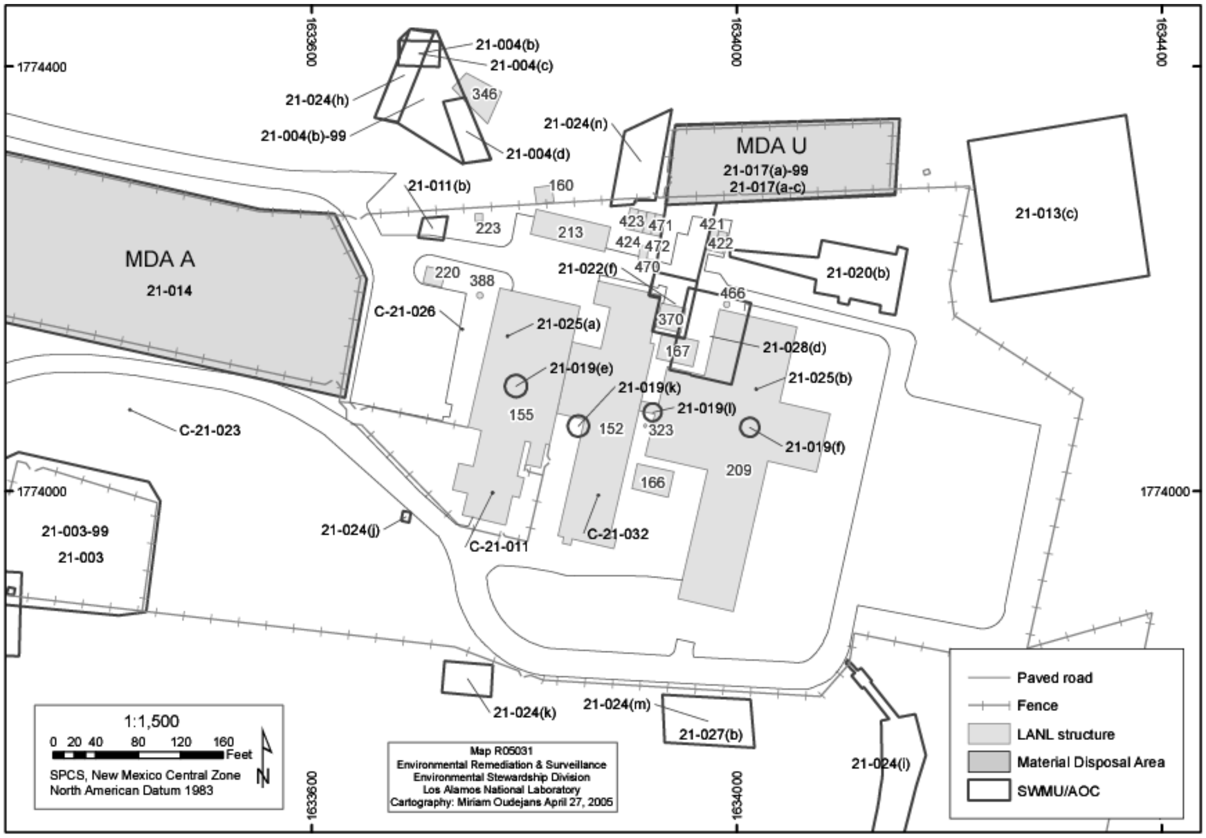


Figure H–4 Technical Area 21 Map of DP East Buildings and Solid Waste Management Units

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, provides pretreatment of liquid radioactive wastes prior to their transfer to the TA-50 Liquid Radioactive Waste Treatment Facility for final

[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.*

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 are now transported from TA-21 to TA-50 or TA-53 by truck for final treatment and disposal (LANL 2004d). Building 21-0257 would remain to support the deactivation of the DP East buildings, after which it would be deactivated. The disposition of any contaminated effluent piping would be addressed as an environmental remediation activity.

DP East buildings historically supported polonium and actinium initiator research and production, 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 that shows DP East and DP West and their relationship to the western portion of TA-21 and the Los Alamos townsite.

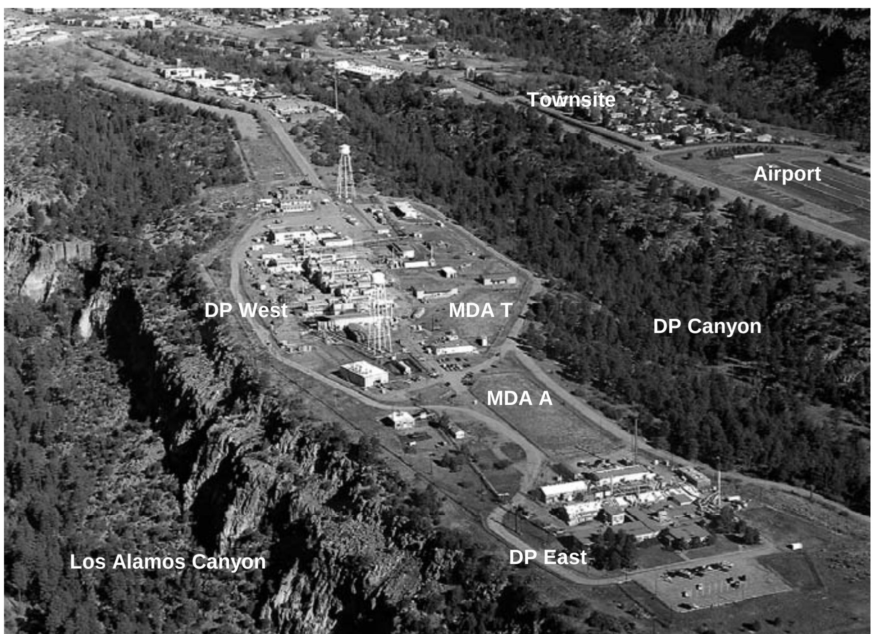


Figure H–5 Aerial Photograph of the DP East and DP West Sites, Looking West (1995)

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 starting 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 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 Building 21-0166, 21-0167, 21-0213, and 21-0370, provide mechanical equipment, exhaust filtration, and warehouse support.

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, and are currently in the final stage of operation – building deactivation – although minor mission activities are scheduled to continue through 2006. After completion of building deactivation, LANL would place the buildings into a surveillance and maintenance status pending DD&D.

The remaining active TA-21 buildings are used for administrative or logistics support (such as general offices, warehouses and maintenance shops) or are facilities that support the overall DP Site. 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 State Road 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 State Road 502 (Trinity Drive) and Diamond Drive to TA-3, or east on State Road 502 to State Highway 4. The route east on State Road 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 solid waste management units and potential release sites, NNSA would remove a number of the larger remaining TA-21 structures to allow reasonable access to nearby solid waste management units 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 solid waste management unit would need to be integrated with the DD&D schedules of the obstructing buildings. The Consent Order requires that DOE complete all corrective actions within the Los Alamos and Pueblo watershed by 2011. Building 21-0257 is collocated with MDA T, where final remedial action is scheduled in 2009 (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 or transfer parcels of land at or in the vicinity of LANL to the Incorporated County of Los Alamos or the U.S. Department of 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 six subtracts within TA-21 as shown in **Figure H–6**. One of the TA-21 subtracts, TA-21-2, contains the DP West and DP East Sites, along with other currently occupied portions of TA-21. Section 4.1.1 includes additional information about the conveyance and transfer of TA-21 and other LANL tracts (DOE 1999c). These "subtracts" include DP Road-1 (A-8), DP Road-2 (A-9), DP Road-3 (A-10), DP Road-4 (A-11), TA-21-1 (A-15-1 and A-15-2), and TA-21-2 (A-16). All of the DP Road tract (46 acres [18.6 hectares]) and approximately 7.6 acres (3 hectares) of the TA-21 tract have been, or are expected to be, conveyed to Los Alamos County. The remaining portions of the TA-21 tract (referred to as subtracts A-15-2 and A-16), about 253 acres (102 hectares), contains the DP West and DP East Sites and the majority of the areas within TA-21 that will need to be remediated under the Consent Order.

In the midst of the DP Road tract 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 east, north, and west by the DP Road tract (A-9, A-10, and A-15), and bounded on the south by the TA-21-2 tract. MDA B is located directly across DP Road from these businesses. There is the potential for deferral of the transfer of subtracts DP Road-1 and TA-21-1 until the investigation of MDA B is complete.

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 2005g).

Although the TA-21-2 subtract is currently "deferred" from transfer 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 transfer 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.

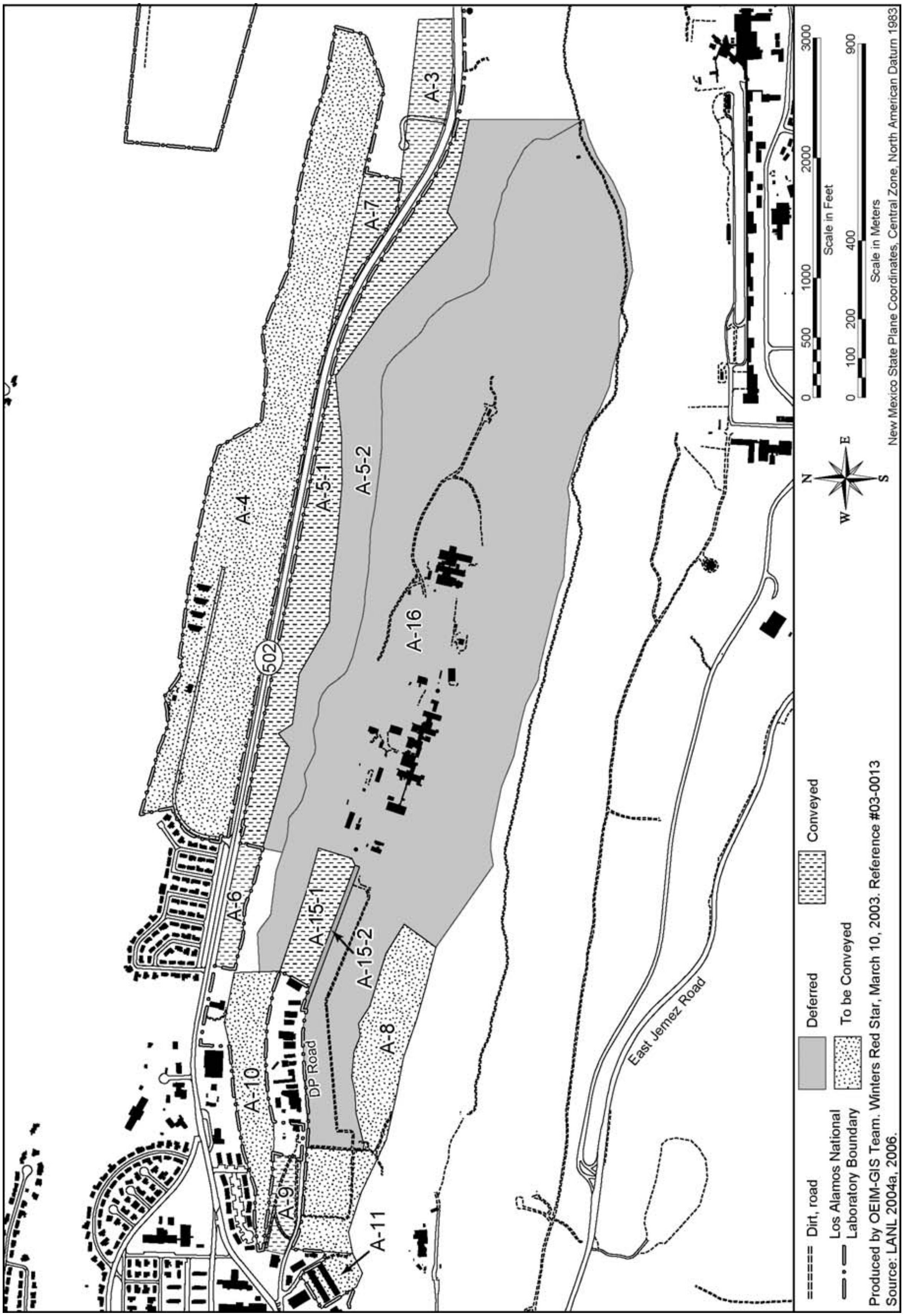


Figure H–6 Land Transfer

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 2005g). 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 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, (CT ElS)*, DOE/EIS-0293 (DOE 1999c) 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 Congress under Public Law 105-119. The transfer of TA-21 areas is considered under the *CT EIS*, including the DP Road and TA-21-1 tracts identified for transfer and development for commercial and industrial uses, and the TA-21-2 subtract, containing the DP East and DP West sites, that has been deferred. 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 2002c) analyzes the construction of a gas line that would provide natural gas to TA-53 and other LANL areas. The new line would provide 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 2005b). 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 Consent Order requires that all corrective actions within the Los Alamos and Pueblo watershed be completed by 2011.

Finally, TA-21 has been designated as an area with potential for reuse under Public Law 105-119. The area is adjacent to the Los Alamos townsite and the airport, and is not (due to residual contamination) currently planned for conveyance or transfer to either Los Alamos County or the Department of Interior in trust for the San Ildefonso Pueblo. It is, however, the subject of a substantial planning effort to identify options for reuse after remedial actions are complete.

H.2.2 Options Description

This section provides descriptions of the three options – the TA-21 Complete DD&D Option of all structures within TA-21; the Compliance Support Option, which removes structures only as necessary to support the environmental restoration activities; and the No Action Option. The TA-21 Complete DD&D Option and the Compliance Support Option support the Expanded Operations and Reduced Operations Alternatives, respectively, within the overall SWEIS (Chapter 3 of this SWEIS).

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 127 buildings and structures totaling approximately 271,000 square feet (25,177 square meters) (LANL 2006). It would generate approximately 35,000 cubic yards (26,760 cubic meters) of radioactive waste, 49,000 cubic yards (37,463 cubic meters) of nonradioactive waste, and would require on the order of 270,000 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, solid waste management units and other areas 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, since the scope of that project is to DD&D those facilities that inhibit or preclude the cleanup of solid waste management units. 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 26 buildings and structures totaling approximately 200,000 square feet (18,580 square meters). It would generate approximately 35,000 cubic yards (26,760 cubic meters) of radioactive waste, 20,000 cubic yards (15,290 cubic meters) of nonradioactive waste, and would require on the order of 240,000 person-hours of DD&D effort (LANL 2006). 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.

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
21-0210	Plutonium research
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 2006.

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 solid waste management units 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.

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 the following resource areas, a determination was made that no further analysis was necessary: environmental justice and infrastructure.

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 7.55-acre [3-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. 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 two tracts for purposes of the land conveyance, TA-21-1 (West) and TA-21-2 (East). These tracts have also been designated as A-15 and A-16, respectively (see Figure 4–6). The former parcel is 7.55 acres (3 hectares) and is 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, Service and Support, Nuclear Materials Research and Development, and Reserve (see 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 will eventually be decommissioned (LANL 2001a). Two areas within TA-21 are noted as No Development Zones (Hazard). TA-21 also includes six MDAs and numerous solid waste management units and Areas of Concern 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 deferred from conveyance to Los Alamos County (that is, the 252.1-acre [102-hectare] TA-21-2 [East] Parcel and 1.18 acre [0.5 hectare] A-15-2 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 2003a).

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 State Road 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 1999c).

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 State Route 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 averaged about 25 million gallons (95 million liters) per year over the past 5 years, representing about 5 percent of LANL usage. As the tritium mission at DP East is completed, the need for process and cooling water is expected 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 as identified in the *2004 SWEIS Yearbook* for the TA-21 facilities, the Steam Plant and the Tritium Science and Fabrication Facility (LANL 2005d).

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*	*2004 SWEIS Yearbook Actual Flow*
Tritium	02A-129	155N, 357	Steam Plant	22.01
Tritium	03A-158	209	Tritium Science and Fabrication Facility	0.09

NPDES = National Pollutant Discharge Elimination System.
Note: To convert gallons to liters, multiply by 3.785.
Source: LANL 2005d.

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 2004b).

Table H–6 Calculated Actual Emissions for Regulated Pollutants Reported to the New Mexico Environment Department for 2004

Pollutants	*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	0.012	0.12	1.33	0.09	0.03
All Other LANL	49.0	1.6	4.7	34.1	11.4	6.7
Total	50.5	1.6	4.8	35.5	11.4	6.7
Percent TA-21 Steam Plant	3.1	0.8	2.5	3.8	0.8	0.4

TA = technical area.
Note: Air emissions in tons per year (LANL 2005f).

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 2003e).

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. TA-21 has no current operations that would result in beryllium emissions, although past activities at TA-21 facilities have involved handling of beryllium materials (LANL 2005f).

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, NNSA has established an Asbestos Report Project with internal requirements defined in their Quality Assurance Project Plan, and conducts internal inspections of job sites and asbestos packaging on approximately a monthly basis (LANL 2003d, 2005f).

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**.

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 2004b). There may be a short-term increase in tritium emissions from the Tritium Systems Test Assembly and Tritium Science and the 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.

Table H–7 Technical Area 21 Radiological Point Source Emissions

Location	***Emissions Point***	***Six-year Average (1999-2004) Radionuclide Emissions (curies per year)*** [a]
21-155 (TSTA Stack)	21015505	271 (tritium) [b]
21-209 (TSFF Stack)	21020901	538 (tritium) [b]
Total		809 (tritium) [b]

TSTA = tritium systems test assembly, TSFF = Tritium Science and Fabrication Facility.
[a] Sources: LANL 2000c, 2001b, 2002c, 2003c, 2004e, 2005h.
[b] Tritium gas and tritium oxide combined.

Table H–8 Technical Area 21 Ambient Air Monitoring

Radionuclide	2004 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	1.5×10^{-13}	1.5×10^{-13}
Americium-241	-1.7×10^{-20}	1.0×10^{-20}
Plutonium-238 [b]	2.2×10^{-21}	1.5×10^{-20}
Plutonium-239 [b]	-6.2×10^{-21}	1.2×10^{-20}
Uranium-234	1.7×10^{-19}	1.9×10^{-19}
Uranium-235 [b]	-5.1×10^{-21}	1.2×10^{-20}
Uranium-238	1.3×10^{-19}	1.8×10^{-19}

TA = technical area.
[a] Source: LANL 2005h.
[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.

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 Tritium Science and the 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 (*Pinus ponderosa* P. & C. Lawson) Forest vegetation zone, the more easterly portions of Los Alamos Canyon are within the Piñon- (*Pinus edulis* Engelm.) Juniper (*Juniperus monosperma* [Engelm.] Sarg.) 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 1999c). Wildlife within undisturbed portions of the TA would be expected to be typical of those two communities. The Cerro Grande Fire (LANL 2000a) 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 (Army Corps of Engineers 2005). Los Alamos Canyon contains a perennial water source flowing a few cubic feet per second during most of the year (DOE 1999c). 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 (*Strix occidentalis lucida*) Areas 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 (*Haliaeetus leucocephalus*) or southwestern willow flycatcher (*Empidonax traillii extimus*) (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, the elimination of two NPDES-permitted outfalls nor DD&D activities would affect this resource.

Excess noise or light associated with the removal of buildings and structures at TA-21 has the potential to disturb the Mexican spotted owl. Direct loss of habitat would not occur, since all activities would take place within developed portions of the TA. However, if DD&D were to take place during the breeding season (March 1 through August 31) owls could be disturbed and surveys would need to be undertaken to determine if owls were present. If none were found, there would be no restrictions on DD&D activities. However, if owls were present, restrictions could be implemented to limit noise and lighting (LANL 2000b). Since future development is likely within TA-21, DD&D of buildings and structures would not result in a long-term change in current habitat conditions with respect to the Mexican spotted owl.

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	*Six-year Average Dose (1999-2004) (millirem per year)*	
	Dose to LANL MEI at East Gate	*Dose to Facility-Specific MEI*
21-155 (TSTA Stack)	0.0111	0.0105
21-209 (TSFF Stack)	0.0101	0.0228
Total	0.0212	0.0333

MEI = maximally exposed individual, TSTA = Tritium Systems Test Assembly, TSFF = Tritium Science and Fabrication Facility.
Sources: LANL 2000c, 2001b, 2002c, 2003c, 2004e, 2005h.

Table H–10 Radiological Doses (above background) Measured at Technical Area 21 and the East Gate Locations, Based on Ambient Air Monitoring

Radionuclides	*Six-year Average Dose (1999-2004) (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	0.0428	0.0465
Americium-241	0.00233	0.00367
Plutonium-238	0.000333	0.000667
Plutonium-239	0.000333	0.0100
Uranium-234	0.00600	0.00933
Uranium-235	0.00117	0.00167
Uranium-238	0.00783	0.0120
Total	0.0617	0.0833

TA = technical area.
Sources: LANL 2000c, 2001b, 2002c, 2003c, 2004e, 2005h.

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 5 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 modestly 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 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 maximally exposed individual during most years of the analysis has been at the East Gate along State Road 502, entering the east side of Los Alamos County. The 6-year (1999 through 2004) average dose the LANL maximally exposed individual would have received is 1.14 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 350 to 500 millirem per year based on where the individual lives). Of the dose to the LANL maximally exposed individual at the East Gate, the average portion attributed to the TA-21 facilities was minimal (0.0212 millirem per year).

In addition to the LANL maximally exposed individual, each Key Facility has a facility-specific maximally exposed individual, 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 maximally exposed individual is 0.0333 millirem per year.

The 6-year (1999 through 2004) average collective population dose attributable from all LANL operations to persons living within 50 miles (80 kilometers) of LANL was 1.02 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 2004b).

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 6-year average dose received by East Gate maximally exposed individual from current emissions from the DP East tritium facilities is 0.0212 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 maximally exposed individual 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 maximally exposed individual 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 6-year average collective total effective dose equivalent for the LANL worker population is 162 person-rem (LANL 2003a, 2004d, 2005d). 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 is 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 6-year average of 162 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 the expected DD&D labor hours and national construction accident statistics, the DD&D of the TA-21 buildings could cause on the order of 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 1999c).

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

Approximately 130 personnel are currently located in TA-21 facilities, along with additional seasonal employees or summer students. These personnel support 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 1999c]); 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 by 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 State Road 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.

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.

Due to its limited activity, TA-21 has generated relatively little waste over the past five 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 been limited to investigation and minor source removal actions; 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 2004d). 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.

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	1 to 143	Not applicable
	Average	77	3,360
Mixed Low-level Radioactive Waste (cubic yards)	Range	0 to 2	Not applicable
	Average	0.7	Not applicable
Chemical Waste (pounds)	Range	22 to 11,385	Not applicable
	Average	3,466	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, 2003b, 2004b.

Liquid sanitary wastes generated from all TA-21 facilities are treated at the TA-46 Sanitary Wastewater Systems Plant. Building 21-0257, 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 will require processing in Building 21-0257. Table H–10 provides the range and average liquid radioactive waste volumes pretreated at Building 21-0257.

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**.

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.

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	77 cubic yards	35,000 cubic yards	35,000 cubic yards
Bulk Low-level Radioactive Waste [b]	Not available	26,000 cubic yards	26,000 cubic yards
Packaged Low-level Radioactive Waste [b]	Not available	8,700 cubic yards	8,700 cubic yards
Mixed Low-level Radioactive Waste (RCRA/TSCA constituents; not radioactive asbestos is considered low-level waste)	0.7 cubic yards	65 cubic yards	65 cubic yards
Transuranic Waste [a]	0.0	1.3 cubic yards	1.3 cubic yards
Solid Waste (nonradioactive construction debris and sanitary waste)	Not available	48,000 cubic yards	19,000 cubic yards
Chemical Waste (asbestos and hazardous)	1.6 cubic yards	440 cubic yards	440 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] 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.

[b] 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 "strong-tight" or "Type A" containers.

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.

The Los Alamos County Landfill is expected to close in 2007. 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 four 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 the waste transportation would vary between about 1,000 and 1,500 trips per year for 2006 to 2010, which would average 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 latent cancer fatalities 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	9.37	0.006	2.71	0.002
	Commercial Facility	9.07	0.005	2.65	0.002

rem = roentgen equivalent man, LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes are disposed 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, c]	*Number of Shipments* [b]	*Distance Traveled (million kilometers)*	*Accident Risks*	
			Radiological (excess LCF)	*Traffic (fatalities)*
LANL TA-54	4,852	1.23	1.7×10^{-11}	0.015
Nevada Test Site	4,852	6.42	2.8×10^{-7}	0.066
Commercial Facility	4,852	5.90	2.1×10^{-7}	0.061

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 asbestos and hazardous wastes.
[c] Transuranic wastes are disposed at WIPP.

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 State Route 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 70 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. Impacts on the Mexican spotted owl, and activities to mitigate those impacts would be similar between options.

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 800 during the transfer of land under Public Law 105-119.

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 will 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. 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 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 (Area 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 and MDA 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] stored below-grade in Area G and MDA G would need to be retrieved, processed, and shipped for final disposal at the 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 Transuranic Waste Consolidation Facility in a location other than Area G and MDA 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 and newly-generated wastes.

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. NNSA expects to characterize and prepare about 353,150 cubic feet (10,000 cubic meters) of contact-handled transuranic waste for shipment. About 296,650 cubic feet (8,400 cubic meters) of this waste is located in above-ground storage units and subsurface storage units at MDA G, and about 56,500 cubic feet (1,600 cubic meters) will be newly-generated in the future from other areas within LANL. 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. Remote-handled transuranic waste is stored in 55 shafts at Area G (LANL 2005b).

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

---

[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.*

shipment as they contain almost 60 percent of the radioactive material-at-risk at Area G (LANL 2005b).

Facilities that currently support the processing and shipment of contact-handled transuranic waste to WIPP include the following:

- 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. This facility has been analyzed through NEPA (DOE 1999b).

- 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 (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 to duplicate the capabilities provided by the Waste Characterization, Reduction, and Repackaging facility. In addition, processing functions would be consolidated in one of the large domes (such as Dome 375) to increase processing efficiency and speed. 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 2002a).

Transuranic waste in below-ground storage is found in the following locations (LANL 2005b):

- 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 2002a) and the Environmental Assessment prepared for the Decontamination and Volume Reduction System (DOE 1999b), however, the retrieval and processing of transuranic waste in below-ground storage requires analysis through the NEPA process.

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 Zone 4 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 prior to this waste being shipped offsite for treatment and disposal. NNSA would continue to generate mixed low-level radioactive waste and hazardous and chemical waste.

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 2005a). 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 2005b).

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 Resource Conservation and Recovery Act (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 considered solid waste management units subject to corrective action requirements and some are disposal units subject to Resource Conservation and Recovery Act closure and post-closure care requirements. The New Mexico Environment Department, DOE, and the University of California entered into a Consent Order for corrective action on March 1, 2005, which requires closure of the affected areas (referred to as MDA L and MDA G in the corrective action program) by December 31, 2010 for MDA L and December 29, 2015 for MDA G (NMED 2005a, LANL 2005b). 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 related Supplement Analysis of the *1999 SWEIS*. Retrieval and processing of the transuranic waste stored below-ground in trenches, pits and shafts, however, needs to be analyzed under NEPA 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 will 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.

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.

H.3.2.1 No Action Option

In this option, no new action would be taken. 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. Specifically, the following would occur:

- Contact-handled transuranic waste stored at Area G in fabric domes would be retrieved and processed using existing facilities (that is, the Decontamination and Volume Reduction System, Waste Characterization, Reduction, and Repackaging facility, and Radioassay and Nondestructive Testing facility), and modular units.

- All 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 (that is, 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.

- 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

For 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 – 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. 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. 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 2006).

NNSA would construct a remote-handled transuranic waste retrieval facility on the following schedule (LANL 2005b):

- Plan: start by 4/3/2006; complete by 9/26/2007.
- Design: start by 10/1/2007; complete by 9/30/2009.
- Build: start by 10/1/2009; complete and become operational by 9/30/2011.

The remote-handled transuranic waste retrieval facility 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 would remain in the ground to be incorporated into the Area G and MDA G closure.

H.3.2.2.2 Transuranic Waste Consolidation Facility

Operations at LANL would 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.
- Offsite Source Recovery Project.

A new Transuranic Waste Consolidation Facility would therefore be needed to replace current capabilities at Area G for storing, processing, and shipping newly generated transuranic waste. Based on pre-conceptual analysis, the Transuranic Waste Consolidation Facility would be sized for a throughput of up to 1,000 drum equivalents per year, plus approximately 600 cubic feet (17 cubic meters) large items (such as gloveboxes) per year. An additional contingency capacity of 500 drum equivalents per year is being considered to accommodate fluctuations throughout the waste management chain from LANL to WIPP. The facility (which may be comprised of 2 to 4 separate buildings) would be approximately 30,000 to 40,000 square feet (2,790 to 3,720 square meters) and would require a 2 to 4 acre (1.2 to 1.6 hectare) site (Vance 2005).

The facility would accommodate the following functions (LANL 2006):

- 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 10,000 square feet (930 square meters).
- Decontamination and Size Reduction consisting of approximately 5,000 square feet (465 square meters).
- Utilities and Support (including office and technical support space) consisting of approximately 5,000 square feet (465 square meters).
- Shipping (for example, TRUPACT II loading operations) consisting of approximately 5,000 square feet (465 square meters).

It is anticipated that 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 Transuranic Waste Consolidation Facility would contain systems similar to the Perma-Con® containment system (NFS 2005) to enclose a waste staging area, waste characterization equipment, decontamination equipment, or other associated systems. 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.[6]

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.

NNSA is evaluating two sites for constructing and operating the facility. These include a site at TA-50 (adjacent to the intersection of Pajarito Road and Pecos Road) and a site near TA-63 (at the intersection of Pajarito Road and Puye Road). Both sites are between 2 and 4 acres (0.8 and 1.6 hectares) and are relatively close to TA-55, the facility that generates the majority of the transuranic waste at LANL. Other sites would be considered if these two sites are found to be unsuitable during conceptual design development.

Design of the Transuranic Waste Consolidation Facility would begin in 2008, with construction commencing in 2010. A permit modification request would be submitted to the New Mexico Environment Department in 2009, which would need to be approved prior to construction. Startup would occur in late 2011 and operations would commence in 2012 (LANL 2005b). The facility would have a design life of 30 to 35 years.

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 and would be consolidated in one of the large domes (such as Dome 375). The additional equipment and facilities include the following (LANL 2005b):

- 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.

[6] *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.*

- 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.
- MART washers re-installation 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 2005b):[7]

- 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 Characterization, Reduction, and Repackaging facility; and modular units.
- 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.

[7] 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.

- 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 prepackaged at the Decontamination and Volume Reduction System, 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 2005b):

- An access control and monitoring building (Building 54-0295).
- 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 duplicated in the new structures and processes 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 2006).

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 2006):

- 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 (that is, workers that are 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 2005b). 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 2006):

- 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 2006). The building would be operational by 2010 (LANL 2005b).

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 2006):

- 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 2006). The compactor would be operational by 2011 (LANL 2005b).

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 2005b.

Using a single closure cover, NNSA would undertake the following actions (LANL 2005b):

- 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.

LANL would continue to consolidate mixed low-level radioactive waste storage operations 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 is 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 2005b). 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 the Consolidated Remote Waste Storage Site project, which has established locations across the LANL site as hazardous waste collection and consolidation sites. Hazardous wastes can be stored up to 90 days at these sites before direct shipment off-site for treatment and disposal. These sites currently handle the majority of hazardous and chemical wastes. For periods when waste generation exceeds the capacity of the smaller waste collection points, NNSA uses Dome 282 in TA-54, Area J, near the Radioassay and Nondestructive Testing facility for overflow from other locations. 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 in Area G to another location outside of Area G to be stored until processed and shipped. NNSA would construct two additional storage structures at the Transuranic Waste Consolidation Facility or another location for storage of legacy transuranic wastes. This option considers that transuranic waste currently stored in Pit 9 and 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 is combined with the Transuranic Waste Consolidation Facility, since the Transuranic Waste Consolidation 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: LANL staff would leave the high-activity remote-handled transuranic waste in Shafts 200-232 in place in the shafts in Area G and MDA G (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. Leaving the higher activity remote-handled transuranic waste in place is contingent on whether the New Mexico Environment Department would require all radioactive wastes to be removed from MDA G. The New Mexico Environment Department is expected to make this decision by December 18, 2007 (NMED 2005a).

Option 2c: Mixed low-level radioactive waste and hazardous and chemical waste would be stored at the Transuranic Waste Consolidation Facility and the use of Area L would cease for these operations. LANL would continue to manage hazardous and chemical wastes through other sites in the Consolidated Remote Waste Storage Site project and would obtain a RCRA permit for the Transuranic Waste Consolidation Facility for storing hazardous wastes for periods greater than 90 days.

H.3.2.4 Options Considered but Eliminated

NNSA considered but eliminated several options associated with the management of transuranic wastes. The following presents these options and the reasons they were eliminated from further consideration.

Locate the Transuranic Waste Consolidation 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 (Vance 2005).

This option was eliminated from further consideration because (Vance 2005):

- The limited space in the Radioactive Materials Research, Operations and Demonstration Facility and perhaps less than optimum configuration of its floor space may not allow accommodation of all of the intended transuranic waste management functions.

- Road closures would be required.

Use a Vendor for Transuranic Waste Management Services

In this option, NNSA (or the DOE Carlsbad Field Office) would contract with a commercial vendor for characterization, certification, packaging and shipping responsibilities. The vendor would provide a certified program and NNSA would provide the equipment and facilities for headspace gas sampling and analysis, non-destructive analysis, real-time radiography, visual examination, repackaging, and TRUPACT II loading and shipping. The activities would be located at TA-54 West near the Radioassay and Nondestructive Testing facility. NNSA would also be responsible for transuranic waste storage and movement. Audits would be performed during the drum processing campaigns. Use of a vendor could be more cost-effective if transuranic waste processing could occur on a campaign-basis as opposed to continuously (Vance 2005).

This option was eliminated because:

- Road closures would still be required on Pajarito Road from TA-55 to TA-54.
- A storage and decontamination and size reduction facility would still need to be constructed at TA-54 West.
- If transuranic waste needs to be processed continuously throughout the year, then the cost-effectiveness of this option becomes questionable since the cost advantage is achieved through processing in campaigns (or batches).
- NNSA personnel, equipment, and facilities are still required to support this option, therefore requiring significant indirect costs.
- The facility would need RCRA permitting.

Locate the Transuranic Waste Consolidation Facility in TA-54 West

In this option, a new structure would be built at TA-54 West that would contain the decontamination and size reduction functions. Nondestructive analysis and real-time radiography activities would be conducted at TA-55 in existing facilities. Loading and shipping activities would remain at the Radioassay and Nondestructive Testing facility, which is also located in TA-54 West. A modular unit may be required for any routine visual examination and repackaging activities (Vance 2005).

This option was eliminated because road closures between TA-55 and TA-54 West would still be required.

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: environmental justice and socioeconomics.

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-63 is 50 acres (20 hectares) in size and is located along Pajarito Road approximately 1.5 miles (2.4 kilometers) southeast of TA-3. Current land used designations include Physical and Technical Support and Reserve; however, future land use would see most of the site dedicated to Waste Management with the exception of two small areas along the northern and eastern border which would remain Reserve (LANL 2003a). TA-63 is located within the Pajarito Corridor West Planning Area as set forth in the *Comprehensive Site Plan* for 2001. According to the Plan much of the site is designated as Secondary Development with remaining areas being Potential Infill. The proposed site of the Transuranic Waste Consolidation Facility is within an area designated as Potential Infill (LANL 2001a).

TA-50 is 62 acres (25 hectares) in size. It is 1.3 miles (2.1 kilometers) southeast of TA-3 along Pajarito Road. Current land use designations include Waste Management and Reserve. Only that portion of the TA located north of Pajarito Road 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 2003a). TA-50 is within the Pajarito Corridor West Planning Area as set forth in the *Comprehensive Site Plan* for 2001. The potential area within which the Transuranic Waste Consolidation Facility could be located is designated as Potential Infill (LANL 2001a).

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, which is where the additional transuranic waste processing equipment and facilities (including the remote-handled transuranic waste retrieval facility) would be located. 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 2003a). 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).

Construction, DD&D, and Operations Impacts—All actions within TA-54, including construction of a remote-handled transuranic waste retrieval facility; removal of the white 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 of Zone 4 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 Transuranic Waste Consolidation Facility would be required under this option. The specific location of this facility has not been selected but it could be built as a new structure occupying 2 to 4 acres (0.8 to 1.6 hectares) at TA-50 adjacent to the intersection of Pajarito Road and Pecos Road), or at a site near TA-63 at the intersection of Pajarito Road and Puye Road. Both sites are relatively close to TA-55, where the majority of the transuranic waste is generated. There would be no impact on land use if the new building were built in either TA-50 or TA-63 since future land use within both proposed construction sites has been designated Waste Management. Both areas are also designated as Potential Infill in the *Comprehensive Site Plan* for 2001 (LANL 2001a).

Visual Environment

Although TA-63 is included within a series of highly developed TAs along the upper portion of Pajarito Road, little development has taken place within its boundaries. Those portions of the TA located adjacent to the road are generally open fields. Areas to the north of Puye Road are wooded and include a portion of Mortandad Canyon. Views of the area from Pajarito Road are available only to site personnel due to the closure of Pajarito Road to the public. Distant views from higher elevations to the west would be of an open area with the intersection of Pajarito and Puye Roads helping to define the location of the site. The area within which the Transuranic Waste Consolidation Facility could be constructed presents an open appearance with a few scattered trees.

TA-50 is located along Pajarito Road. TA-50 is one of a series of TAs along the upper 2.7 miles (4.3 kilometers) of the road within which development has taken place. TA-50 itself includes portions of the mesa and Mortandad Canyon. Development has occurred on that part of the site that is north of Pajarito Road with most of area south of the road remaining forested. Although near views of TA-50 are industrial in nature, they are available only to site personnel due to the closure of Pajarito Road to the public. From a distance, the TA appears as part of the highly developed corridor along the upper portion of Pajarito Road. That portion of the TA within which the Transuranic Waste Consolidation Facility could be constructed is presently an open field.

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 white-colored domes of MDA G 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 2004a). 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 white-colored domes at MDA G would have a beneficial impact on both near and distant views.

The Transuranic Waste Consolidation Facility could be located at TA-50 adjacent to the intersection of Pajarito Road and Pecos Road, or at a site near TA-63 at the intersection of Pajarito Road and Puye Road. Construction of the new facility within undeveloped areas of either TA-50 or TA-63 would alter the generally open view. Construction would cause temporary impacts on visual resources due to the presence of equipment and dust during construction. However, since Pajarito Road is not open to the public and dust generation would be controlled using best management practices, offsite impacts would be negligible. Once complete, near views of the Transuranic Waste Consolidation Facility would only be available to employees since Pajarito Road is not open to the public. Further, there would be little impact to the viewshed from higher elevations to the west due to the highly developed nature of LANL along Pajarito Road.

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. TA-50 and TA-63 are 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 TA-63 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 Section 4.2, 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 Transuranic Waste Consolidation Facility to be constructed near either TA-50 or TA-63, 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 Transuranic Waste Consolidation 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. This would include the consolidation of transuranic waste processing equipment into a dome such as Dome 375 from outdoor areas.

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 in TA-50, TA-63 and TA-54 so neither option will have any impact on geological resources (Stephens and Associates 2005). All proposed new facilities would be designed according to their seismic design safety basis.

It is anticipated that the new remote-handled transuranic waste retrieval facility and Transuranic Waste Consolidation Facility would be Performance Category 3 facilities while the characterization and verification and compactor buildings would be Performance Category 2 facilities. 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 420.1A (DOE 2002b) 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 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.

TA-50, located at the head of Ten Site Canyon, and TA-63, located on a finger mesa between Mortandad Canyon and Ten Site Canyon, is 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 Transuranic Waste Consolidation 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 Transuranic Waste Consolidation 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 through 2011, nor will 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 Transuranic Waste Consolidation Facility would direct any unexpected liquids to a sump for recovery, treatment, and proper disposal. Regardless of where the Transuranic Waste Consolidation Facility is located, that site would need to 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–16** 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–16 Nonradiological Air Pollutant Emissions at Solid Radioactive and Chemical Waste Management Key Facility – 2004

Pollutant	*Tons per Year*
Ethanol	0.00122
Hydrogen chloride	0.36171
Nitric acid	0.01354
Potassium hydroxide	0.00303
Propane	0.00
Sulfuric Acid	0.23839

Note: To convert tons to kilograms, multiply by 907.18.
Source: LANL 2005d.

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 Transuranic Waste Consolidation 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 of other facilities in the general areas at TA-50, TA-63 and TA-54 has indicated 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 Transuranic Waste Consolidation Facility, would be assumed to emit radiological air emissions equivalent to the Decontamination and Volume Reduction System. **Table H–17** summarizes the annual air emissions to be expected from each of these three facilities.

Table H–17 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: Appendix C of the *Consolidation EIS*.

The radiological air emissions for the Decontamination and Volume Reduction System would continue until approximately 2015. The radiological air emissions for 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 for the Transuranic Waste Consolidation Facility, which may be located in TA-50 or TA-63, would occur starting in 2012 and continue for the next 30 to 35 years.

Radiological air emissions from area sources in TA-54 are expected to continue at current rates until 2016, after which time there should be some decrease because of closure of MDA G. The primary radionuclide in area air emissions is tritium, with approximately 60.9 curies per year projected to be released (see Appendix C).

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–16 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 to 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-63 is within the Ponderosa Pine (*Pinus ponderosa* P. & C. Lawson) Forest vegetation zone. Those areas of the site along Pajarito Road are generally open field, with little development, while portions of the site located within Mortandad Canyon are forested. Wildlife use of the site would be typical of ponderosa pine forests, although some species could avoid open areas near roadways (DOE 1999a). During the Cerro Grande Fire the entire area was burned at a low, unburned severity level (LANL 2000a). There are no wetlands present within TA-63 (Army Corps of Engineers 2005).

TA-63 is within both the core and buffer zone of the Pajarito Canyon Mexican spotted owl (*Strix occidentalis lucida*) Area of Environmental Interest and the buffer zone of the Sandia-Mortandad Canyon Area of Environmental Interest. That portion of the TA within which the Transuranic Waste Consolidation Facility could be located is in the buffer zone of both Areas of

Environmental Interest. TA-63 does not include portions of the Areas of Environmental Interest for the bald eagle (*Haliaeetus leucocephalus*) or southwestern willow flycatcher (*Empidonax traillii extimus*) (LANL 2000b).

TA-50 lies within the Ponderosa Pine Forest vegetation zone. While 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 was also burned at a low, unburned severity level (LANL 2000a). Wildlife present within undeveloped portions of the area would be expected to be typical of ponderosa pine forests (DOE 1999a). There are no wetlands or aquatic resources present within TA-50 (Army Corps of Engineers 2005).

TA-50 falls within both the core and buffer zone of the Pajarito Canyon Mexican spotted owl Area of Environmental Interest and the buffer zone of the Sandia-Mortandad Canyon Area of Environmental Interest. Those portions of the site within which the Transuranic Waste Consolidation Facility could be located are in the buffer zone of both Areas of Environmental Interests; however, potential sites north of Pajarito Road are within developed areas. TA-50 does not include portions of Areas of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000b).

TA-54 is largely located within the Piñon (*Pinus edulis* Engelm.)-Juniper (*Juniperus monosperma* [Engelm.] Sarg.) Woodland vegetation zone; however, the western most 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 (LANL 2000a). 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) (Army Corps of Engineers 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).

Construction, DD&D and Operational Impacts—Under Option 1, all actions within TA-54, including new construction expansion of 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 impact on ecological resources. Further, the TA does not fall within Areas of Environmental Interest for the Mexican spotted owl or bald eagle. While it does include a portion of the southwestern willow flycatcher Area of Environmental Interest along its southern boundary, best management practices should prevent stormwater actions associated with work in Areas G and L from impacting willow flycatcher habitat. If closure activities were to take place during the breeding season (May 15 through September 15), southwestern willow flycatchers could be disturbed and surveys would need to be undertaken to determine if flycatchers were present. If none were found, there would be no restrictions on project activities. However, if they were present, restrictions could be implemented to ensure that noise and lighting limits were met (LANL 2000b**)**.

Construction of the Transuranic Waste Consolidation Facility within TA-50 would disturb 2 to 4 acres (0.8 to 1.6 hectares) of generally open field containing some ponderosa pine trees, while construction within TA-63 would involve disturbance to the same acreage of open field. During construction, ground disturbing activities could result in the loss of less mobile species and the displacement of other more mobile animals. Also during construction, noise and human presence could disturb animals living in adjacent areas. Such disturbance would be temporary and could be mitigated by keeping workers within the designated construction zone and properly maintaining equipment. Impacts to wetlands and aquatic resources would not be expected within either TA-50 or TA-63 since none are found in either TA. Operation of the Transuranic Waste Consolidation Facility would not impact ecological resources.

Portions of TA-50 and TA-63 fall within the Sandia-Mortandad Canyon and Pajarito Canyon Mexican spotted owl Areas of Environmental Interest. Both potential sites for the Transuranic Waste Consolidation Facility are located within the buffer zone of the Areas of Environmental Interest. While direct impacts would not be expected, construction has the potential to disturb the spotted owl due to excess noise or light. If construction were to take place during the breeding season (March 1 through August 31), owls could be disturbed and surveys would need to be undertaken to determine if they were present. If none were found there would be no restrictions on construction activities. However, if they were present restrictions could be implemented to ensure that noise and lighting limits were met. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any part of TA-50 or TA-63; thus, these species also would not be adversely affected by the new facility.

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 TA-50 and TA-54 since the majority of waste management facilities are located in these two areas. There are currently no major waste management operations in TA-63.

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–18 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–18 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–18 Potential Radiation Dose from Current Technical Area 54 Operations

Source	***Dose to the Facility-Specific Maximum Exposed Individual (millirem per year)***	***Latent Cancer Fatality 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, rem = roentgen equivalent man.

The 6-year average (1999 to 2004) collective total effective dose equivalent for the LANL worker population was 162 person-rem (LANL 2003a, 2005d). In general, determining the collective total effective dose equivalent for each Key Facility or technical area is difficult to determine because this data is 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 163 millirem. Approximately 20 percent of the waste management operations personnel obtain measurable dose (DOE 2005a). 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 2005e). 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 2005e). These radiation levels contribute to a radiation dose ranging from 42 to 729 millirem per quarter over the last 10 quarters reported 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 2005e).

Construction, DD&D and Operational Impacts—As 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 Transuranic Waste Consolidation Facility. It is assumed that the remote-handled transuranic waste retrieval facility and the Transuranic Waste Consolidation Facility would be designed such that radiological releases would not exceed the releases that are documented from the Decontamination and Volume Reduction System.[8] 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 2015. The Transuranic Waste Consolidation Facility, located in TA-50 or TA-63, could incur a radiological dose to the facility-specific maximally exposed individual of approximately 0.0018 millirem per year beginning in 2012 and lasting for about 30 years. The facility-specific (TA-50) maximum exposed individual is assumed to be located at the Royal Crest Trailer park. The radiological dose to the facility-specific maximum exposed individual is higher from facilities in TA-54 than TA-50 and TA-63 because TA-54 has a smaller distance to the maximum exposed individual location. The impact of the Transuranic Waste Consolidation 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 0.0005 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 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 (0.0122 person-rem per year) if these facilities are operated in TA-54. If the Transuranic Waste Consolidation Facility is located in TA-50 or TA-63, then the Transuranic Waste Consolidation Facility would contribute approximately 0.00812 person-rem per year to the population, assuming emissions are the same as those from the Decontamination and Volume Reduction System.

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

[8] *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.*

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 2002a). Waste management workers would be expected to maintain current exposure levels because of these administrative controls.

For nonradiological impacts, approximately 3 recordable injuries may occur for performing DD&D activities in TA-54 (which includes Areas L and G) using national safety statistics. 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 safety statistics for LANL, approximately 3 recordable injuries may occur during construction of the low-level radioactive facilities, the Transuranic Waste Consolidation 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

TA-63 contains two cultural resource sites which have been identified as a wagon road and historic artifact scatter; both are associated with the Homestead Period. The former is eligible for listing on the National Register of Historic Places while the latter is not. Neither site is located adjacent to the proposed site of the Transuranic Waste Consolidation Facility. TA-50 contained one cultural resource site which has been excavated.

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 white colored 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.

For the Transuranic Waste Consolidation Facility, direct impacts to the cultural resources at TA-50 would not occur since the site once located in this TA has been excavated. Direct impacts at TA-63 are unlikely since the location of the Transuranic Consolidation Facility does not coincide with any of the identified cultural resource sites at either TA. Indirect impacts are also unlikely since cultural resources are located at least 600 feet (180 meters) from the potential facility sites.

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-50 and TA-54. However, removal of the white-colored fabric domes at TA-54 would have a positive impact on views from Pueblo of San Ildefonso lands which border the TA to the north.

Infrastructure

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 203,000 gallons (768,439 liters) of liquid fuels (diesel and gasoline) would be consumed for site work mainly for use by heavy equipment and 220,000 gallons (832,791 liters) 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 approximate 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 easily 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 Transuranic Waste Consolidation Facility do not have energy-intensive operations.

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 2004a). 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–19**.

Table H–19 Waste Generation Ranges and Annual Average Generation Rates for the Solid Radioactive and Chemical Waste Facilities

Waste Type	*Rates for the Period 1999 to 2004*	
Low-level Radioactive Waste (cubic yards)	Range	17 to 267
	Average	72
Mixed Low-level Radioactive Waste (cubic yards)	Range	0 to 0
	Average	0
Transuranic Waste (cubic yards)	Range	0 to 115
	Average	42
Mixed Transuranic Waste (cubic yards)	Range	0 to 77
	Average	21
Chemical Waste (pounds)	Range	66 to 2,638
	Average	1,527

Notes: The Solid Radioactive and Chemical Waste Facilities data was compiled jointly for waste management facilities at both TA-54 and TA-50. Only activities within TA-54 will be affected by the proposed 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 2003a, 2004d, 2005d.

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 240 cubic yards (183 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–20**.

Table H–20 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*
22,594	7,531	8	54,099	62	529

[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 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 New Mexico 502; from Española – New Mexico 30 to New Mexico 502; and from Jemez Springs and western communities – New Mexico 4. Hazardous and radioactive material shipments leave or enter LANL from East Jemez Road to New Mexico 4 to New Mexico 502. Only two major roads, New Mexico 502 and New Mexico 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 New Mexico 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–21 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–21 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 Transuranic Waste Consolidation 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 (2009 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 latent cancer fatalities in **Table H–22**. 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 latent cancer fatalities 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–22, disposal offsite would lead to a higher dose and risk than disposal onsite.

Table H–22 Incident-Free Transportation Impacts – Waste Management Facility Transition Decontamination, Decommissioning and Demolition Activities

Disposal Option	*Low-level Radiation 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	5×10^{-3}	2	1×10^{-3}
	Commercial Facility	8	5×10^{-3}	2	1×10^{-3}

rem = roentgen equivalent man, LCF = latent cancer fatality, TA = technical area.
[a] Transuranic wastes are disposed at WIPP.
Note that the number of shipments is based on DD&D of all above-ground facilities in TA-54, Areas G and L and only includes radioactive waste shipments. For Option 1, a few facilities in Area L would remain, such as the mixed low-level radioactive waste storage dome, some hazardous and chemical waste storage facilities, and administrative facilities, but these remaining facilities do not significantly contribute to the radioactive waste streams for DD&D and the values in this table reasonably reflect potential impacts for Option 1. In Option 2, all above-ground facilities in TA-54, Areas G and L would undergo DD&D.

Table H–23 presents the impacts from traffic and radiological accidents. This table provides population risks in terms of fatalities anticipated due to traffic accidents from both the collision and excess LCFs from exposure to releases of radioactivity. 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 likely to occur from the activities during DD&D activities in TA-54.

Table H–23 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	4,856	1.3	NA [d]	0.02
Nevada Test Site	4,856	5.9	2×10^{-7}	0.06
Commercial Facility	4,856	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 at WIPP.
[d] No traffic accident leading to releases of radioactivity for onsite transportation is hypothesized.
Note that 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, along with a small mixed low-level radioactive waste storage area and administrative facilities, but these remaining facilities do not significantly contribute to the radioactive waste streams for DD&D and the values in this table reasonably reflect potential impacts for Option 1. In Option 2, all aboveground facilities in TA-54, Areas G and L would undergo DD&D.
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, that 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 Transuranic Waste Consolidation Facility may be located in the TA-50 or TA-63 area. 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 since the Transuranic Waste Consolidation 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, as the transportation pattern as currently observed 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 2005b). 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 explosion during waste removal from MDA-G provided in Appendix I.

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 maximally exposed individual (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 shaft 206.

Also for Option 1, the Transuranic Waste Consolidation Facility, which may be located in either TA-50 or 63, was analyzed for an accident scenario in which a seismic event occurs and the radiological contents 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 Transuranic Waste Consolidation Facility would be similar to current operations at the Decontamination and Volume Reduction System.

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 Transuranic Waste Consolidation Facility. The Transuranic Waste Consolidation Facility may be located in either TA-50 or 63. A site at the intersection of TA-50, TA-63, and Pajarito Road was chosen to represent the location of this new facility in these two adjacent technical areas; the MEI would then be located at the Royal Crest Trailer Park, approximately 4,720 feet (1,440 meters) to the north.

Two analyses were performed which bound the processing and storage of transuranic waste in Option 2a. 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 Transuranic Waste Consolidation 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 2a 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–24 shows the source information used to calculate impacts to the workers and public from these three additional accident scenarios. **Tables H–25, H–26, and H–27** present the associated impacts.

Table H–24 Alternative Site Seismic 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 Transuranic Waste Consolidation 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
Scenario Name: Seismic Event Releasing CH-TRU from Two Storage Buildings at the Transuranic Waste Consolidation 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

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?
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 Transuranic Waste Consolidation 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 = materials 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–25 Alternative Site Seismic Radiological Accident Consequences

Accident Scenario	Maximally Exposed Individual		Population to 50 miles	
	Dose (rem)	Latent Cancer Fatality [a]	Dose (person-rem)	Latent Cancer Fatalities [b, c]
Explosion at MDA-G RH-TRU Shaft 205	0.325	0.000195	13.5	0.0081
Explosion at MDA-G RH-TRU Shaft 206	0.747	0.000448	14.5	0.0087
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at Transuranic Waste Consolidation Facility Location	0.0378	0.0000227	11.5	0.0069
Seismic Event Releasing Transuranic Waste from the Transuranic Waste Consolidation Facility Assuming Equivalent to DVRS Operations	2.13	0.00128	600	0.360
Seismic Event Releasing CH-TRU from Two Storage Buildings at the Transuranic Waste Consolidation Facility Location	28.8	0.0346	3700	2.22

rem = roentgen equivalent man, MDA = material disposal area, RH-TRU = remote-handled transuranic, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic.

[a] Increased risk of a latent cancer fatality to an individual, assuming the accident occurs.

[b] Increased number of latent cancer fatalities for the population, assuming the accident occurs.

[c] Offsite population size out to a 50-mile radius is approximately 302,000 (TWCF), 343,000 (MDA-G).

Table H–26 Alternative Site Seismic Radiological Accident Onsite Worker Consequences

Accident Scenario	Non-involved Worker (at 100 meters)	
	Dose (rem)	Latent Cancer Fatality [a]
Explosion at MDA-G RH-TRU Shaft 205	2.38	0.00143
Explosion at MDA-G RH-TRU Shaft 206	5.48	0.00329
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at Transuranic Waste Consolidation Facility Location	2.37	0.00142
Seismic Event Releasing Transuranic Waste from the Transuranic Waste Consolidation Facility Assuming Equivalent to DVRS Operations	132	0.158
Seismic Event Releasing CH-TRU from Two Storage Buildings at the Transuranic Waste Consolidation Facility Location	1820	2.18

rem = roentgen equivalent man, MDA = material disposal area, RH-TRU = remote-handled transuranic, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic.

[a] Increased risk of latent cancer fatality to an individual, assuming the accident occurs.

Table H–27 Alternative Site Radiological Accident Offsite Population and Worker Risks

Accident Scenario	Onsite Worker	Offsite Population	
	Non-involved Worker (at 100 meters) [a]	Maximally Exposed Individual [a]	Population to 50 Miles [b, c]
Explosion at MDA-G RH-TRU Shaft 205	1.43×10^{-6}	1.95×10^{-7}	8.10×10^{-6}
Explosion at MDA-G RH-TRU Shaft 206	3.29×10^{-6}	4.48×10^{-7}	8.70×10^{-6}
Seismic Event Releasing Entire RH-TRU Inventory from Two Storage Buildings at Transuranic Waste Consolidation Facility Location	7.11×10^{-7}	1.13×10^{-8}	3.45×10^{-6}
Seismic Event Releasing Transuranic Waste from the Transuranic Waste Consolidation Facility Assuming Equivalent to DVRS Operations	0.0000792	6.39×10^{-7}	0.000180
Seismic Event Releasing CH-TRU from Two Storage Buildings at the Transuranic Waste Consolidation Facility Location	0.00109	0.0000173	0.00111

MDA = material disposal area, RH-TRU = remote-handled transuranic, DVRS = Decontamination and Volume Reduction System, CH-TRU = contact-handled transuranic.
[a] Increased risk of a latent cancer fatality to an individual per year.
[b] Increased number of latent cancer fatalities for the population per year.
[c] Offsite population size out to a 50-mile radius is approximately 302,000 (TWCF), 343,000 (MDA-G).

Based on Table H–27, 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 Transuranic Waste Consolidation Facility are less than those that would result from the release of contact-handled transuranic waste from the Transuranic Waste Consolidation Facility. The impacts from the latter are less than those that could occur at TA-54 from current operations. The population dose is approximately one-half that at TA-54 from current operations, mainly as a result of locating only two domes at the alternative location versus the eleven domes at TA-54. 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 met tower for the alternative site, TA-54 met tower at TA-54) and the smaller dome inventory.

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

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 Transuranic Waste Consolidation Facility or be separate from it, but at one of the same locations being considered for the Transuranic Waste Consolidation Facility. In Option 2c, mixed low-level radioactive waste and hazardous and chemical waste storage would also be provided at the Transuranic Waste Consolidation 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 2002b).

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 Transuranic Waste Consolidation 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 Transuranic Waste Consolidation 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 420.1A (DOE 2002b) 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 Transuranic Waste Consolidation 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, nor will groundwater resources 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 since 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 since 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 Transuranic Waste Consolidation 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 2002a).

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.

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. Electrical energy demands for new facility construction are projected to total about 235 megawatt-hours. Approximately 429,000 gallons (1.6 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work mainly for use by heavy equipment and 466,000 gallons (1.7 million liters) 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 approximate 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 (an additional 260 cubic yards [200 cubic meters]) 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 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 Transuranic Waste Consolidation 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 Transuranic Waste Consolidation Facility, then additional shipments would need to occur to move the transuranic waste from the storage buildings to the Transuranic Waste Consolidation 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

In Option 2a, an accident scenario would involve a fire that would cause the release of all of the contents in the two transuranic waste storage buildings that would be constructed to store transuranic waste that could not be shipped for disposal in a timely manner that would allow closure activities in Area G and MDA G to be completed. These two storage buildings would be located in the TA-50 or TA-63 areas. The accident results presented for Option 1 are applicable to this option.

H.4 References

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*, 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, *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), 1999d, *DOE Standard, Radiological Control*, DOE-STD-1098-99, Washington, DC, October.

DOE (U.S. Department of Energy), 2001, DOE Order 435.1, Change 1, *Radioactive Waste Management,* Office of Environmental Management, Washington, DC, August 28.

DOE (U.S. Department of Energy), 2002a, *Supplement Analysis, Site-Wide Environmental Impact Statement for Continued Operation of the 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), 2002b, DOE Order 420.1A, *Facility Safety*, Office of Environment, Safety and Health, Washington, DC, May 20.

DOE (U.S. Department of Energy), 2002c, *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), 2002d, *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), 2002e, *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, July 24.

DOE (U.S. Department of Energy), 2005a, "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 October 3.

DOE (U.S. Department of Energy), 2005b, *Environmental Assessment for the Proposed Consolidation of Neutron Generator Tritium Target Loading Production,* DOE/EA-1532, Sandia Site Office, Albuquerque, New Mexico, June.

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, 2000/Notices.

KSL (KBR SHAW LATA), 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., Witkowski, M., Birdsell, K., Newman, B., and Walther, D., 2005, "Development of an Infiltration Map for the Los Alamos Area, New Mexico," *Vadose Zone Journal*, 4:672-693.

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.

LANL (Los Alamos National Laboratory), 2000a, *Special Environmental Analysis for the Department of Energy, National Nuclear Security Administration, Action Taken in Response to the Cerro Grande Fire at the 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), 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 National Laboratory, Los Alamos New Mexico, April 13.

LANL (Los Alamos National Laboratory) 2001b, *U.S. Department of Energy Report, 2000 LANL Radionuclide Air Emissions Report*, LA-13839-MS, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2002a, *Occupational Radiation Protection Requirements*, LIR402-700-01.1, Attachment D, Chapter 4, Los Alamos, New Mexico, February 14.

LANL (Los Alamos National Laboratory), 2002b, *Site + Architectural Design Principles*, LA-UR-01-5383, Site Planning and Development Group, Los Alamos, New Mexico, January.

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, *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), 2003b, *Waste Volume Forecast*, LA-UR-03-4009, Revision 0, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003c, *U.S. Department of Energy Report, 2002 LANL Radionuclide Air Emissions*, LA-14058-PR, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003d, *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) 2003e, *Facility-Wide Air Quality Impact Analysis*, LA-UR-03-3983, 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, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004d, *SWEIS Yearbook - 2003, Comparison of 2003 Data to Projections of the Site-Wide Environmental Impact Statement for Continued Operation* *of the Los Alamos National Laboratory*, LA-UR-04-6024, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004e, *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), 2005a, *Our Mission*, http://www.lanl.gov/natlsecurity/index.html, Accessed on September 9.

LANL (Los Alamos National Laboratory), 2005b, *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 to 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), 2005e, *Direct Environmental Penetrating Radiation at LANL*, Environmental Stewardship Division, Los Alamos, New Mexico, Available at http://www.airquality.lanl.gov, Accessed on September 30, 2005, August 11.

LANL (Los Alamos National Laboratory), 2005f, *Environmental Surveillance at Los Alamos during 2004*, LA-14239-ENV, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2005g, Field Summary Report for Technical Area-21 Site Surveys, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2005h, *2004 LANL Radionuclide Air Emissions Report*, LA-14233, Los Alamos, New Mexico, 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.

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*, 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, 2005.

NMED (New Mexico Environment Department), 2005a, *Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act S 74-4-10 and the New Mexico Solid Waste Act S 74-9-36(D)*, Los Alamos, New Mexico, March 1.

NMED (New Mexico Environment Department), 2005b, *Proposed Closure Strategy for Technical Area 54, Area L Landfill, Los Alamos National Laboratory (LANL), EPA ID# NM0890010515*, Letter from James P. Bearzi, Chief, Hazardous Waste Bureau, 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 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.

Vance, Jene, 2005, Vance and Associates, *An Evaluation of LANL's Future Transuranic Waste Management Needs After Project 2010*, LA-UR-04-7125, Los Alamos National Laboratory, Los Alamos, New Mexico.

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 project-specific analysis 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 (Consent Order) entered into by NNSA, 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 project-specific analysis accordingly addresses environmental consequences through fiscal year (FY) 2016.

> NNSA is not legally obligated to include the Consent Order impacts analysis, but for purposes of this Site-Wide Environmental Impact Statement, NNSA is including this information in support of collateral decisions NNSA may make to facilitate Consent Order activity.

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 program to identify locations where radioactive and hazardous constituents may have been released into the environment and to carry out corrective measures. These potential release sites (PRSs) include:

- Material disposal areas (MDAs), where radioactive or hazardous constituents have been disposed, generally by burial within soil or underlying tuff
- 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

Corrective actions performed at LANL in accordance with the Atomic Energy Act are regulated by DOE; in accordance with RCRA and HSWA, primarily by the New Mexico Environment Department (NMED) pursuant to the New Mexico Hazardous Waste Act. Since 1990, LANL staff has conducted these 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, which prescribes a specific program of environmental investigations and corrective measure analyses.

The Consent Order prescribes investigation programs, including schedules, for LANL PRSs, subject to RCRA and HSWA requirements. From the investigation program results, and as directed by NMED, alternative corrective measures must be developed for these PRSs. 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 extent of some activities and their temporal application may be different from that 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 project-specific analysis 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).
- Identify a limited number of PRSs—particularly large MDAs—that may require significant effort to remediate (Section I.3).

- Aggregate the remaining PRSs where remediation efforts will probably be more significant in totality than individually (Section I.3).
- Consider 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).

This project-specific analysis 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 project-specific analysis 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 project-specific analysis, then additional NEPA review may be needed.

For this project-specific analysis, 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 project-specific analysis 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. The second group of MDAs is listed in **Table I–3**.

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–1 Large Material Disposal Areas Considered in This Project-Specific Analysis

Technical Area	MDA and SWMU	Description
TA-21	MDA A 21-014	Contains two 50,000-gallon underground tanks, two small pits, and one large pit.
TA-21	MDA B 21-015	Used for solid radioactive waste and chemical waste disposal. Uncertain number of disposal trenches.
TA-21	MDA T 21-016(a)-99	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)	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)	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	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 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, Na-K = sodium-potassium.
[a] MDA U is smaller than the other MDAs in this table. It was included 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	11/9/2006	TBD	TBD	3/11/2011
B	Submitted	3/26/2006	TBD	TBD	6/23/2011
T	Submitted	9/18/2006	TBD	TBD	12/19/2010
U	Submitted	2/5/2006	TBD	TBD	11/6/2011
C	Submitted	12/6/2006	TBD	TBD	9/5/2010
L	Submitted	Submitted	TBD	7/31/2007	6/30/2011
G	Submitted	Submitted	6/5/2006	8/5/2007	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.
Note: Schedules have been adjusted from those in the Consent Order to account for delays in New Mexico Environment Department approvals.

Table I–3 Additional Material Disposal Areas Considered in This Project-Specific Analysis

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.

TA = technical area, MDA = material disposal area, SWMU = solid waste management unit.

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 Project-Specific Analysis

Three broad-scope options are considered:

- **No Action Option**. For NEPA purposes, 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 as it is today, but no extensive corrective measures would be conducted for major PRSs.

> The No Action Option is considered in this project-specific analysis because such an action is required by NEPA. DOE is legally required to carry out the provisions of the Consent Order.

- **Capping Option**. 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, subsurface transuranic waste within MDA G may be difficult to retrieve, an option to leave this 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 (40 CFR 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**. 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 occur as assumed 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.

1.1.4 Related National Environmental Policy Act Analyses

Two NEPA analyses related to this project-specific analysis 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 2004a)

- *Categorical Exclusion for Proposed Remediation of MDA V within TA-21* (LANL 2004f)

NNSA is not legally obligated to include a NEPA analysis of the Consent Order impacts. NNSA is including this information in this Site-Wide Environmental Impact Statement (SWEIS) in support of collateral decisions NNSA may make to facilitate Consent Order activity implementation. NNSA is legally required to carry out the Consent Order provisions and is considering a No Action Option pursuant to NEPA mandates.

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 technical areas (TAs) are shown in **Figure I–1**. LANL is bordered by the Santa Fe National Forest to the north, west, and south. The American Indian Pueblo of San Ildefonso and the Rio Grande 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 township 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 1999a). 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 Table 4–20, Chapter 4, of the 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).

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, Congress enacted several major statutes addressing environmental protection, including RCRA, HSWA, and the Federal Facility Compliance Act. LANL currently operates under 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 authority for management of hazardous materials defined under RCRA and its amendments, particularly HSWA, as well as corrective actions taken pursuant to these statutes. The State of New Mexico has been given implementation authority.

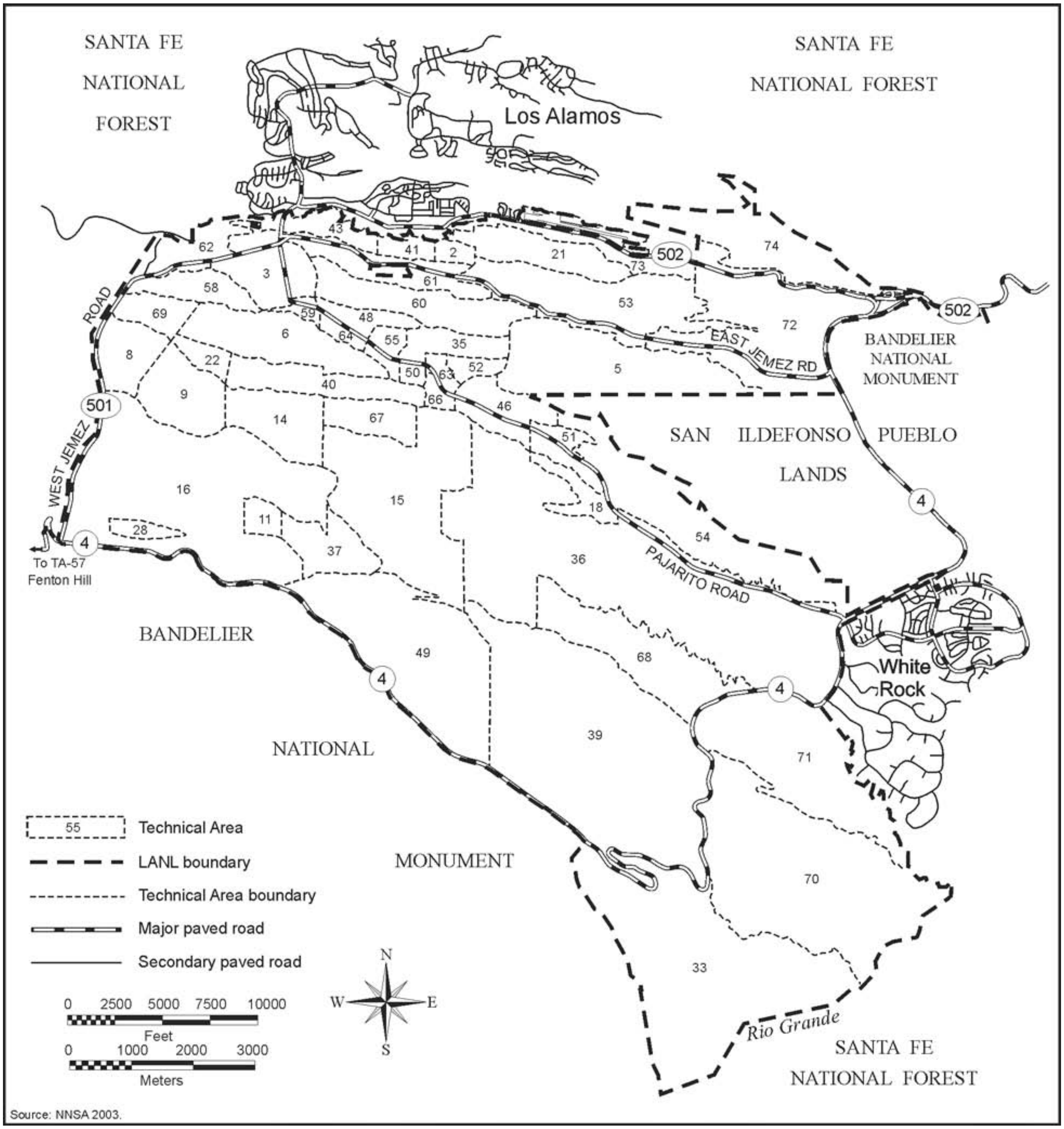


Figure I–1 Los Alamos National Laboratory Technical Area Locations

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 investigation and monitoring 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).

LANL's environmental restoration project was reorganized in late 1997. Corrective action sites were assigned to: (1) site canyons and corrective action sites in canyons; (2) major MDAs and nearby corrective action sites; and (3) all other corrective action sites not assigned to canyons or MDAs. 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 planned. Since 1993, over 100 voluntary cleanup actions have been conducted (LANL 2002b). By the end of calendar year 2004, only 829 PRSs remained. About 711 units had been approved for no further action, and 146 units had been removed from LANL's Hazardous Waste Facility Permit (LANL 2005q).

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, 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 as stated in the Consent Order may be adjusted to account for delays in NMED approvals.) The Consent Order applies to PRSs subject to RCRA and HSWA requirements, and not to PRSs, such as those containing or releasing radionuclides, that are regulated by DOE under the Atomic Energy Act. To avoid duplication of completed work, neither does the Consent Order apply to those PRSs that received No Further Action decisions from BPA when it had primary regulatory authority.

The Consent Order requires installation of subsurface units to provide site characteristic or environmental information; collection and investigation of sample data; and preparation and submittal of investigative reports. Following the investigation phase for a subject PRS, and upon NMED determination that corrective measures are needed, a corrective measure evaluation work plan and a corrective measure evaluation report[1] must be prepared. After NMED authorizes a PRS corrective measure, the corrective measure is implemented. After completing the remedy, 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 project-specific analysis:

- 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
- Section I.2.6: Other SWMUs and 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

[1] A corrective measure evaluation work plan and report correspond essentially to a RCRA Corrective Measures Study work plan and report.

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 project-specific analysis 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 1993a).

TA-15 has been used since World War II for explosive testing of nuclear weapons components. Firing Points A and B were both used by the end of World War II, and, by 1948, Firing Points C through H had been added. These firing points are not used today, and most of their structures have been decommissioned and dismantled (LANL 1993a). Areas R-40, R-183, and The Hollow contain office buildings. Firing Sites R-44 and R-45 were built in the 1950s (LANL 1993a). The Pulsed High-Energy Radiographic Machine Emitting X Rays (PHERMEX) was completed in the 1960s. A second radiographic machine, Ector, was installed in the early 1980s. A newer facility near PHERMEX is the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility (LANL 1993a).[2]

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 1993a). The septic system has been recommended for no further action (LANL 2005a).

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 1993a). 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 1993a).

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) – OD RCRA unit
14-006	Tank and/or associated equipment	39-004(d)	Firing Site 39-57 (active) – OD 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

[2] *PHERMEX stands for Pulsed High Energy Radiographic Machine Emitting X-Rays (facility); DARHT stands for Dual-Axis Radiographic Hydrodynamic Test (facility).*

Site Identification	*Description*	*Site Identification*	*Description*
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
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, OD = open detonation.
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.

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 1993a).

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 220 pounds (100 kilograms) of lead, less than 220 pounds (100 kilograms) of mercury, and bismuth, copper, cobalt, nickel, tin, and thorium. Little high explosive (HE) probably survived the tests (LANL 1993a).

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 2005a).

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 1993a). 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 2005a).

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 2005a).

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 1993a, 2001a) 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 1993a).

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 1993a). 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 1993a).

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 1993a).

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 2005a).

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 2001a). 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, 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 1993b).

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 1999a).

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 1993b).

From 1949 through 1951, work orders were written for three smaller pits on Twomile Mesa (LANL 1993b):

- 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 1993b). Arial photographs from 1954 show two large disturbed areas that may be the two pits referenced in the Bradbury memoranda (LANL 1993b). 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 1993b).

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 1993b). Yet later this individual stated that no hazardous materials were buried, and that burial was not the accepted practice for disposal of explosives (LANL 1993b). 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 1993b).

Current Configuration. MDA F comprises a small area encompassed by, and in the vicinity of, a pair of fenced areas north of Twomile Mesa Road (**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 1993b, 1999a). Some of these lenses contained Baratol, which contains barium and 2,4,6-trinitrotoluene (TNT) (LANL 1999a). West of MDA F is the “timbered pit” that may have been used for test firing Jumbino vessels.[3] 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 1993b). 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.

[3] 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).

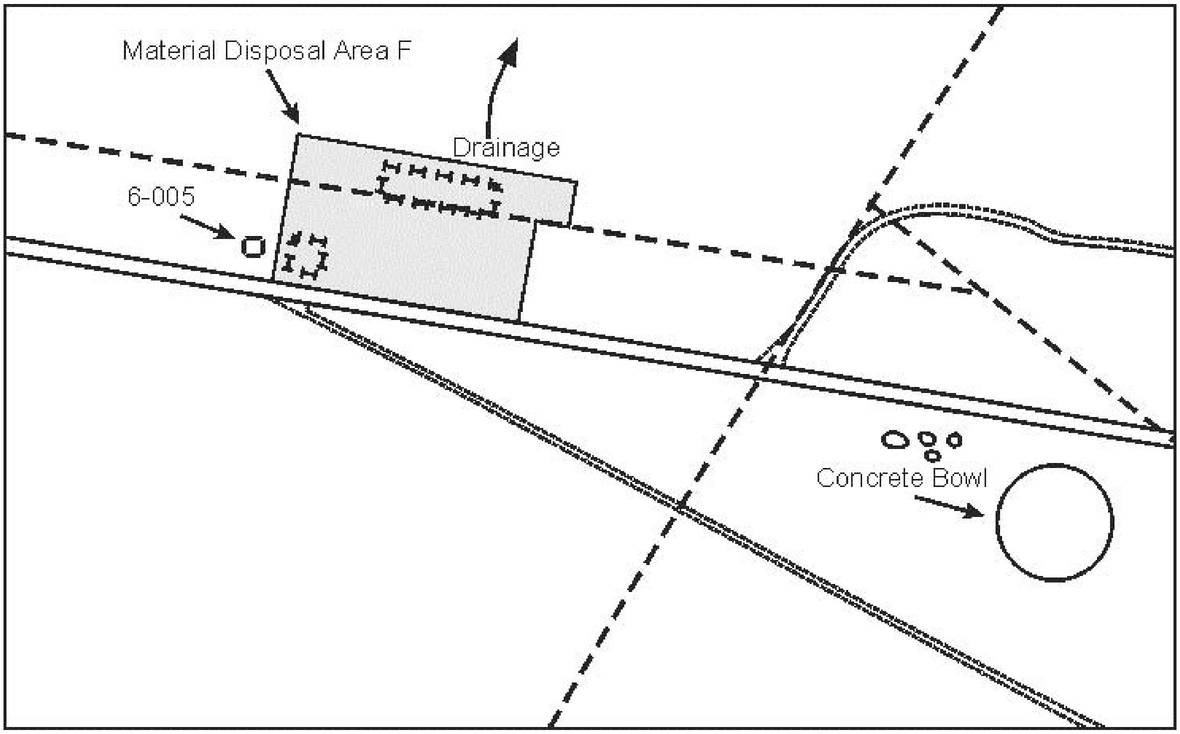


Figure I–3 Material Disposal Area F

The site was contoured and reseeded with native grasses in 1996. The MDA vicinity MDA 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 1999a). According to the 1993 RFI Work Plan for Operable Unit 1111 (LANL 1993b), 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 1993b). 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 1993a, 1999a). One reference states that chunks of uranium are visible (LANL 1999a), although a 1982 aerial radiological survey detected no radioactive contamination above background values (LANL 1993a).

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 2005a).

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.[4] The MDA AA trench area was graded to lessen the potential for stormwater run-on. Samples taken from the last active trench in 1987 and 1988 showed elevated levels of cadmium and uranium (LANL 1993d, 1999a, 2005a).

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 2005a).

[4] *A permitted burn area west of MDA AA is still used to burn combustible firing site debris (LANL 1999a).*

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 1999a, 2005a).

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 2005a).

SWMU 31-001(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 1999a, 2005a). 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 1993e). 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 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 1993e).

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 2005a).

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.[5] 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

[5] *At the time of Consent Order issuance, some canyon work plans had already been submitted to NMED while others were still under development.*

- 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.

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 isotopes, 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 a 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 2005c).

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 1999a, 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.

TA-21 currently contains four MDAs. From west to east, they are MDAs B, T, A, and U.[6]

I.2.5.2.1 Material Disposal Area A

MDA A (SWMU 21-014) is on a site covering 1.25 acres (0.51 hectares) 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–4**) (LANL 1991).

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 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"[7] (LANL 1999a). 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 1999a).

[6] *MDA V in TA-21 is also cited in the Consent Order. It was removed, however, before the time period considered in this SWEIS.*

[7] *Rogers 1977.*

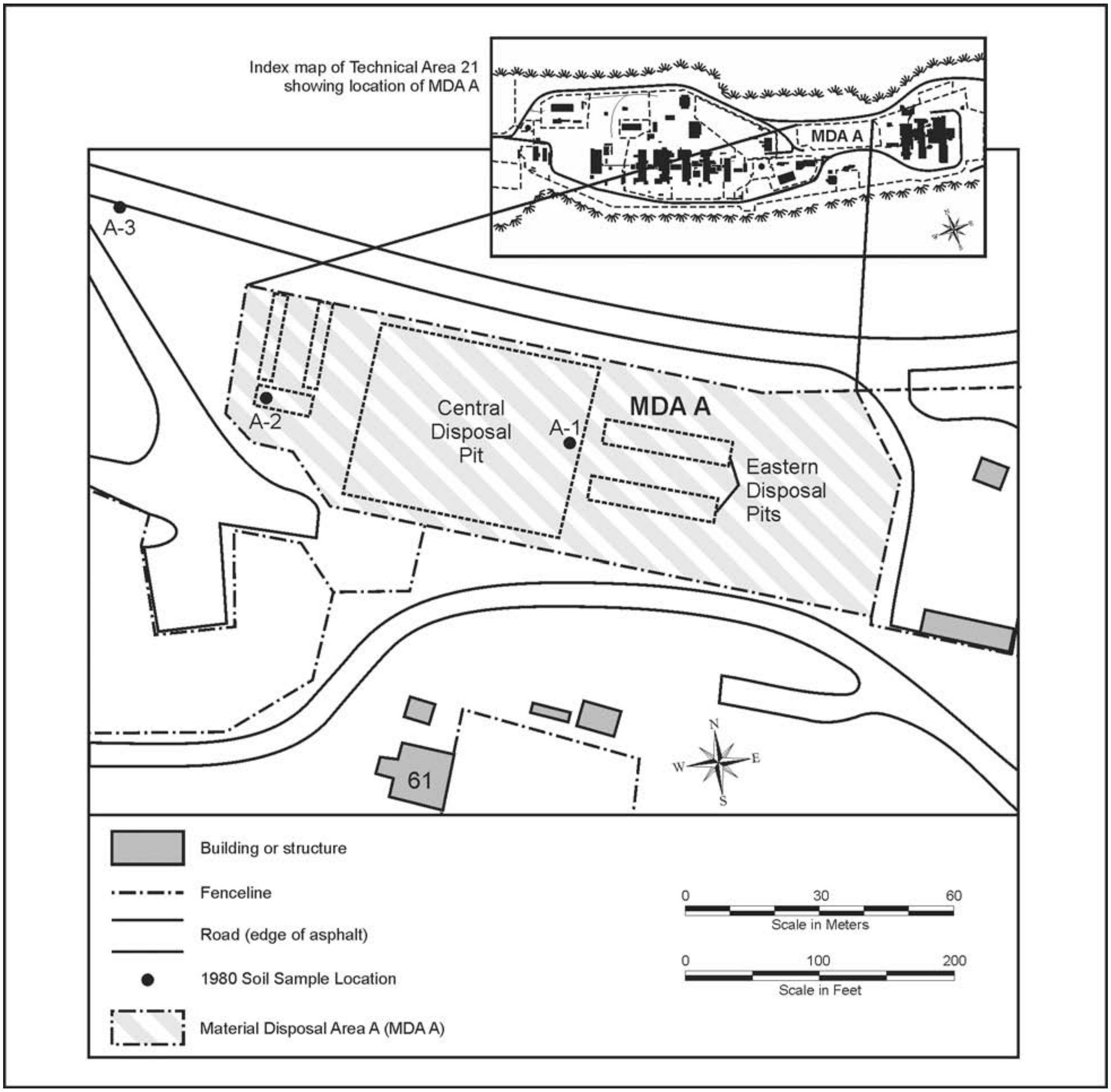


Figure I–4 Material Disposal Area A

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 1999a). The tanks are shown in **Figure I–5** 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 feet-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.

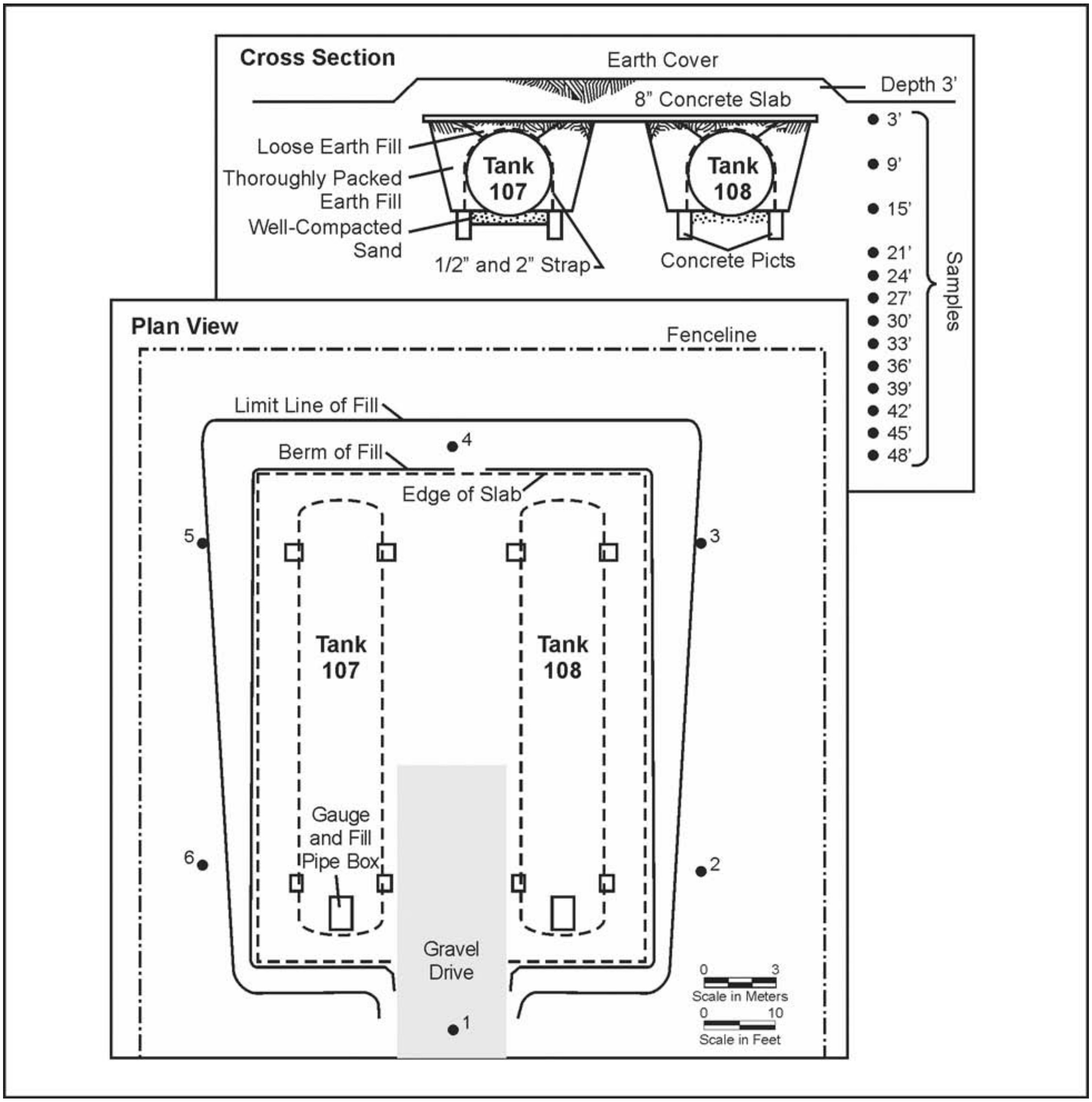


Figure I–5 General's Tanks within Material Disposal Area A

Solutions containing plutonium-239 and plutonium-240 in sodium hydroxide were to be stored until the plutonium could be extracted (LANL 1991, 1999a). But in 1975, the solution was removed, solidified in cement, and buried in MDA A, leaving a residual sludge. The solidified waste was subsequently moved to Pit 29 in MDA G, where it is being stored (LANL 1999a). Tank openings were sealed 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-23 and plutonium-238 (LANL 2004o). 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

[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).*

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 deadline, (LANL 2005t).

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 long, narrow site covering 6 acres (2.4 hectares) south of and parallel to DP Road to the west of DP West.

History of MDA B. MDA B operated from 1945 to 1948 (LANL 1999a) and received waste from DP East and DP West, including laboratory waste and debris, and probably limited volumes of liquid wastes (LANL 2004b). 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, 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 (**Figure I–6**). 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 1999a).

Waste Inventory. Inventory information is largely anecdotal. The following description is from the Historical Investigation Report for the MDA B Investigation Work Plan (LANL 2004b):

> 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.

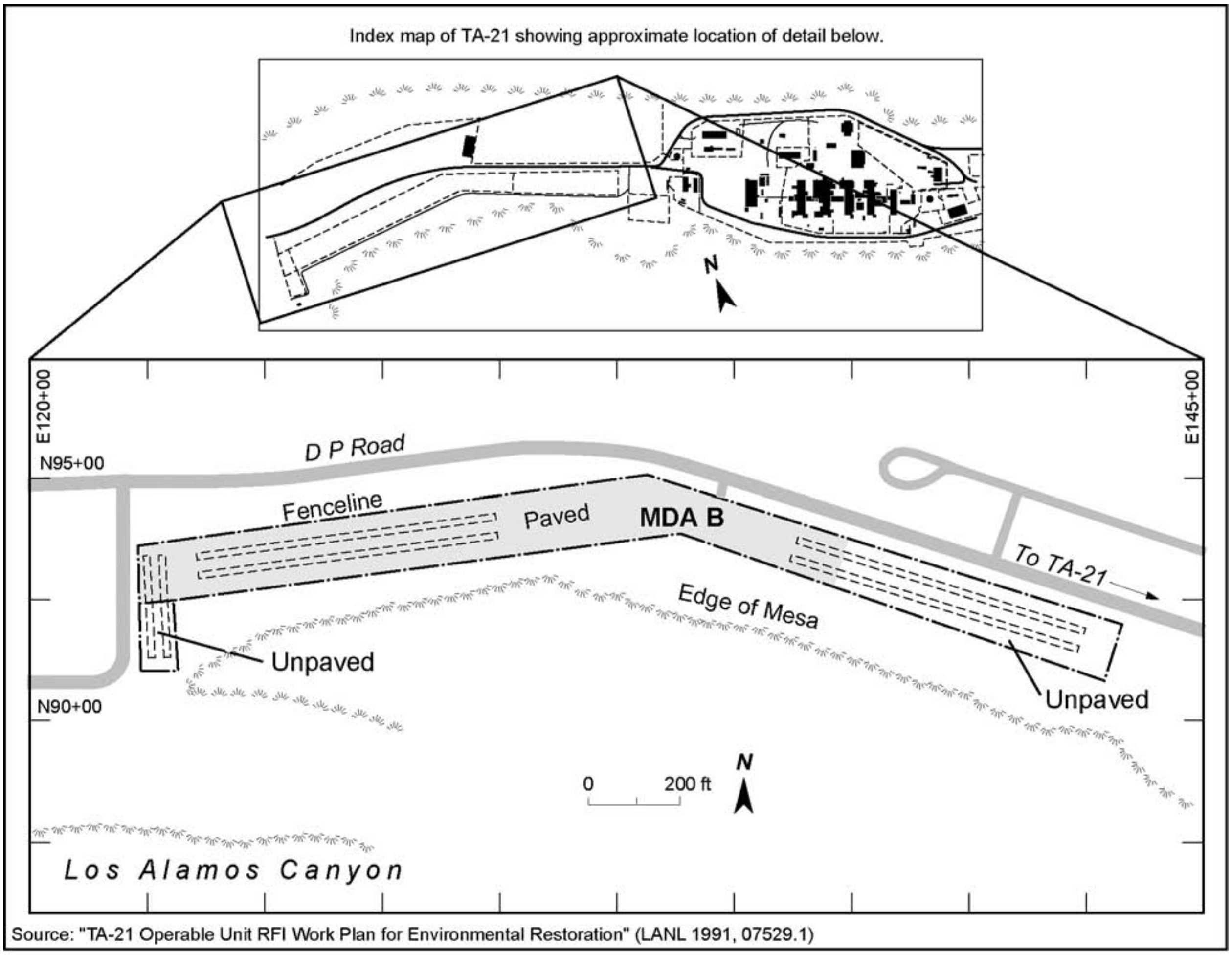


Figure I–6 Material Disposal Area B Base Map Showing Estimated Disposal Trench Locations

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 Historical Investigation Report (LANL 2004b):

> 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 (Figure I–6) (LANL 1991). The 1991 RFI Work Plan estimated that the disposal trench surface area was 1.1 acres (0.46 hectares), covering 27,780 cubic yards (21,240 cubic meters) of buried waste (LANL 1991).

Geophysical surveys conducted in 1998 (LANL 2004b) 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 2004b). The MDA B Investigation Work Plan estimates that the disposal trench surface area is 2.4 acres (0.97 hectares), and the volume is 47,910 cubic yards (36,630 cubic meters) (LANL 2004b).

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 2004b).

In 2004, LANL conducted workshops wherein subject matter experts concluded that for purposes of a planned program of investigation, 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 2005m). The investigation program for MDA B is addressed in Section I.3.3.2.7 of this project-specific analysis.

MDA B contains no structures. The site is surrounded by a galvanized steel chain-link fence and consists of (LANL 2004b):

- 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 2004b).

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 is a vacant lot. An abandoned underground radioactive liquid waste line runs outside the fence along the southern boundary of the site. 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 an air monitoring station is outside the east fence (LANL 2004b).

Site Investigations. Numerous investigations have occurred since 1948. Pre-RFI investigations are summarized in the Operable Unit RFI Work Plan for TA-21 and in the Investigation Work Plan for MDA B (LANL 1991, 2004b). RFI investigations are summarized in the Investigation Work Plan (LANL 2004b). These site investigations indicate (LANL 2004b):

- Some radionuclides and metals were found in concentrations greater than background values in surface soils along the perimeter of the site in areas not covered by asphalt or the 1982 cover.
- volatile organic compounds were found in the subsurface soil pore gas in all seven angled boreholes drilled in 1998 beneath the disposal area.
- Tritium, plutonium-239, uranium, and lead were found at concentrations above background values in three of the seven boreholes drilled in 1998.
- Other inorganic compounds were isolated detections above background values.
- The average moisture content in soils beneath the asphalt (10.6 weight-percent) was elevated compared with the surrounding surface soils (5.1 weight-percent) and subsurface materials (5.6 weight-percent).
- Elevated radionuclides, organic chemicals, and inorganic chemicals were detected in some surface soil samples.

The Investigation Work Plan for MDA B is designed to: characterize the types and estimate the quantities of waste in MDA B; characterize the radiological, organic chemical, and inorganic chemical concentrations in the soil and rock next to the disposal trench sides and bottoms; and generate operational performance data for potential future corrective actions (LANL 2004b). Additional information about the planned investigation program is provided in Section I.3.3.2.7 of this project-specific analysis.

I.2.5.2.3 Material Disposal Area T

MDA T is on a site covering 2.2 acres (0.9 hectares) in the northeast corner of DP West (**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 2005a). 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 2005a).

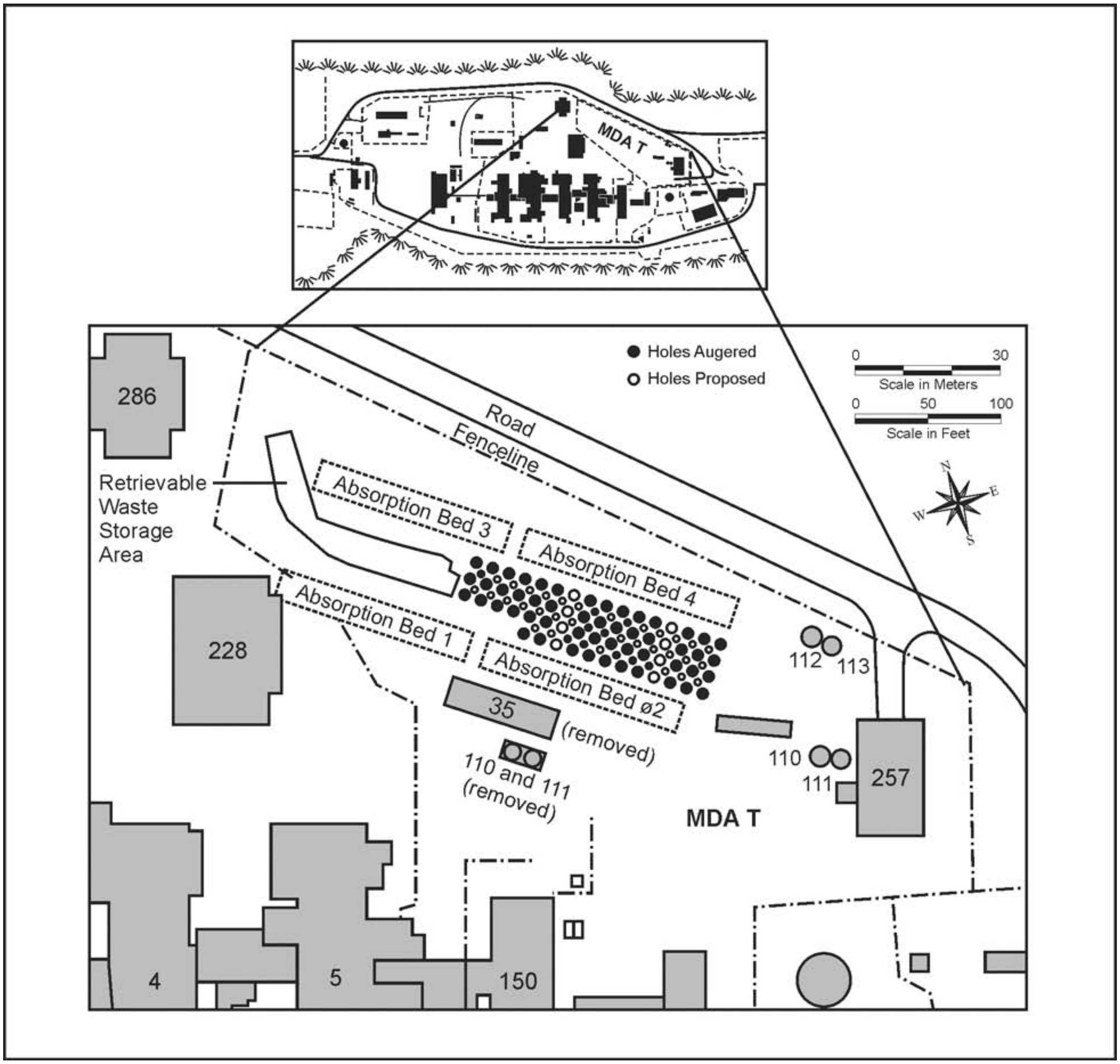


Figure I–8 Material Disposal Area T

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).[9] The four absorption beds were each 120 by 20 by 6 feet deep (36.6 by 6.1 by 1.8 meters deep).[10] 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).

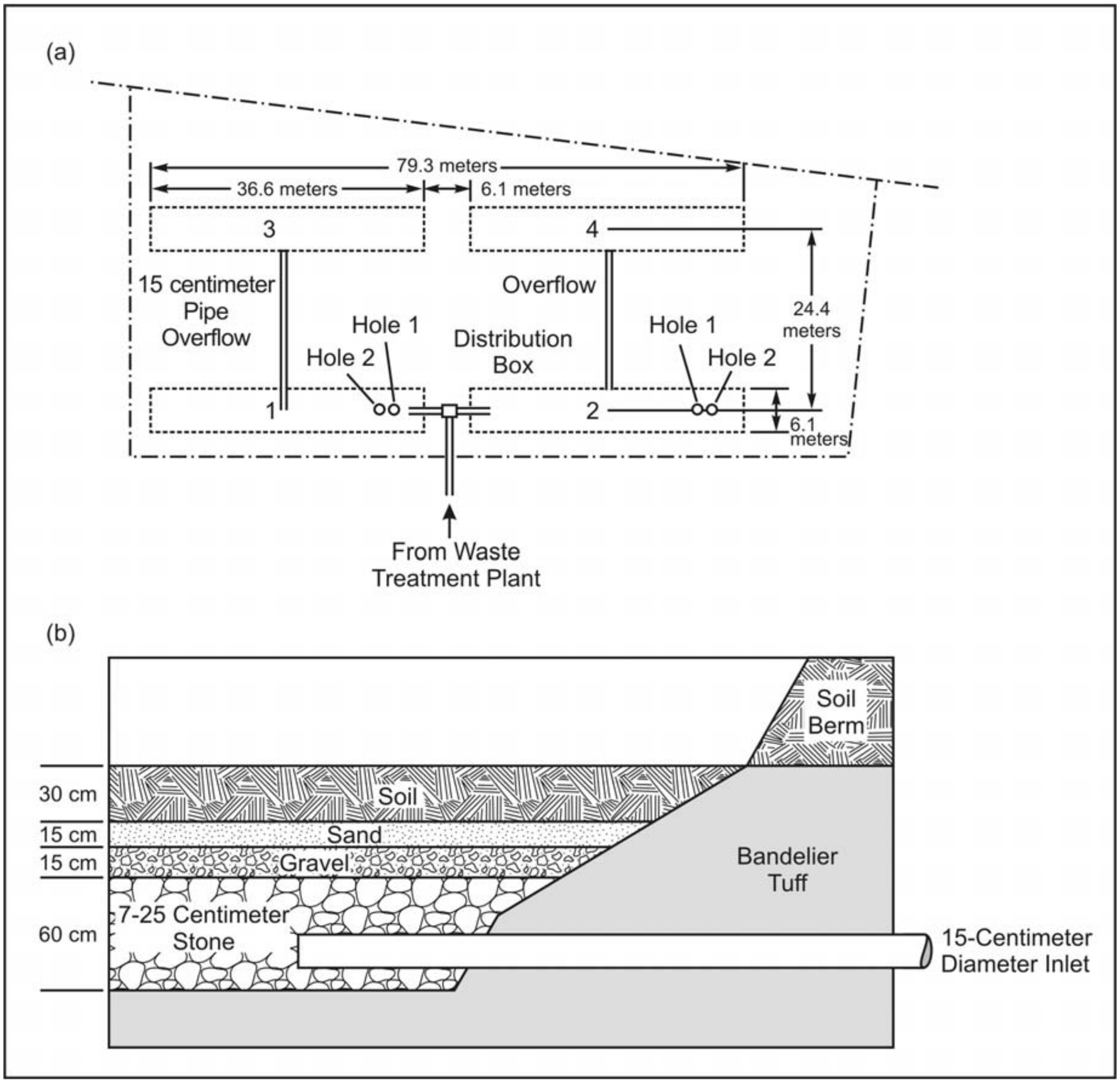


Figure I–9 Absorption Bed and Distribution Pipe Cross-Section

---

[9] *MDA T may have received wastes as early as 1943 (LANL 1991).*

[10] *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).*

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[11] floor drain that was piped directly to Bed 1

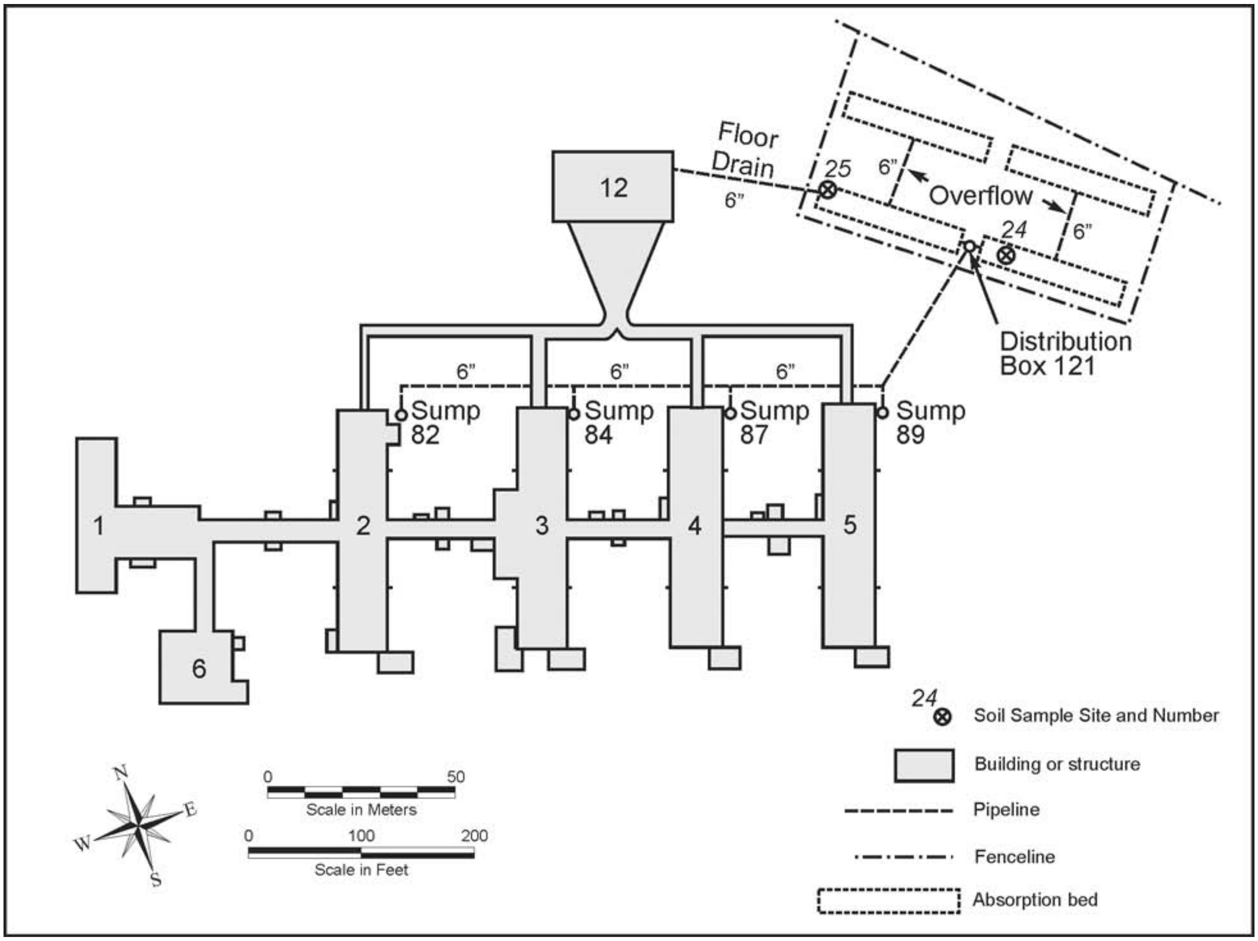


Figure I–10 Location of Lines Discharging to Absorption Beds at Material Disposal Area T Before 1952

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).

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).

[11] *This building was removed in 1973 (Rogers 1977).*

Disposal Shafts. Starting on May 1, 1968, more than 60 disposal shafts (SWMU 21-016) were augured, 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 (**Table I-7**) (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 matrix of the larger shafts (Rogers 1977).

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.

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).

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 2005a). 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.[12] 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 2005a).

- 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 2005a).

- 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 2005a).

Waste Inventory. Much less radioactive material was disposed of into the beds than the shafts.

Absorption beds. Between 1945 and 1952, the beds received 14 million gallons (53 million liters) of untreated wastewater containing plutonium and fluoride. 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) 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.

[12] *Remediation of the outfall SWMU (21-011k) has been completed (see Section I.2.7.6).*

- Shaft 17 contains six drums of cyanide salts fixed in asphalt.
- Shafts 50 and 54 contain demolition debris from Filter Building 012.
- Shafts 52 and 58 together contain four drums of uranium-233.

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.

Shaft-specific inventories (as of 2004) of plutonium-239, plutonium-238, 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).[13]

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	–	–

[13] *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)***
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	–	–
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.

LANL proposed additional work in 2004: 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).

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)).

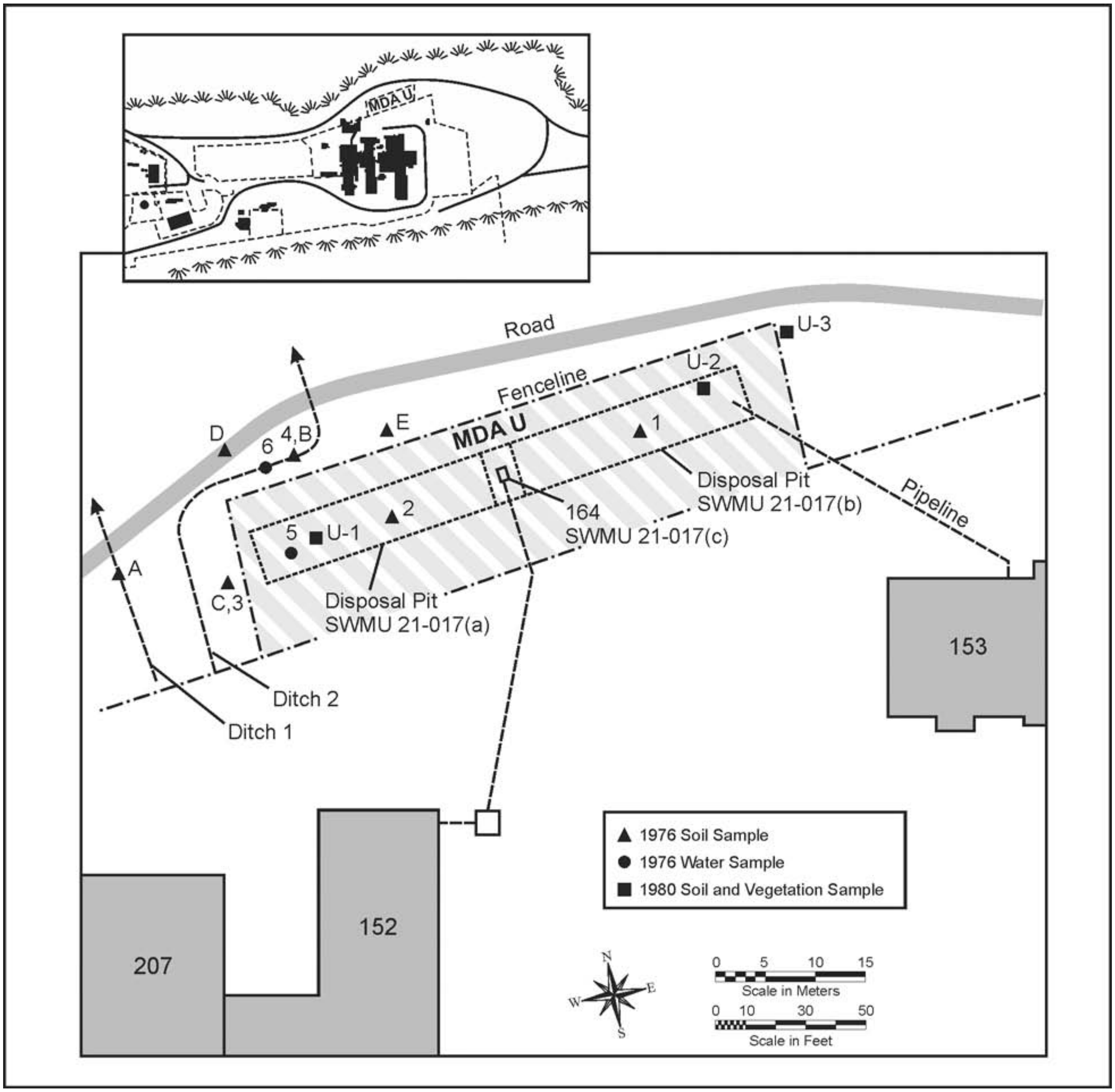


Figure I–11 Material Disposal Area U Showing Pipelines for Liquid Effluents

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 2004d). 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 2004d). Between the two beds was a distribution box (SWMU 21-017(c)) with lines leading to the beds (LANL 1999a). Liquid waste included effluent from Buildings 21-152, 21-153, and 21-155 (LANL 2004d).

Effluent from Buildings 21-152 and 21-153 was received until 1968 (LANL 2004d). 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, the Tritium Systems Test Assembly (LANL 1991, 2004d). MDA U also received oil from precipitrons[14] and from Building 21-152 floor drains (LANL 2004d).

In 1985, the distribution box and lines were removed (LANL 1991), as was a portion of the line from the cooling tower (LANL 2004d). 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 run-on; 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).

Waste Inventory. Between 1945 and 1968, the beds received 135,000 gallons (511,000 liters) of liquid. The primary radionuclide was polonium-210.[15] 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.[16] 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 2004d).

Much of the contamination discharged to the beds has been removed.

Current Configuration. MDA U is a grassy area north of Building 21-209, 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 2004d).

---

[14] *Precipitrons were air filters installed in the filter building, Building 21-153, and used to filter air exhausted from Building 21-152 (LANL 1991).*

[15] *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.*

[16] *A filter building decommissioned in 1978.*

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 2004d).

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 (thorium-227, radon-219, and radium-223) were found in the eastern beds (LANL 2004d). The 1998 investigations found uranium-234 and uranium-235 above background values in two boreholes on the western side of MDA U. Actinium-227 progeny were found in one borehole within the east bed at 54 to 55 feet (16 to 17 meters) below ground surface in a fractured interval. Tritium was found in eight boreholes in concentrations smaller than 1 picocurie per gram and at the bottoms of two boreholes, each 75 feet (23 meters) below ground surface (LANL 2004d). 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. One borehole showed toluene concentrations of 86 parts per billion by volume at 25 feet (7.6 meters) below ground surface, 480 parts per billion by volume at 55 feet (17 meters), and 220 parts per billion by volume at 75 feet (23 meters) (LANL 2004d).

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 (**Figure I–12**). 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 PRSs (LANL 1992b):

- 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 35 hydronuclear and 12 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 (SNM) 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. SNM 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).

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).[17]

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).

[17] *Containment experiments characterized the extent to which the detonations would fracture the tuff in the vicinity of the detonation points (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. 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).

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 (LANL 1992b).

In March 1975, collapse of asphalt over backfilled Hole 2-M left a hole 6 by 3 by 3 to 4 feet deep (1.8 by 0.9 by 0.9 to 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. Core Hole 2 was bailed dry. In May 1991, 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 (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; (2) remove asphalt from Area 2; (3) regrade the site with clean, crushed tuff; (4) spread topsoil over the regraded site; (5) reseed the topsoil with shallow-rooted grasses; (6) place gravel on the topsoil for erosion protection; and (7) cover part of the site and vicinity with a biointrusion barrier (LANL 1998a, 1999b, 1999c).

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 2005a).

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 2005a).

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 2005a).

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 2005a).

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 2005a). 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 acres (0.3 hectares) 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 2002b).

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 (LANL 2005). Materials disposed of in the nearby landfill (SWMU 49-005(a)) were mainly wood and metal (LANL 2005a).

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 2005a). Area 6 currently supports microwave research.

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 2005a).

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 Buildings 49-23, 49-121, and 49-144. An air monitoring and dosimetry station is northwest of Building 49-23 (LANL 2005a).

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.

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 by area.

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 2005a).

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 2005a).

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). The RFI report recommended no further action, although it indicated that the site would be evaluated for ecological risks. EPA Region 6 concurred (LANL 2005a).

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 2005a). Regarding the nearby landfill (SWMU 49-005(a)), a Phase I RFI was conducted during 1995 and 1996. The RFI report recommended no further action, although it indicated that the site would be evaluated for ecological risks. EPA Region 6 concurred (LANL 2005a).

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 2005a). Regarding the leach field (SWMU 49-003), a 1995 Phase I RFI collected 13 shallow subsurface samples. From a human health risk-based screening assessment, 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 and recommended collecting subsurface samples for organic chemicals (LANL 2005a).

Area 12. In 1995, Phase I RFI sampling found radiation levels above background values at four survey points around Building 49-23. 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 Building 49-23. Additional soil removal occurred in 1998 (LANL 2005a).

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 1999a).

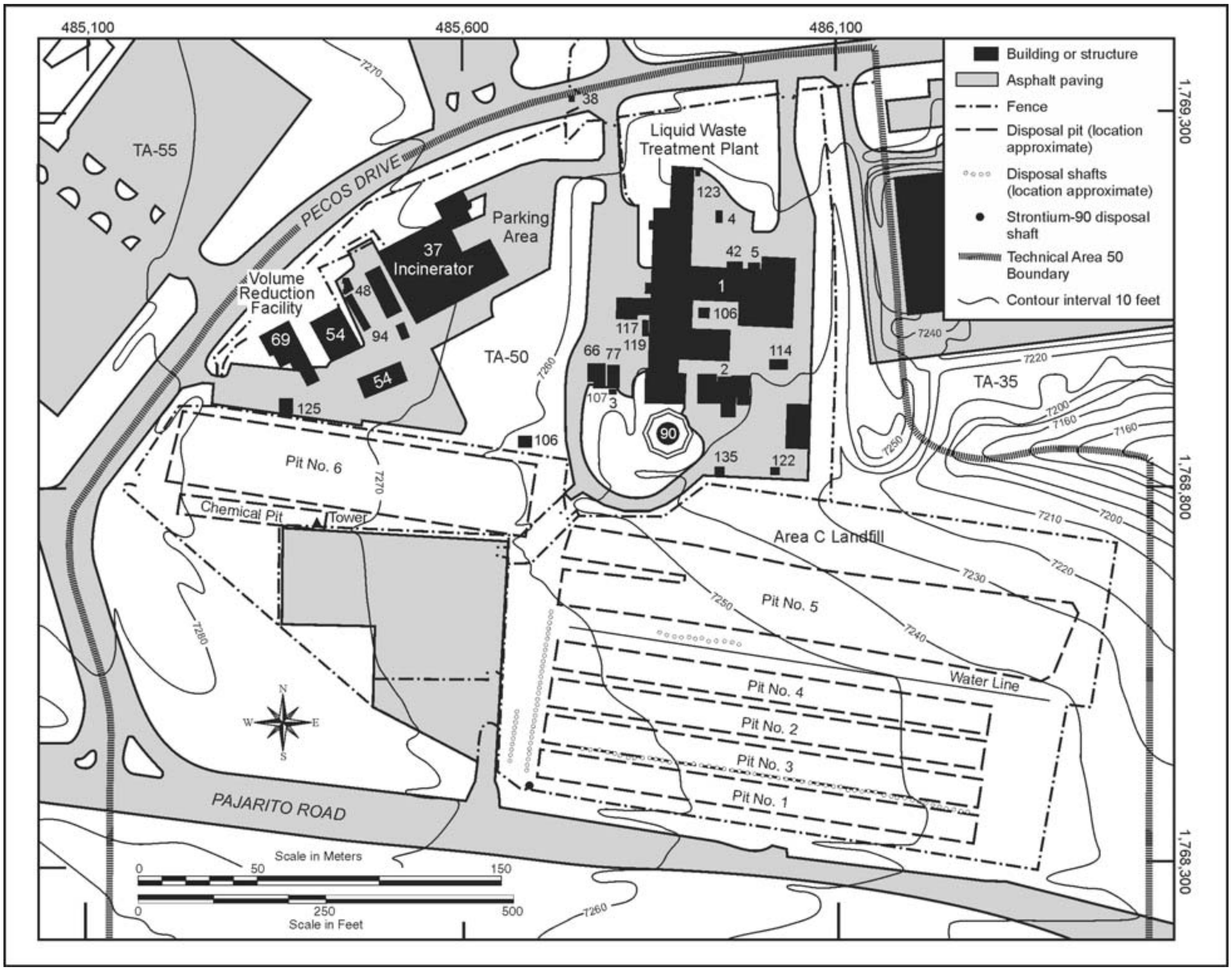


Figure I–13 Material Disposal Area C Within Technical Area 50

History of MDA C. MDA C is bordered by Pajarito Road to the south, Pecos Drive to the west, TA-50 waste management facilities to the north, and Ten Site Canyon to the northeast. MDA C covers 11.8 acres (4.8 hectares).

MDA C was used from 1948 to 1965. In 1963, the Radioactive Liquid Waste Treatment Facility (RLWTF) (Building 50-1) was built to the north of MDA C. Additional facilities near MDA C are the Radioactive Materials Research, Operations, and Demonstration (RAMROD) Facility (Building 50-37),[18] built in 1975, and the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) (Building 50-69), built in 1983. Liquid wastes from these facilities are piped to the RLWTF (LANL 1992c).

[18] *RAMROD is now called the Actinide Research and Teaching Integration Center (ARTIC).*

MDA C (SWMU 50-009) comprises seven pits, including one chemical pit, and 108 shafts. The disposal units are within a site covering 12.3 acres (9.0 hectares) (LANL 1999a). All pits and shafts were dug into the overlying soil and the Tshirege Member of the Bandelier Tuff (LANL 2003a). The MDA C disposal unit dimensions and periods of operation are shown in **Table I–12** (LANL 2003a). 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 2003a). (Shaft designation numbers do not reflect their sequence of use.)

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 2003a.

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 2003a). Nonroutine waste included debris from the demolition of the Bayo Site and TA-1, classified materials, and tuballoy (a uranium alloy) chips (LANL 2003a). Hazardous constituents and uncontaminated classified material were buried with radioactive waste. A 1959 memorandum complains that much 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).

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 2003a).

The shafts were used for disposal of "beta-gamma waste," mostly from the Chemical Metallurgy Research Building at TA-3 (Rogers 1977, LANL 2003a). 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).

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 2003a).

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 2003a). No information is available for the strontium-90 shaft.

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 1999c) estimates 57 curies of plutonium-239 in MDA C shafts.

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 2003a).

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 2003a), 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, across the boundary between TA-50 and TA-35 (Stephens 2005).

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 rod assembly, waste oil, detonator components, NRX (Navy experiment) reactor parts, trinitrotoluene (TNT) element samples, americium-242, aluminum-105, zinc-65, neptunium-237, contaminated materials and trash, americium-241, classified material, actinium-227, radium-226, lead, sliver, strontium-90, and "induced activity."

LAMPRE = Los Alamos Molten Plutonium Reactor Experiment.

[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.

Source: LANL 2003a.

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.

Geophysical surveys were conducted in 1994, 2001, and 2004. 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.[19] 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 2003a).

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)[20] (LANL 2003a). Buried utility conduits running across the pits are in the northwest portion of the site (Stephens 2005).

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, 2003a). 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 2003a):

- 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

[19] *The survey suggests that Pit 6 may extend beyond the fence at the east end of the pit. A photograph in confirms the proximity of the northern edge of Pit 6 to the north perimeter fence (Rogers 1977).*
[20] *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).*

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.

Further work was proposed 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 perchorate, 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 2003a).

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 1999a). 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**). These areas include:

- *Area G*. Area G is a 63-acre (25.5-hectare) site used since 1957 (LANL 2005e). It includes MDA G, a site having numerous disposal pits and shafts that are the subject of 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.
- *TA-54 West*. TA-54-West is the site of the Radioactive Assay and Nondestructive Test (RANT) 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 disposal of chemical wastes.

- *Area H*. This area consists of nine inactive shafts used until 1986 for disposal of classified radioactive wastes. The area is being remediated pursuant to the Consent Order.
- *Area J*. This 2.65-acre (1.1-hectare) area was used from 1961 until 2001 for disposal of solid wastes. The six pits at Area J are covered with clean fill and all four shafts are capped. An asbestos transfer station has been removed. Area J is undergoing closure under the New Mexico Solid Waste Act of 1990.

I.2.5.5.1 Material Disposal Area G

MDA G is comprised of older units potentially 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**).

History of MDA G. Disposal began during the 1950s. Up until the early 1970s, wastes disposed at Area G included transuranic isotopes exceeding 10 nanocuries per gram as well as nonradioactive hazardous constituents. After the decision to retrievably store 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,[21] but, until July 1986, still contained nonradioactive hazardous constituents (RAE 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).

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).[22] 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–18 organizes the disposal units by their SWMU groupings (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.

---

[21] *The transuranic limit for DOE disposal of low-level radioactive waste was revised in the early 1980s from 10 to 100 nancuries per gram.*
[22] *Additional shaft information is available in Table B-3 in the Investigation Work Plan for MDA G (**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.
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.

Pit Number	***Operational Period***	***Dimensions (feet) (length by width by depth)***	***Pit Volume [a] (cubic yards)***	***Waste Volume [a] (cubic yards)***	***Waste Description***
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, D-38 = depleted uranium.

[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 Material Disposal Area G Solid Waste Management Unit Groupings

Inactive Subsurface Disposal 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
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 54-13(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 in the south-central portion of Area G. 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 and are in the eastern portion of Area G. 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 and are primarily located in the northeast quadrant of Area G. 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. Located in the northeast quadrant of Area G, 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 pipe inside a mound of fill within the top of 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 1997a). **Table I–19** summarizes the hazardous chemical inventories within MDA G as summarized in the MDA G Investigation Work Plan (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.

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.

Area G is to be closed to meet the Consent Order deadline for closure of MDA G. The approach used to close Area G 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. Activities required to close Area G are analyzed in Section H.3.3.

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 2005u).

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 2003d), and an environmental assessment was issued in June 2004 (DOE 2004a).

The recommended corrective measure capping with an evapotranspiration cover (see Section I.3.3.1.3.2). NMED has not yet selected a corrective measure. The Consent Order requires collection and analysis of subsurface vapor samples and monitoring of groundwater in canyons potentially effected 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 1999a).

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 2003b). The dimensions and operation periods of each of the disposal units are summarized in **Tables I–20** and **I–21** (LANL 2003b). 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 1999a).

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 2003b).

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	$200 \times 12 \times 10$	1950s - 12/1978
B	$60 \times 18 \times 10$	1/1979 - 6/1985
C	$35 \times 12 \times 10$	7/1985 - 12/1986
D	$75 \times 18 \times 10$	1972 - 1984

Note: To convert feet to meters, multiply by 0.3048.
Source: LANL 2003b.

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 2003b.

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 [23] (LANL 2003b).

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

[23] *The tanks were closed in 1990 under RCRA regulations.*

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 2003b).

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 2003b). 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 2003b).

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 2003b):

- Ammonium bifluoride waste was neutralized with calcium chloride and calcium hydroxide, yielding an aqueous solution of ammonium chloride, caldium, 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 2003b).

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 MDA L disposal units along with important structures and the former location of waste oil storage tanks (LANL 1992a).[24] Figure I–17 shows operational waste management units at Area L (LANL 1992a). An asphalt pad covers Pit A as well as portions of Impoundments B and C. A second asphalt pad covers many of the disposal shafts. 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. Administrative offices are outside of the security fence adjoining Mesita del Buey Road. The area has water, electricity, and telephone services (LANL 1992a, 2003b).

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 possible presence of perched water (none was found). 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 2003b).

Phase I RFI fieldwork was conducted from 1993 through 2003 (LANL 2003b). 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 2003b).

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 2003b).

The required site Investigation Report for MDA L was submitted to NMED in September 2005 (LANL 2005v).

[24] *The former location of the tanks is an area of concern under RCRA.*

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 analysis; Section VI is discussed in Section I.2.7.) The Consent Order sets forth requirements for identifying, investigating, and taking corrective action at (if necessary) any SWMU discovered after the effective date of the Consent Order. More significantly, the Consent Order presents requirements for addressing SWMUs and AOCs located in aggregate areas[25] (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. Submittal dates for aggregate-area-specific investigation reports will be specified by NMED (NMED 2005).

The required list of aggregate areas was submitted in 2005 (LANL 2005n). All SWMUs and AOCs, except for canyons identified as AOCs,[26] 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 2004n); the Guaje, Barrancas, Rendija Canyons Aggregate Area at TA-00 (LANL 2005p); and the Pueblo Canyon Aggregate Area (LANL 2005o). 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 2005t).

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

---

[25] *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.*

[26] *Areas of Concern that are canyons were not assigned an aggregate area and are being investigated pursuant to Section IV.B of the Consent Order.*

Order was originally issued in November 2002. Hence, many Consent Order requirements for the listed SWMUs have already been met.

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.

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.

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 State Highway 4 and by Santa Fe National Forest west of State Highway 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 2003c). TA-16 was established to develop explosives, cast and machine explosives, and assemble and test explosives for nuclear weapons. This mission continues (LANL 2003c).

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 2005a, 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).

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 2005a).

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 2005a, 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) landfill 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.

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 2003c). 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 2003c). 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 2003c).

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 2003c).

The 260 Outfall has three areas of contamination (LANL 2003c): 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 2003c). 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 2003c).

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 2003c).

Several site investigations have been conducted as summarized in the Corrective Measures Study Report (LANL 2003c) and the Phase III RFI Report, issued in September 2003 (LANL 2003n) and revised in September 2004 (LANL 2004e).

The land adjacent to the outfall is dedicated to continued LANL operations (LANL 2003c).

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 2002d).

SWMU 21-011(k) was investigated in 1988, 1992, and 1993. A 1996 interim action removed the contaminated soil from the hillside (LANL 2002d). A November 2000 gamma spectrometry for the site was followed in March 2001 by collection of samples that identified remaining hotspots (LANL 2002d). 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 2002d). However, plans for the voluntary corrective measure were modified to eliminate the onsite solidification of waste. The remedy was implemented in 2003 (LANL 2003m). 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 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.[27] 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).

Among the PRSs in Table I–28 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 1999a).

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 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 an investigation report for the Middle Mortandad-Ten Site Canyon Aggregate Area was submitted to NMED in September 2005.

[27] 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).

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)	WWTF	Mesa top
	35-003(b)	WWTF	Mesa top
	35-003(c)	WWTF	Mesa top
35-003(d)-00	35-003(d)[a]	WWTF	Pratt Canyon
35-003(a)-99	35-003(e)[a]	WWTF	Pratt Canyon
	35-003(f)	WWTF	Mesa top
	35-003(g)	WWTF	Mesa top
	35-003(h)	WWTF	Mesa top
35-003(j)-99	35-003(j)	WWTF	Mesa top
	35-003(k)	WWTF	Mesa top
35-003(d)-00	35-003(l)[a]	WWTF	Pratt Canyon
35-003(a)-99	35-003(m)	WWTF	Mesa top
	35-003(misc)	Industrial waste lines	Mesa top
	35-003(n)	WWTF	Mesa top
	35-003(o)	WWTF	Mesa top
	35-003(p)	WWTF	Mesa top
35-003(d)-00	35-003(q) [a]	WWTF	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
	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

Consolidated Unit	***Potential Release Site***	***Potential Release Site Description***	***Subarea within the Aggregate***
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, WWTF = Wastewater Treatment Facility.
[a] These potential release sites are consolidated with mesa top potential release sites but also have a canyon component.

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 Consent Order requirement to document the interim action was met.

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 2001e, 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 2001b).

Subsequently, data needed to design a final cover for the landfill was 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 2005c, 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 2005b). 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. The work plan is ongoing.

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), once containing 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 1999a).

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 2005a). The MDA occupies an irregularly shaped area having dimensions of 270 by 260 feet (81 by 78 meters) (LANL 1999a). 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 1993f). Later investigations indicated that the disposal area covered a larger area (LANL 1993f). The MDA Core Document estimates a 0.2-acre (0.8-hectare) area (LANL 1999a).

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 2005a).

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 2005a).

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 2005a).

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 1993a). A later report estimated the size as 300 by 100 feet (91 by 30 meters) (LANL 2005a). 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 1993a). A 1965 aerial photograph showed it to be closed (LANL 2005a). The pit is covered and vegetated (LANL 1999a).

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 1993a).

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 1999a).

A later document (LANL 2005a) 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 1993c). 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 2005a). A geophysical survey suggests that the depth of waste at MDA R is shallow (LANL 1999a).

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 run-on 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 2005a).

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 1999a). 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 1999a).

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 2005a).

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 2005a). The four pits[28] have the following dimensions, based on contemporary engineering drawings (LANL 2005a):

- 33-001(a): 20 by 60 feet (6.1 by 18 meters);

[28] Two additional pits were constructed but were backfilled, apparently withoug 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).

- 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 1999a). 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 2005a).

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 2005a).

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 2005a).

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 2005a). 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 hectares) (LANL 1992f). All former SWMUs 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 2005a). SWMUs (33-002(a–e)) were remediated in 2005 as part of an accelerated corrective action at TA-33. A remedy completion report for this accelerated corrective action will be submitted for NMED approval by March 13, 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 2005a).

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:

1. **No Action Option**. For NEPA purposes, 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 as it is today, but no extensive corrective measures would be conducted for major PRSs. Waste management operations in Area G would remain, including above-ground and below-ground storage of transuranic waste.

> The No Action Option is considered in this project-specific analysis because such an action is required by NEPA. DOE is legally required to carry out the provisions of the Consent Order.

2. **Capping Option**. 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, subsurface transuranic waste within MDA G may be difficult to retrieve, an option to leave their waste in place would be considered. If this option were pursued, a performance assessment pursuant to 40 CFR 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, AB, C, G, and L, 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 PRS would occur from FY 2007 through FY 2016.

3. **Removal Option**. Environmental investigations would take place as assumed 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 be conducted as assumed 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.

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 more than 2,100 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.

I.3.2.1 Existing Waste Forecasts

Estimates of waste generation from the environmental restoration program were presented in the *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 2004i). 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 2003g) that was attached to the 2004 LANL information document (LANL 2004i) 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 2004i).

The focus of this project-specific analysis is on waste that could be generated from LANL's environmental restoration project.[29] Projections of environmental restoration project waste from the June 2003 report (LANL 2003g), as updated for years 2006 through 2008 by a subsequent report (LANL 2004m), 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 2004m). The larger estimate is reflected in the table.

Table I–25 Projections of 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)	7,457	1,644	1,165	162.7	0	38.4	27.6
Low-level radioactive waste (cubic yards)	1,295	994	3,662	4,175	31	0	0
Mixed low-level radioactive waste (cubic yards)	6.5	129	196	20	0	303	89
Transuranic waste (cubic yards)	80	80	80	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.
Source: LANL 2004i.

The Consent Order requires the investigation and remediation of numerous release sites and areas of concern, including several MDAs. Hence, the Consent Order may increase the quantities of environmental restoration waste to be generated. 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.

For MDAs A, B, T, U, AB, C, G, and L, it was assumed that these MDAs would be remediated in conformance with remedy completion report due dates. 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 a few selected PRSs were estimated. From this estimate, an average annual waste generation rate was assumed starting in FY 2007 and continuing through FY 2016.

[29] *Wastes potentially generated from DD&D of LANL structures are addressed in 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.*

The waste types assumed for this project-specific analysis 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 radioactive material. Low-level radioactive waste was divided among six subtypes. This distinction was made to enable assessment for transportation impacts in this project-specific analysis 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 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.[30]

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 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 2004n); the Guaje, Barancas, Rendija Canyons Aggregate Area at TA-00 (LANL 2005p); and the Pueblo Canyon Aggregate Area (LANL 2005o). 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

[30]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.

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.

Any investigation-derived waste generated during the site investigation process would 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 degrees Fahrenheit (-196 degrees Celsius)—as the circulating medium. The nitrogen stream freezes moisture in the ground surrounding the borehole, thus stabilizing it (DOE 1998).

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 project-specific analysis 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 830. LANL staff has developed a documented safety analysis for surveillance and maintenance of the sites (LANL 2004o).

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 WWTP	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, MDA = material disposal area, TA = technical area, WWTP = Wastewater Treatment Plant.
[a] An additional site is outside the LANL boundary in Bayo Canyon.
Source: LANL 2004o.

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

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 handtools 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 meters) 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; handtools 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, LANL must screen potential corrective measure technologies must 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. The investigations will establish conceptual models and evaluate the likely performance of the MDAs 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. 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.**

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.

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

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, interlocking boreholes filled with grout would surround each of the 6-foot shafts. A concrete cap would be installed. A third alternative is discussed in Section I.3.3.1.1.2 (LANL 2006a).

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 considered for encapsulation of the nine disposal shafts at MDA H (LANL 2003d). 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 2003d).

The Kajima system may not be effective for all disposal units considered in this project-specific analysis. 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.[31] 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 project-specific analysis. 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.[32]

Compacted clay cover. A 1- to 3-foot (conversion) layer of compacted clay would be placed over the tops of disposal units. Because clay, when effective, has a very low permeability and

[31] See Section I.3.3.1.1.6 for a discussion on applying vitrification to waste in an entire disposal unit. In this case, vitrification is used for long-term waste stabilization.
[32] The asphalt layer at MDA AB was removed in 1999 and an evapotranspiration cap installed (LANL 1999a).

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 2003d).

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 capillary barriers include an interface between an upper fine-textured soil and lower coarse-textured material.[33] 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, Nyhon, and Davenport 2005; Nyhon 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.

[33] *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).*

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 1999a).

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 2003d).

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 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 2003d).

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 2003d).

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 2003d).

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 2003d, FRTR 2005).

Vitrification. In situ vitrification uses an electric current to melt soil or waste at temperatures from 2,900 to 3,650 ^{o}F (1,600 to 2,000 ^{o}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 2003h, 2004f).

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 2004a).

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 2003d).

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.3.3.2.1; the last two are addressed in Section I.3.3.2.2. Some case studies are summarized in Section I.3.3.2.3.

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.**

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

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 Notice of Intent Regulatory corrective action approval NEPA authorization 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.

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** (from 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

(Sandia 2003b). 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–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.

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	System consists of a 80-foot-wide (24-meter-wide) girder, two trolley assemblies with vertically

Equipment	***Comments***
Telerobotics Retrieval System	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.

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.

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.

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 2003d):

- *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.[34] 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.

[34] *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.*

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 (soon 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 at Area G, and because LANL personnel must complete remediation at MDA G by the end of 2015, LANL is developing new low-level radioactive waste disposal capacity within Zone 4 at TA-54 (see Section I.4.9).

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. A web site by the U.S. Army Corps of Engineers provides information about 21 operating commercial hazardous waste landfills (http://www.environmental.usace.army.mil/library/pubs/tsdf/sec2-3/sec2-3.html). Information about six hazardous waste sites near LANL is provided in **Table I–33**.

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[35] low-level radioactive waste disposal facility near Barnwell, South Carolina; the U.S. Ecology low-level radioactive waste disposal facility on the Hanford

[35] *Chem-Nuclear, LLC, is a wholly owned subsidiary of Duratek, Inc.*

Reservation; the Envirocare of Utah disposal facility near Clive, Utah; the Waste Control Specialists Facility near Andrews, Texas; and DOE's Nevada Test Site (NTS).

Table I–33 Hazardous Waste Operations Near Los Alamos National Laboratory

Operator, Location, and Distance	*Operations*	*Waste Groups Accepted*	*Waste Groups Not Accepted*
Laidlaw Environmental Services Westmorland, California 816 miles (1,313 kilometers)	Solidification/stabilization Physical treatment Chemical treatment Landfill Neutralization Transportation services		Radioactive materials Infectious materials Forbidden explosives Compressed gases Municipal garbage/refuse
Laidlaw Environmental Services Englewood, Colorado 422 miles (679 kilometers)	Solidification/stabilization Physical/chemical treatment Landfill Solvent collection/blending Microencapsulation Macroencapsulation Contracted transportation		Radioactive waste Compressed gases Reactive waste Explosives PCBs > 50 parts per million Dioxin > 1 part per billion Infectious waste
U.S. Ecology Beatty, Nevada 784 miles (1,262 kilometers)	Solidification/stabilization PCB services Landfill	Wastes exhibiting: - Ignitability - Corrosivity - Reactivity - Toxicity (some exceptions)	
Laidlaw Environmental Services Waynoka, Oklahoma 564 miles (908 kilometers)	Wastewater treatment Solvent recovery Stabilization Solidification Landfill	Ignitables Corrosives Toxics Most Listed wastes	
Waste Control Specialists Andrews, Texas 431 miles (694 kilometers)	Landfill Neutralization Solidification/stabilization	Acidic/corrosives Metal Cyanides PCBs Dioxins Reactives Solvents Halogenated organics	
Laidlaw Environmental Services Lake Point, Utah 698 miles (1,123 kilometers)	Wastewater treatment Solvent recovery Solidification/stabilization Neutralization Fuel blending PCB services Oxidizer deactivation Landfill Transportation	Ignitables Corrosives Cyanide Toxics PCBs Halogenated organics	

PCB = polychlorinated biphenyl.

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.[36] The U.S. Ecology facility accepts waste only from the eight states composing the Northwest Interstate Compact and from the three

[36] *South Carolina Code of Laws, Title 48, Chapter 46, Atlantic Interstate Low-Level Radioactive Compact Implementation Act.*

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 Envirocare of Utah disposal facility near Clive, Utah, accepts Class A[37] 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 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 (Envirocare 2003).

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 2005).

DOE's Nevada Test Site (NTS) 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 NTS. (LANL has, in the past, shipped waste to NTS for disposal.)

Transuranic waste capacity. Transuranic waste disposal capacity is available at WIPP near Carlsbad, New Mexico. WIPP currently accepts defense-generated, contact-handled 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. WIPP expects to receive remote-handled transuranic waste (DOE 2002a, WIPP 2004).

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 high explosive (HE), HE residues in soil, barium, and asbestos; and low levels of uranium, lead, and cadmium. The closure process began in February 1997 (LANL 2001c), when a clean closure

[37] 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.

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 2001c). Work crews used high-pressure water to remove debris potentially contaminated with HE (LANL 2001d). Nonremote excavation of contaminated soil beneath the landfill began after the May 2000 Cerro Grande Fire and was completed in March 2001. Additional material was removed in February 2002 (LANL 2001c).

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 2001c).[38] 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 (Sandia 2003a).

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 (Sandia 2003a): 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

[38] *Revised waste summaries are in (LANL 2003e).*

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 2004a, LANL 2005a). An investigation program has been completed and submitted to NMED, along with an addendum. A Corrective Measures Study Report for MDA H was completed in May 2003 (LANL 2003d) and an environmental assessment in June 2004 (DOE 2004a). The corrective measure alternatives considered included capping with an evapotranspiration cover, removal, and partial or complete encapsulation of the shafts.

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 2004a). 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 2004a).

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 structure 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 2004a).

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 2004a]).

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 2004a).

After excavation and waste sorting is complete, the site would be restored. Stored overburden would be placed back in the hole and additional fill trucked in. After grading the filled area, stored topsoil would be reused and the site revegetated (DOE 2004a).

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 2004a).[39]

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.
- 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 project-specific analysis are generally deeper than those analyzed (except for MDA H).
- The large MDAs considered in this project-specific analysis frequently contain transuranic and other radionuclides and often present external radiation hazards.
- The large MDAs considered in this project-specific analysis 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

[39] *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 2004a).*

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.

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.

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 off site.

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 run-on, 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. For conservatism, the former is assumed. 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 this SWEIS.

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 1999a). 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, run-on and runoff, precipitation rate, evapotranspiration, and biointrusion (see, for example, Appendix C of the *MDA Core Document* [LANL 1999a]). 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 Consent Order requires closure of MDA G within TA-54 by August 31, 2015. 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 removal of waste management operations from MDAs G and L so that these areas can undergo closure is analyzed in 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 2005i). 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 permitted 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.

Table I–34 Belowground Storage and Disposal Units at Area G

AEA-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 CMPs (stored atop Pit 29)	Pit 29 (below storage of transuranic waste CMPs) Shaft 124

AEA = Atomic Energy Act, CMP = corrugated metal pipe, RCRA = Resource Conservation and Recovery Act.
[a] Units regulated under RCRA and Corrective Action Requirements are also regulated by DOE under the AEA.
[b] Unused and empty.
Source: LANL 2005i.

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 2005i).

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).

Closure of MDA G within the constraints of the Consent Order will occur as waste management operations and facilities are removed 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 2005i).

While MDA G is being closed, new low-level radioactive waste disposal capacity would be developed in Zone 4 at TA-54. Six buildings currently outside of MDA G and across from MDA 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 2005i).

Table I–35 Closure Phases for Area G

Phases 1 and 2 (Western Portion of Area G): 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 of Area G): 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 of Area G): 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 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 2005i.

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 Section H.3.3.

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 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:[40]

- 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.)

[40] *40 CFR 191 also contains qualitative requirements pertaining to the use of active and passive institutional controls, monitoring, resource avoidance, and so forth.*

- 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.

Without prejudicing the analyses needed to make a decision on this option, it may be noted 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 occur assuming future (that is, after year 2133) loss of institutional control at the generator-storage sites. Consequences included those that may be experienced by a future inadvertent human intruder into the 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).[41]

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.

---

[41] *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.*

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):

- *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 (MRA) 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).

I.3.3.2.1.2.3 Final Stabilization of Area G

Stabilization of Area G 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 2005i).

Waste Generation. It was postulated that small quantities of waste would be generated as part of capping MDA 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.

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		52,000		5.2×10^{6}
Mercury		77		77		100,000		100,000
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.

Bulk Materials for Area G Final Cover. The cover for MDA G is being developed to support the revised performance assessment and composite analysis for the active low-level radioactive waste disposal site. The final 65-acre cover will also cover the active and inactive disposal units that are subject to RCRA closure and the Consent Order (LANL 2003e, 2005i). 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 2002h).

The current material list for MDA G includes (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 project-specific analysis report, 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 project-specific analysis for MDA G are listed in **Table I–38**.

Table I–38 Estimated Cover Materials for Material Disposal Area G

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 project-specific analysis (LANL 2005i):

- 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.[42] The waste is sent off site for further processing (as needed) and disposal. Waste management units at Area L are summarized in **Table I–39** (LANL 2005i).

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, CSU = container storage unit, MDA = material disposal area.
Source: LANL 2005i.

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 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 2005i).

In addition to remedial investigations, a pilot study is being conducted to determine the effectiveness of an extraction system for the vapor phase volatile organic compound plume under the site (LANL 2005i).

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 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 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

[42] *Container storage units at MDA L are described in Attachment G of the LANL TA-54 Part B Permit Renewal Application (LANL 2003i).*

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 2005i). 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.

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.

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. Planned schedules for closure of MDA L and subsurface Area L RCRA units are given in the 2005 TA-54 Status Report (LANL 2005i). DD&D of structures would occur over about 13 months, mostly during FY 2009. Placement of Area L covers would occur over 14 months, beginning about November 2009 (LANL 2005i).

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 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.[43] 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).

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 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, old fencing would be removed and disposed of, and that existing concrete and asphalt covering some of MDA A and MDA L would be removed and disposed of.

[43] Pipes beyond 50 feet (15 meters) would be removed under remedy programs for other solid waste management units.

Table I–41 presents the assumed volumes of solid waste produced from site preparation, where the linear footage of fencing 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).[44] 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.[45]

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	4,800	140
T	1,500	43
U	700	20
AB	450	13
C	6,900	200
G	9,500	270
L	500	14

MDA = material disposal area.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; feet to meters, multiply by 0.3048;. Numbers have been rounded.

Portions of MDAs A, B, L, and G are covered with asphalt or concrete that would be removed before installation of the site covers. These surface areas were assumed as follows:

- MDA A: Estimated upon assumption of 10 to 20 percent of surface covered with asphalt. Fifteen percent of 1.3 acres (0.53 hectares) is 8,200 square feet (762 square meters).
- MDA B: Estimated from Section I.2.3.2.2 (1,500 by 120 feet = 180,000 square feet [457 by 37 meters = 16,909 square meters]).
- MDA L: Estimated by scaling from Figure B–1 of the MDA L Historical Investigation Report (LANL 2003b).
- 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.)

---

[44] 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.

[45] From (Reade 2005), the bulk density of common rubbish (garbage) is 480 kilograms per cubic meter (30 pounds per cubic feet).

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.
[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.

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

MDA = material disposal area.
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 project-specific analysis. 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 acres [0.3 hectares]) 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**.

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	6.0	260,000	35,000	2,900	38,000	95,000	7,900	100,000
T [a]	6.2	270,000	36,000	3,000	39,000	98,000	8,200	110,000
U	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] Does not include 0.75 acres of riprap comprising 1,210 cubic yards, assuming a thickness of 1 foot.
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 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–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	2,700	230	2,900	7,400	620	8,000
21	T [a]	2,800	230	3,000	7,700	640	8,300
21	U	90	8	100	250	21	270
49	AB (Areas 1–4)	630	53	690	1,700	140	1,900

[a] Delivery of riprap for Material Disposal Area T would entail an additional 72 shipments.
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.[46] 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**).

[46] 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 1999a). 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 2005a). 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).

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.

In addition to MDAs, other landfills or contaminated areas may require capping. These include the Airport Landfill, the landfill at Area 6 at TA-49, and contaminated soils at Area 12 at TA-49. Capping of the Airport Landfill should be completed by the remedy completion date in the Consent Order, March 31, 2007 (LANL 2005c). Remediation decisions about Areas 6 and 12 of TA-49 have not yet been made.

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 2004a). To remediate MDA H, the final evapotranspiration cover proposed for MDA H (DOE 2004a) would cause the importation (using onsite LANL or local sources) of about 2,185 cubic meters (2,860 cubic yards) of bulk materials. 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.

The Consent Order requires remediation of MDA H by September 30, 2006. The Consent Order also allows for a delay in completion of remediation commensurate with a delay in a regulatory decision. Although the required corrective measure evaluation for MDA H has been submitted, NMED has not determined the corrective measure to be implemented. 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. MDAs for which hydraulic barriers are contemplated include MDA A and MDA T. 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.

A hydraulic barrier is considered for MDA A because shallow perched water may be in the soil overlying bedrock. This shallow cutoff 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 (244 meter) wall would require 20,000 square feet (1,858 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 (1,859 cubic meters) of bentonite and native materials would be needed.

A hydraulic barrier is also contemplated for MDA T because shallow perched water may be in the soil overlying bedrock. The barrier would 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 (351 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 (351 meters) and an average depth or 25 feet (7.6 meters), about 28,750 square feet (2,671 square meters) of HDPE sheeting would be required, plus 3,500 cubic yards (2,678 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 (SVE) 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 2003a, 2003b, 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. A pilot study will be implemented at MDL using entailing an active system to evaluate the rate of contaminant concentrations around the source terms. Two boreholes will be constructed to depths of 215 feet (66 meters) in the immediate vicinity of two source zones. The equipment used in the extraction process is portable (being usually mounted on a trailer) and will be powered by electricity from Area L infrastructure. Volatile organic compounds removed from the plume will be treated using catalytic oxidation or other methods as appropriate. The results of the intended 4-month study will be used to evaluate the potential of SVE 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 2005k).

Active SVE 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 1999i). 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 (PSVE), also known as barometric pumping, uses differences between atmospheric pressure and subsurface pressures to move contaminants from the vadose zone to the soil surface. PSVE 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). PSVE systems have been used at Hanford (Initiatives 2001) and Savannah River (WSRC 1997, 2000).

Whether active or passive, SVE 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. The jet grout system developed by AEA Technology 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 1999b).

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 1999b).

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 (191 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 1999b).

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 3.2 cubic yards (2.46 cubic meters) (LANL 2003o). 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.[47] 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

[47] *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 1992b) and because the sludge has been left in place for several years.*

about 50 percent results in a final waste volume of 33.7 cubic yards (25.8 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.

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 could be placed into 662 drums, which would require about 16 shipments to WIPP, assuming the waste can be contact handled.[48]

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**.

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	2/23/2010	6/23/2011	16
T	6/19/2009	12/19/2010	18
U	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	14

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 2005i, DOE 2004a). 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.

[48] *This waste was conservatively included for the Capping Option.*

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.

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 1999a) 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 between 2005 and 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 1999g). 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.[49]

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 1993g). 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 1999g). The distance to the regional aquifer is 1,300 feet (396 meters) (LANL 2005f).

[49] *The entrance to the borrow pit is near a steep hill, and there is little room for an acceleration lane (LANL 2003k).*

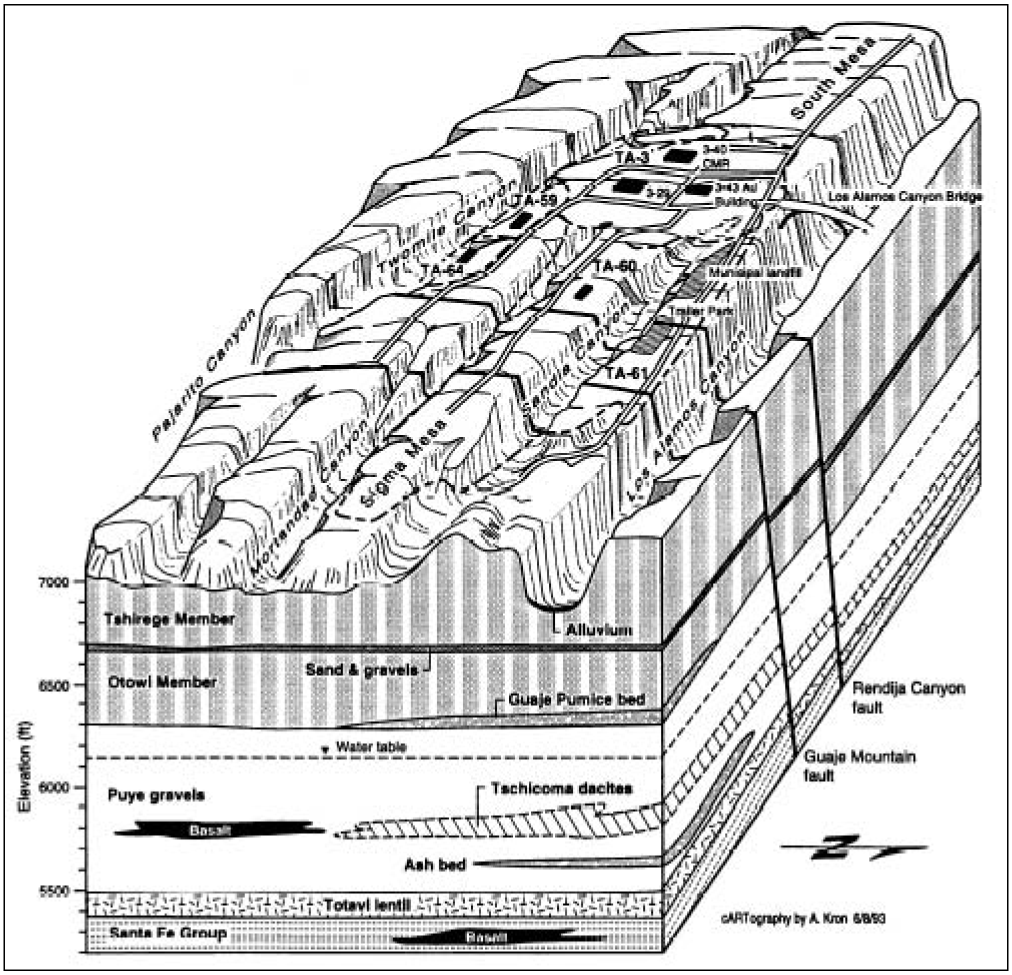


Figure I–21 Conceptual Geologic Model of Operable Unit 1114

Used for soil and rubble storage and pickup, the borrow pit is within a 43-acre (17-hectare) site (LANL 2003k). 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 2004j, 2005f).

Figure I–22 is an aerial photograph of the triangular-shaped clearing in the forest that comprises the borrow pit (LANL 2003k). Figure I–22 shows the jog in the stream in Sandia Canyon that occurs at the borrow site.[50] **Figure I–23** is a view from within the pit looking to the east (LANL 2003k). The knoll to the left (north) in the figure shields the pit from visibility from East Jemez Road.

[50] *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*

I.3.3.2.4 Removal Options

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 or breaking up 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.[51] It was 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 off site.

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 of topsoil and existing cover soil was assumed to be removed from the existing MDA covers and 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

[51] *It was assumed that generation of solid waste, chemical waste, and low-level radioactive waste during site preparation would be the same as those for the Capping Option.*

(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 a containment structure 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 containment structure 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 will be very 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.[52] 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.[53] This DOE study developed its estimates through surveys of DOE national laboratories. Estimates for LANL MDAs are summarized in **Table I–53** (DOE 1999c, 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 project-specific analysis to enable enhanced analyses of possible impacts of radioactive waste transportation.[54]

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 on site or sent to another site. No onsite disposal capacity now exists for mixed low-level radioactive waste.

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 bases for the solid waste and material summaries are provided in Sections I.3.3.2.4.2.1 through I.3.3.2.4.2.8.

---

[52] 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 are 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.

[53] The great bulk of this transuranic-contaminated material was disposed before operational distinctions between low-level and transuranic wastes were made at DOE sites.

[54] 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 1997).

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	20,475 [c]	–	–	525	20,475
50	C	2,600	100,400 [d]	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	–	4,300 [e]	–	–	–	4,300 [e]
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 project-specific analysis to enable enhanced analysis of possible impacts from radioactive waste transportation.
[c] The DOE database (DOE 1999c) estimates that 5,000 cubic meters of the alpha-contaminated low-level radioactive waste in MDA B may be mixed waste.
[d] The DOE database (DOE 1999c) estimates that 25,100 cubic meters of the alpha-contaminated low-level radioactive waste in MDA C may be mixed waste.
[e] Later LANL analyses (LANL 2004f) determined that the transuranic content of this waste was over-estimated.
Note: To convert cubic meters to cubic yards, multiply by 1.308.
Sources: DOE 1999c, 2000a.

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.

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–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	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	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	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.

Note: Volumes are in situ volumes. As-shipped volumes would be larger because of swell of excavated material and packing efficiencies being less 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	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	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	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	1,400	870	2,200	3,400	230	8,100
C	4,000	24,000	28,000	14,000	670	70,000
G	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	34	43	78	41	6	200
AB	480	830	1,300	990	80	3,700

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–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	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	3	–	1 [b]	–	3
C	1 [b]	–	–	–	1 [b]
G	–	–	–	–	–
L	–	13	–	–	13
T	–	–	–	–	–
U	–	–	–	–	–
AB	–	–	–	–	–

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 acres (0.08 hectares) 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[55] (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 acres (0.36 hectares) of soil having an average thickness of 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 action 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 acres (0.36 hectares).

From Table I–62, 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 1999c, 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 1999c). 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

[55] *The soil was contaminated from leaking drums of stable iodine in a NaOH solution.*

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 hazardous waste. It was added to 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–5), 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 AEA Technology 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, remediation, and restoration (IRR) program at MDA B that will excavate trenches perpendicular to the length of the MDA at up to 12 locations, as well as numerous test pits. The quantities of waste that will result from this IRR will depend on the information that is gained from the IRR as it progresses. The IRR may result in quantities of waste ranging from 840 cubic yards (640 cubic meters) to several thousand cubic yards (LANL 2005m). (See Section I.3.3.2.7 of this project-specific analysis.)

For purposes of this project-specific analysis, a bounding analysis was performed on the quantities of waste that could result from complete removal of MDA B. This analysis resulted in larger quantities of waste than those estimated for the IRR**,** and was performed in recognition of the uncertainties inherent in estimating waste volumes that may result from MDA B removal.

From the 2004 Investigation Work Plan for MDA B (LANL 2004b) 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 hectares]) 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 action 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.

From using the DOE database for buried transuranic-contaminated waste (DOE 1999c, 2000a), it was assumed that complete removal of MDA B would generate 686 cubic yards (525 cubic meters) of contact-handled transuranic waste, 20,230 cubic yards (15,475 cubic meters) of alpha low-level radioactive waste and 6,500 cubic yards (5,000 cubic meters) of mixed alpha low-level radioactive waste. This assumption may be a significant overestimate.[56] Improved estimates of transuranic-contaminated materials buried at MDA B will arise from the MDA B investigation, remediation, and restruction 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 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 and operating facilities 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 Section H.2.

---

[56] *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.*

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 project-specific analysis, 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 3,318 cubic yards (2,538 cubic meters) of alpha-contaminated low-level radioactive waste (DOE 1999c, 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).[57] 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 248 cubic yards (190 cubic meters) of alpha-contaminated low-level radioactive waste (DOE 1999c, 2000a). Because the cement paste 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).[58] 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

---

[57] 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.
[58]Uncontaminated topsoil (such as that over the shafts) is included in this volume.

(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 project-specific analysis, 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).

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.

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 2004f), 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.[59]

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.

---

[59] 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.

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 1999c, 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 appears to be reasonable, in that it is consistent with an assumption that the bulk of the contamination is within a radius of 10 feet (3 meters) of 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.[60] 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 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 significant 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 action levels and 13,900 cubic yards (10,600 cubic meters) of waste. The material meeting the screening action 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

[60] Burial depth may be highly variable. Waste was dumped in the test holes and in an unknown number of shallow holes of small diameter.

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.[61] 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 1999c, 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

[61]Aassuming 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).

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 1999c, 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 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 action 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 Section H.3. The specific disposal units that will require remediation under the Consent Order are currently unknown. Therefore, 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,[62] and 194 shafts. The total volume of waste to be generated from pit removal was assumed to correspond to the field-

[62] The transuranic waste in Trenches A–D will be removed and shipped to WIPP, as addressed in Section H.4. The backfill in these trenches was conservatively assumed to be contaminated and was thus included in the removal volumes.

measured volumes for the pits as given in the Investigation Work Plan 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.

Although Area G covers about 63 acres (25.5 hectares), because of topography, only about two-thirds of this area is expected to contain radioactive waste. 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 action 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 for disposal of both contaminated and uncontaminated materials, but was used exclusively for radioactive waste.

From the DOE database on buried transuranic contamination (DOE 1999c, 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-level radioactive waste. The radioactive inventory within the pits composing MDA G was estimated using information from the Performance Assessment and Composite Analysis for Area G (LANL 1997a). Analysis of this inventory suggested that very 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 1999c, 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.

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 have been listed in Table I–48. Decisions about which disposal units may be remediated (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 Section H.4, 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 hectares) 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. 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 action 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.

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**.

Table I–57 Waste Projections for Removing Remaining Material Disposal Areas

Nonliquid Wastes (cubic yards) [a]					
MDA	*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)					
MDA	*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 Operable Unit 1132 (LANL 1993e).

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					
MDA	***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					
MDA	***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.

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).

MDA H. Remediation of MDA H has been addressed in corrective measure investigations and evaluations, as well as NEPA analyses (DOE 2004a). LANL staff has proposed installing an evapotranspiration cover, but, among other remediation alternatives, also considered the alternative of complete removal of waste from MDA H. Complete removal would generate about 610 cubic yards (470 cubic meters) of chemically hazardous waste and about 4,900 cubic yards (3,700 cubic meters) of low-level radioactive waste (DOE 2004a). Using the waste shipment assumptions used in this project-specific analysis (see Section I.3.5), this waste volume implies about 50 chemical waste shipments and 350 low level radioactive waste shipments over the 4 years projected in the MDA H environmental assessment (DOE 2004a) for waste removal. LANL staff have estimated that removal would cause the exhumation of about 50,000 cubic yards (78,000 cubic meters) of clean soil that would be stockpiled and returned (DOE 2004a). About 5,500 cubic yards (4,200 cubic meters) of additional backfill may be required, to account for the waste removed, as well as about 650 cubic yards (500 cubic meters) of topsoil and other growth media. Using the material transportation assumptions used in this analysis, delivery of the backfill would require 390 one-way shipments from a local source, as well as 50 shipments of topsoil and soil amendment.

The Consent Order requires remediation of MDA H by September 30, 2006. The Consent Order also allows for a delay in completion of remediation commensurate with a delay in a regulatory decision. Although corrective measure evaluation for MDA H has been submitted, NMED has not determined the corrective measure to be implemented. Assuming that remediation occurs during the time period covered in this SWEIS, then the waste and bulk material volumes and shipments projected in this section could be augmented by those summarized in the above paragraph.

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	1/23/2009	6/23/2011	29
T	12/19/2008	12/19/2010	24
U	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

The schedules presented in Table I–70 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 one or more MDAs, then schedules for completion of corrective measures at these MDAs would 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 Containment Structures for Material Disposal Area Removal

Containment structures may be used for removal of waste from some MDAs. The structures would be modular enclosures, possibly constructed of fabric over metal frames. Similar structures 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 structure (to be moved as needed) may be cost-effective. For other MDAs, two or more structures 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 (TWISP), 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 2002g).

A decision about the use of a containment structure 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 structure 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, Remediation, and Restoration Program

Under the MDA B investigation, remediation, and restoration (IRR) program, LANL staff would excavate trenches perpendicular to the length of the MDA, at up to 12 locations, as well as numerous test pits. From a review of past disposal history and site investigations, and based on workshops attended by subject matter experts, MDA B was divided into 10 sections for purposes of investigation. The locations of these 10 sections are shown in **Figure I–24**, and the waste volume projected in each of the 10 sections is summarized in **Table I–62** (LANL 2005m).

Table I–62 Estimated Waste Volume by Section at Material Disposal Area B

Section	*Description*	*Estimated Dates of Use*	*Estimated Trench Depth (feet)*	*Estimated Maximum Capacity (cubic yards)*	*Estimated Waste Volume Range (cubic yards)*
1	Chemical slit trenches	1947 to 1948	5	1,177	704–1,111
2	Chemical slit trenches	1947	5	1,177	778–1,111
3	Chemical slit trenches/debris piles	1947	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 to 1946	12	3,872	2,333–3,111
8	Debris pit(s)	1945 to 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

Note: To convert feet to meters, multiply by 1.308; cubic yards to cubic meters, multiply by 0.76456.
Source: LANL 2005m.

These wastes are projected to be made up of solid wastes (debris, clean soil, asphalt, and recycle material); low-level radioactive waste (soil, debris, and radioactively contaminated asbestos); mixed low-level radioactive waste (soil, liquids, and debris); hazardous (RCRA) waste (soil, acid carboys, lab packs, lecture bottles, debris, repackaged liquids, gas cylinders, and shock-sensitive containers); and TSCA wastes (material containing asbestos or PCBs) (LANL 2005m).

The investigation, remediation and restoration program would be conducted in four phases. The conduct of each phase subsequent to Phase 1 would depend on the results of the preceding phase (LANL 2005m). The phases are summarized below (LANL 2005m):

- Phase 1 – Work planning
- Phase 2 – Basic removal trenching and test pit program
- Phase 3 – Evaluation and alternatives assessment
- Phase 4 – Implementation of final remediation alternative

Phase 2 will be conducted under a containment structure and will involve an integrated trenching and test pit investigation program that will include removal of high-hazard wastes. Investigation observations and sampling results will be used to assess the nature and extent of hazardous constituents in MDA B, the distribution of wastes among waste types, and waste handling and treatability concerns.

Equipment, procedures, and administrative controls will be used to ensure safety and environmental protection during the IRR. Visual inspections, using direct or remote means, will occur continuously during removal of overburden and trench contents. Several monitoring or remote sensing tools will be used to monitor for radiological conditions, volatile organic compounds, gases, heat of investigative trench contents, and pyrophoric materials. Interstitial soils and fill will be removed iteratively to carefully expose trench contents for inspection and identification. Techniques such as vacuum or remote excavation may be used to ensure safety and prevent breakage of waste containers. Problematic wastes may be contained before being removed from the excavation using containment methods such as overpacking, cylinder coffins, blast boxes, or plastic sheeting (LANL 2005m). Compressed gas cylinders, for example, may be placed within overpacks designed to contain the contents of the cylinder if it leaks or fails during transport (IES 2005). Unknown materials will be safely transported to a Definitive Identification Facility (DIF) for analysis (see below).

Up to 12 trenches and 40 test pits will be placed at representative locations on MDA B Sections 1 through 10. Waste volumes (including high-hazard wastes) resulting from each trench may range between 70 and 300 cubic yards of waste, not including overburden and low-hazard wastes. Additionally, a minimum of two deep boreholes will be placed next to the site, with the intent of assessing contaminant migration to the Cerro Toledo interval (LANL 2005m). Soil and overburden removed as part of the program will be stockpiled and either reused as clean backfill or disposed of as waste.

Phase 3 will evaluate the investigation results, leading, among other things, to assessments of remediation alternatives. LANL personnel expect that the alternatives evaluation process will lead to final remediation and restoration (Phase 4). Options include comprehensive removal and restoration, removal and restoration of selected sections, or closure and stabilization of the MDA in its existing condition. LANL personnel expect that the option of comprehensive removal and restoration may involve removal of about 24,000 cubic yards (18,400 cubic meters) of waste (LANL 2005m). This estimated volume (and estimated waste shipments) is bounded by that assumed for this project-specific analysis (Section I.3.2.4.2.2). Removal operations would include verification sampling; implementation of stabilization and surface water diversion measures (including temporary stabilization requirements while a trench or pit is open and awaiting verification sampling data); implementation of final restoration measures, including the placement and compaction of backfill equaling the amount of contaminated material removed; 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.3.2.4.2.2.

The planned IRR 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—that is (LANL 2005m):

- Modification or installation of utilities to support administrative facilities and projected work zones
- Preparation of a laydown area for all necessary products and equipment and for stockpiling, waste staging, and loading material removed during site work
- Installation and modification of access and haul roads and routes
- Installation of administrative facilities including, but not limited to, decontamination pads, waste storage and processing pads, and a Definitive Identification Facility (DIF)
- Installation of the work area enclosure
- Installation and testing of safety systems for all enclosures, the DIF, or other work areas
- Installation of run-on diversion structures
- Maintenance, enhancement, and repair of MDA B fencing
- Completion of prefieldwork surveys, including land, radiological, and biological surveys
- Collection of supplemental background samples for comparison of underlying tuff contaminant concentrations
- Installation of area and perimeter monitoring systems and equipment
- Execution of emergency response drills

Support facilities would include a Definitive Identification Facility and storage area, a Waste Processing Facility, field office and laboratory facilities, and spoil staging areas (LANL 2006a). It is expected that none of the following described facilities or capabilities would intrude on habitat or buffer areas of protected wildlife.

The *Definitive Identification Facility (DIF)* and storage area would encompass an area of a few acres located on previously disturbed land behind the currently occupied LANL Ecology Building. This storage area would be enclosed within chain-link fencing with a central temporary "Sprung" type dome structure as the major feature. The dome would enclose several other temporary buildings, such as a Permacon®-type building[63] 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 structure 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* (WPF) is intended to 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 off site. Some temporary buildings would house administrative activities. Various other structures may be necessary to store RCRA and radioactive materials before shipment. The WPF 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 WPF 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 RCRA regulations as it will function as a treatment, storage, or disposal (TSD) facility. The WPF 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.

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

[63] A Permacon® unit is a type of modular containment system (NFS RPS 2005).

administrative activities. The buildings and associated parking areas would fit on less than 2 acres (0.8 hectares) 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 TSD facility for RCRA waste accumulation. It is expected that this waste material will feed into the other waste streams being sent to the Waste Processing Facility.

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 hectares).

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 run-on 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 (32.4 hectares) of previously disturbed area and up to 30 acres (12.1 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, existing LANL capacity to characterize and repackage waste may be overwhelmed. 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 such as those contemplated for the MDA B investigation, remediation, and restoration program (see Section I.3.3.2.7).

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 dome structures. 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 ultimately receiving the wastes.

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 generated 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 remediation of a selection of larger PRSs, including those that have been remediated in the past and those to be remediated in the future. Information from Section I.3.4.2 was used to extrapolate to the numerous other PRSs that may be remediated through FY 2016 (see Section I.3.4.3).

I.3.4.1 Possible Treatment Technologies

A very large number of treatment technologies can 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 treatment technologies are the Interstate Technology and Regulatory Council (ITRC 2005) 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 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.

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.[64]

Waste volumes for this project-specific analysis 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.

[64] *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–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.

Waste volumes for this analysis 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 2003c). The corrective measure alternatives are listed in **Table I–64** (LANL 2003c).

Table I–64 Alternative Corrective Measures for the 260 Outfall

Site Area	*Alternative Number*	*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 PRB (ZVI or GAC 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	

GAC = granulated activated carbon, PRB = permeable reactive barrier, ZVI = zero valent iron.
Note: To convert cubic yards to cubic meters, multiply by 0.76456; from feet to meters, multiply by 0.3098.
Source: LANL 2003c.

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 2002d). 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 2002d). The voluntary corrective measure was subsequently revised and material projected to be solidified on site was removed. Removal occurred in 2003 (LANL 2003m).

SWMU 73-002 Incinerator Ash Pile. Investigations of the ash pile are ongoing (see Section I.2.7.11). Current estimates are that the pile contains 4,500 cubic yards (3,341 cubic meters) of ash debris (LANL 2005b). This waste was assumed to be solid waste.

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 (18.4 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 2005s). Generation of waste from this project was estimated as 3,000 cubic yards (2,294 cubic meters) of solid waste and 500 cubic yards (382 cubic meters) of low-level radioactive waste (LANL 2006a). An accelerated corrective action completion report was submitted to NMED on December 15, 2005.

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. An annual average waste generation rate of 5,200 cubic yards (4,000 cubic meters) was conservatively projected, as shown in **Table I–65**. 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 Annual Waste Generation from Remediating Additional Potential Release Sites

Parameter	*Solid Waste*	*Chemical Waste* [a]	*Low-Activity Low-Level Radioactive Waste*	*Mixed Low-Activity Low-Level Radioactive Waste*	*Total 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.

It was assumed the total annually affected area would be 10 acres (4.0 hectares).

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 on site 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 on site (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 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 (LSA) 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.

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	2.3	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 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 2004b). Remote-handled transuranic waste was assumed to be shipped in RH-72B casks at three drums per cask (Jensen, Devarakonda, and Biedscheid 2001).

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 off site after this treatment should be comparatively small in volume.

Given these assumptions, unit (per shipment) dose and risk estimates were developed for shipments of waste to treatment and disposal facilities. The estimates were performed using the RADTRAN, Version 5, computer code 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 the same assumption. 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 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 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. 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	Latent Cancer Fatality	Person-Rem	Latent Cancer Fatality	Radiological (Latent Cancer Fatality)	Nonradio-logical (fatalities)
DOE Site	LSA [b]	2,500	0.00137	8.21×10^{-7}	0.000274	1.64×10^{-7}	1.30×10^{-8}	0.0000249
DOE Site	LLW and MLLW [c]	2,500	0.0124	7.46×10^{-6}	0.00392	2.35×10^{-6}	1.67×10^{-8}	0.0000249
DOE Site	RH-LLW and MLLW [d]	2,500	0.0108	6.49×10^{-6}	0.00203	1.22×10^{-6}	3.28×10^{-13}	0.0000249
Commercial Site	LSA [b]	2,153	0.00118	7.06×10^{-7}	0.000234	1.40×10^{-7}	9.63×10^{-9}	0.0000211
Commercial site	LLW and MLLW [c]	2,153	0.0107	6.41×10^{-6}	0.00334	2.01×10^{-6}	1.41×10^{-8}	0.0000211
WIPP	CH-TRU [e]	1,210	0.0228	0.0000137	0.00725	4.35×10^{-6}	3.30×10^{-11}	0.0000143
WIPP	RH-TRU [e]	1,210	0.0346	0.0000208	0.00919	5.51×10^{-6}	7.66×10^{-13}	0.0000143

CH = contact-handled, LLW = low-level radioactive waste, LSA = low-specific activity, MLLW = mixed low-level radioactive waste, RH = remote-handled, TRU = transuranic waste, WIPP = Waste Isolation Pilot Plant.

[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.

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 a final evapotranspiration cover. The General's Tanks within MDA A are stabilized using a grout mixture, and several smaller 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.
- Wastes associated with remediating additional 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 several SWMUs 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.
- Wastes associated with remediating additional 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.

MDA H. Assuming that remediation of MDA H occurs during the time period covered in this SWEIS, then the waste projections summarized in this section may be augmented by up to 5,500 cubic yards (4,200 cubic meters) of waste over 4 years, as summarized in Section I.3.3.2.4.3.

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	9,200	23,000	25,000	13,000	9,400	9,400	9,400	9,400	9,200	130,000
Chemical waste[b]	4,600	4,400	9,800	10,000	4,500	2,700	3,200	3,400	2,900	2,700	49,000
Low-level radioactive waste	4,700	7,400	81,000	110,000	99,000	95,000	96,000	96,000	95,000	20,000	710,000
Mixed low-level radioactive waste	250	320	21,000	28,000	14,000	10,000	12,000	12,000	11,000	2,100	110,000
Alpha low-level radioactive waste	–	–	77,000	99,000	41,000	31,000	31,000	31,000	31,000	5,700	350,000
Mixed alpha low-level radioactive waste	–	–	22,000	26,000	6,300	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	100	4,600	6,000	1,900	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	21,000	240,000	310,000	180,000	150,000	160,000	160,000	160,000	41,000	1,400,000
Liquid Waste (gallons)											
Industrial liquid waste	0	0	590	860	610	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	1,100	1,200	1,300	1,200	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	2,200	5,100	5,400	4,300	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 of 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	300	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	260	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.

MDA H. Assuming that remediation of MDA H occurs during the time period covered in this SWEIS, then the waste shipments projected in this section may be augmented by up to 400 shipments of waste as summarized in Section I.3.3.2.4.3.

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.

Other materials may include instrumentation for cover infiltration monitoring, cement grout for stabilizing the General’s Tanks in place, and 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.

Material volumes and shipments for the MDAs are summarized in **Table I–75**. 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 LANL or within the vicinity.

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	700	1,800	1,900	980	720	720	720	720	700	9,700
Chemical waste [a]	380	360	820	870	380	220	270	290	240	220	4,000
Low-level radioactive waste	330	520	5,700	7,900	7,000	6,700	6,800	6,800	6,700	1,400	50,000
Mixed low-level radioactive waste	20	25	1,700	2,200	1,100	820	920	970	870	160	8,900
Alpha low-level radioactive waste			6,100	7,900	3,300	2,500	2,500	2,500	2,500	450	28,000
Mixed alpha low-level radioactive waste			1,700	2,000	500	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	12	530	700	220	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	1,600	19,000	24,000	14,000	11,000	12,000	12,000	12,000	3,100	110,000
Liquid Waste											
Industrial liquid waste			1 [b]	1	1 [b]						3
Hazardous liquid waste		1	4	4	3						13
Low-level radioactive liquid waste	1	1	2	2	2	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	3	6	7	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.
[e] 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

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	9100	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	9,700	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

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*										*Total*
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	
Volumes (cubic yards)											
Remove top layer	850	1,400	58,000	75,000	42,000	33,000	35,000	36,000	34,000	6,7000	320,000
Remove additional soil	5,200	6,300	560,000	750,000	470,000	440,000	440,000	440,000	440,000	84,000	3,600,000
Stockpile return	6,100	7,600	600,000	810,000	510,000	470,000	470,000	480,000	470,000	91,000	3,900,000
Additional fill	9,300	9,600	230,000	300,000	170,000	150,000	150,000	150,000	150,000	34,000	1,300,000
Topsoil, soil amendment, etc.	550	630	11,000	15,000	7,700	5,9900	6,200	6,400	6,000	1,500	61,000
Total material moved	22,000	26,000	1,500,000	1,900,000	1,200,000	1,100,000	1,100,000	1,100,000	1,100,000	220,000	9,300,000
Shipments											
Remove top layer	60	97	4,100	5,300	3,000	2,300	2,500	2,600	2,400	470	23,000
Remove additional soil	370	450	40,000	53,000	34,000	31,000	31,000	31,000	31,000	6,000	260,000
Stockpile return	430	540	43,000	57,000	36,000	33,000	34,000	34,000	33,000	6,400	280,000
Additional fill	660	680	16,000	21,000	12,000	10,000	11,000	11,000	11,000	2,400	95,000
Topsoil, soil amendment, etc.	39	45	800	1,000	550	420	440	460	430	110	4,300
Total material moved	1,600	1,800	100,000	140,000	86,000	77,000	78,000	79,000	78,000	15,000	660,000

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 by up to 400 shipments of waste as summarized in Sections I.3.3.2.2.2 and I.3.3.2.4.3.

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.[65]

Several case studies were developed using the Means data that were applicable to the different remediation efforts addressed in this project-specific analysis. 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 from the Computerized Accident and Incident Reporting System database (DOE 2004d) and information from the U.S. Bureau of Labor Statistics for the overall construction industry (BLS 2003). Information from these tables was used for each of the options in this project-specific analysis as discussed below. The assessments developed using the procedures described in this section are uncertain, and their primary value is to identify possible concerns and to compare options.

---

[65] *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	1.0	3.0 [a]	6,292	1.5	0.086	0.053	0.332	0.60	0.36	2.30
Case 1Ab – Small area, thick cap	1.0	8.2 [a]	17,198	1.5	0.175	0.107	0.674	0.44	0.27	1.71
Case 1Ba – Large area, thin cap	20.0	3.0 [a]	125,840	1.5	0.075	0.046	0.289	0.52	0.32	2.00
Case 1Bb – Large area, thick cap	20.0	8.2 [a]	343,963	1.5	0.147	0.090	0.568	0.37	0.23	1.44
Case 2A – Removal of contaminated soil	1.0	1.0	1,613	1.5	0.117	0.038	0.208	3.15	1.01	5.62
Case 3A – Removal of shallow material from small MDA	1.0	15.0	24,200	1.5	1.616	0.520	2.881	2.91	0.94	5.19
Case 3B – Removal of shallow material from large MDA	20.0	15.0	484,000	1.5	1.351	0.435	2.408	2.43	0.78	4.33
Case 4A – Deeper soil or shaft removal	1.0	60.0	48,400	2.0	32.453	12.180	74.157	29.21	10.96	66.74

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.

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	2,295	14,458	3.9	9.8	0.3	0.3	157.8	0.1	0.7
Case 1Ab – Small area, thick cap	4,657	29,342	7.9	19.9	0.5	0.5	320.2	0.1	1.5
Case 1Ba – Large area, thin cap	40,030	252,204	67.7	170.7	4.4	4.7	2,752.0	1.2	12.8
Case 1Bb – Large area, thick cap	78,560	494,953	132.9	335.0	8.6	9.3	5,400.9	2.3	25.1
Case 2A – Removal of contaminated soil	1,636	9,067	2.4	6.1	0.2	0.2	98.9	0.0	0.5
Case 3A – Removal of shallow material from small MDA	22,644	125,480	33.7	84.9	2.2	2.4	1,369.2	0.6	6.4
Case 3B – Removal of shallow material from large MDA	378,611	2,098,079	563.3	1,420.0	36.6	39.3	22,894.1	9.9	106.3
Case 4A – Deeper soil or shaft removal	530,573	3,230,293	867.3	2,186.3	56.3	60.5	35,248.8	15.2	163.7

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.

Table I–78 Remediation Case Study Total Industrial Risks

Case Study	Total Labor Hours	Safety – Construction Industry			Safety – Overall DOE		
		Recordable Injuries	Lost Workdays	Fatalities	Recordable Injuries	Lost Work Days	Fatalities
Case 1Aa – Small Area, Thin Cap	3,750	0.16	1.7	3.9×10^{-4}	0.036	0.21	2.8×10^{-6}
Case 1Ab – Small Area, Thick Cap	7,610	0.32	3.5	7.9×10^{-4}	0.072	0.43	5.7×10^{-6}
Case 1Ba – Large Area, Thin Cap	65,408	2.8	30.0	6.8×10^{-3}	0.62	3.7	4.9×10^{-5}
Case 1Bb – Large Area, Thick Cap	128,364	5.4	58.9	0.013	1.2	7.3	9.6×10^{-5}
Case 2A – Removal of Contaminated Soil	5,087	0.22	2.3	5.3×10^{-4}	0.048	0.29	3.8×10^{-6}
Case 3A – Removal of Shallow Material from Small MDA	70,396	3.0	32.3	7.3×10^{-3}	0.67	4.0	5.3×10^{-5}
Case 3B – Removal of Shallow Material from Large MDA	1,177,047	49.9	540.3	0.12	11.2	67.3	8.8×10^{-4}
Case 4A – Deeper Soil or Shaft Removal	1,413,664	59.9	648.9	0.15	13.4	80.8	1.1×10^{-3}

MDA = material disposal area.

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 × 5.62 gallons per cubic yard × 2.4 tons per 9,067 gallons consumed, or 1.48 tons (1,340 kilograms) of NO_x 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 2.2×10^{-6} rems per hour (the same as the same hourly exposure rate for remediation of the combined PRS area, as discussed in Section I.3.6.4.3).

I.3.6.4.2 Capping Alternative

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 hectares) 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 acres (0.2 hectares) (DOE 2004a). 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 (Sandia 2003b). Idaho National Laboratory projected about 0.4 person-hours 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 small 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).

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 2004a; INEEL 2002a, 2002d; Sandia 2003b; LANL 1981), while one addressed the completed removal of a chemical waste landfill (Sandia 2003a). Estimates of personnel requirements (and other factors) were quite variable.

For this project-specific analysis, emissions and personnel were estimated by scaling waste volumes removed for each MDA to unit volume factors for these parameters from Case Studies 2A, 3A, 3B, and 4A, as summarized in **Table I–79**. Also shown are the assumed radiation environments associated with removal of the MDAs.

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.

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 1999e). Assuming 2,000 workhours 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 dose rate was the maximum assumed for removal of any MDA.

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^{-7}	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	3.3×10^{-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.

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
- 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 far less than 1 acre (0.4 hectares). (The management area envisioned for remediating MDA H under any alternative covered only 0.2 acres (0.1 hectares) [DOE 2004a].) 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 hectares). 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 (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 131 cubic yards (100 cubic meters) of waste, would cover only about 0.1 acres (0.04 hectares).

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.[66] 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 about 0.2 acres (0.1 hectares) for each MDA. (Additional areas may be needed for removal of waste from larger MDAs.) 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 acres (0.004 hectares) would be required to store 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.[67]

---

[66] *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.*

[67] *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.*

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.[68]

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, remediation, and restoration program for MDA B (Section I.3.3.2.7), complete MDA removal could involve up to 84 acres (34 hectares).[69]

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 project-specific analysis. 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 (BLM 1986).

I.4.1.1 Land Use

Land use at LANL is addressed in Section 4.1.1 of this SWEIS. Existing land use is depicted in Figure 4–4. MDAs addressed in this project-specific analysis are listed in **Table I–80**, along with their 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 LANL borrow pit.

---

[68] 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).

[69] 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, remediation, and restoration 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).

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	12.3	–	–
54	G	63	–	–
54	L	2.6	–	–
73	–	–	Ashpile	1.2

[a] Although Material Disposal Area 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 Technical Area 35.

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 2003l). 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 2001f).

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 2001f). Current land use designations include High-Explosive Research and Development and Reserve; future land use is not expected to change (LANL 2003l). MDA Q is within an area designated as Potential Infill (LANL 2001f).

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 Waste Management. The future land use designation is likely to remain the same (LANL 2003l). 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 2001f).

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 2003l). 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 2001f).

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 Section 4.1.1 of this SWEIS). This TA has been divided into three subtracts for purposes of the land conveyance: TA-21-1 (West), which consists of two subtracts, and TA-21-2 (East). (The tracts have also been designated as A-15-1, A-15-2, and A-16, respectively—see Table 4–1 of this SWEIS). Subtract A-15-1 covers 7.5 acres (3.0 hectares) and is scheduled to be conveyed to the county. Conveyance of the remaining two subtracts have been deferred. All MDAs (A, B, T, U) are within Parcel TA-21-2 (East).

Land use includes Waste Management, Service and Support, Nuclear Materials Research and Development, and Reserve. Future land use is slated as Reserve (LANL 2003l). 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 2003l). 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 2001f).

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 2003l). 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 2001f).

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 2001f). 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 2003l). TA-36 is within the Water Canyon Development Planning Area. MDA AA is in an area designated as Potential Infill (LANL 2001f).

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 2003l). 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 2001f).

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 2003l). 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 2001f).

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 2003l). 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 2001f).

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 2003l). 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 2001f).

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) 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 2003l). According to the *Comprehensive Site Plan* for 2001, the TA is within the Sigma Mesa Development Area that could undergo considerable future development (LANL 2001f).

Technical Area 73. This TA covers 272 acres (110 hectares) along the northern boundary of LANL next to Highway 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 2003l). 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 public 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 Table 4–1) (LANL 2001f).

I.4.1.2 Visual Environment

LANL visual resources are addressed in Section 4.1.2 of this 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 State Road 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 1999d).

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 State Road 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 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 2001f).

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 2004i). 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 Highway 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 1999d).

I.4.2 Geology and Soils

Geology, soils, and mineral resources at LANL are addressed in Section 4.2 of this SWEIS.

Geology. LANL site geology consists primarily of a complex series of interlayered volcanic deposits. As discussed in Section 4.2 of this SWEIS, 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 1999a).

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 *LANL SWEIS* and is updated in 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 Section 4.3 and Appendix E ("Groundwater in the Vicinity of LANL") of this SWEIS. Appendix F ("Environmental Sample Data") of this SWEIS presents sample information pertaining to water resources.

Water resources in the LANL region include surface waters, sediments, floodplains, and groundwater located on site, on adjacent properties, and extending to northern New Mexico and southern Colorado. The LANL area includes 15 regional watersheds (see 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 Section 4.3.1.7 of this SWEIS). 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 1999a). 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. 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 on site 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 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 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 1999a).

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 1999a.

Effluent discharge, natural spring discharge, and stormwater runoff create surface waters that infiltrate into the alluvium of some canyons to create shallow, unconfined groundwater. Discharge of radioactive effluents has caused alluvial groundwater contamination in DP, Los Alamos, and Mortandad Canyons. Other contaminants in Acid-Pueblo, Los Alamos, Mortandad, Canada del Buey, Pajarito, Threemile, Water, Cañon de Valle, and Martin Canyons include manganese, aluminum, molybdenum, perchlorate, nitrate, fluoride, dichlorobenzene, iron, volatile organic compounds, hexahydro-1,3,5-trinitro-1,3,5-t (RDX), octahydro-1,3,5,7-tetranitro-1,3 (HMX), and high explosive degradation products (Section 4.3.2.1 of this SWEIS).

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. Some intermediate perched groundwater contamination has been found, as summarized in Section 4.3.2.1 of this SWEIS. Detected contaminants include tritium, strontium-90, perchlorate, manganese, nitrate, HE, volatile organic compounds, HMX, RDX, TNT, barium, tetrachloroethene, and trichloroethene.

Most of the recharge to the regional aquifer beneath the Pajarito Plateau occurs in the Jemez Mountains west of LANL. Regional groundwater flows toward the east and southeast to the Rio Grande. Little 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

Section 4.3.2 of this SWEIS). Some contamination of the regional aquifer has occurred, as summarized in Section 4.3.2.2 of this SWEIS. LANL personnel conduct subsurface modeling addressing contaminant transport pathways near water supply wells.

I.4.4 Air Quality and Noise

Section 4.4 of this 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). Climatalogical 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 on Figure 4–16 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 degrees Fahrenheit (3 degrees Celsius) higher in and near the Rio Grande Valley and 5 to 10 degrees Fahrenheit (3 to 5.5 degrees Celsius) 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 windspeeds vary seasonally, but average 7 miles per hour (3 meters per second). (Wind rose information from the LANL meteorological stations is presented in 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 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 is presented in **Table I–82**. Mesas are typically sunnier and windier than the canyons or slopes (LANL 1999a).

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 1999a.

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. As addressed in Section 4.4 of this SWEIS, 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 (LANL 2004b).

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 2004i).

I.4.4.3 Noise, Air Blasts, and Vibration

The LANL noise, air blast, and vibration environment is discussed in 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 (OSHA). 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 2004a).

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 TAs listed in **Table I–83**, along with that for TA-61. 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	Piñon-Juniper woodland
33	K	Piñon-Juniper woodland
35	X	Ponderosa pine
36	AA	Piñon-Juniper woodland
39	Y	Piñon-Juniper
49	AB	Ponderosa pine
50	C	Ponderosa pine
54	G	Piñon-Juniper woodland
54	L	Piñon-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 Section 4.5 of this SWEIS, and vegetation zones are shown in Figure 4–23 of this SWEIS.

Ecological Resources of Techical 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 2000d). 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 acres (0.1 hectares) in size and contains Baltic rush (*Juncus balticus* Willd.) and a number of grasses (Green et al. 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 Areas of Environmental Interest. Areas of Environmental Interest for the bald eagle and southwestern willow flycatcher do not include any portion of TA-15 (LANL 2000d, Radzinski 2005a).

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 acres (0.02 hectares) in size and contain Baltic rush and various grasses (Green et al. 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 2000d).

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 Piñon-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 (Green et al. 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 2000d). 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 Piñon-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 (Green et al. 2005). MDAs D and K are within the Piñon-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 hectares) in size; coyote willow (*Salix exigua* Nutt.), cattail, Baltic rush, and various sedges (*Carex* spp.) are some of the species present (Green et al. 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 Piñon-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 Piñon-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 zonez 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 2000d).

Technical Area 39. Although most of TA-39 is in a Piñon-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 Piñon-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 2000d).

Technical Area 49. TA-49 contains three separate vegetation zones—Ponderosa Pine Forest, Piñon-Juniper Woodland, and Grassland. In general, Ponderosa Pine Forest is found on north-facing canyon slopes, while Piñon-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 2000d, Radzinski 2005a).

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 2000d).

Technical Area 54. TA-54 is primarily within the Piñon-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 2000d).

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; Green et al. 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 2000d). TA-61 does not fall within the Area of Environmental Interest for the bald eagle or southwestern willow flycatcher (LANL 2000d).

Technical Area 73. TA-73 is covered by ponderosa pine forest and piñon-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 (Green et al. 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 2000d).

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 1999a).

I.4.6 Human Health

Section 4.6 of this SWEIS discusses measures taken at LANL to maintain the quality of human health for both workers and the public. Figures 4–26 and 4–27 of this SWEIS show overall annual reductions in doses to populations and maximally exposed individuals from 1993 through 2004.

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 Section 4.7 of this SWEIS. This section summarizes the cultural resources of each of the TAs 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 Section 4.8 of this SWEIS 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 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. 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 13,319, 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. 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

As addressed in Section 4.9 of this SWEIS, 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 on site, 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.

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 by December 2006 to comply with solid waste management regulations administered by NMED (LANL 2005g). If approved by NMED, the landfill closure deadline may be extended into 2007. A solid waste transfer station will be located at the existing county landfill. Access to the landfill is via East Jemez Road (LANL 2005g). 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 off site. Management and operation of the transfer station will be by county (LANL 2005f).

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. LANL is developing new low-level radioactive waste disposal capacity within Zone 4 at TA-54, an expansion of about 30 acres (12 hectares). This expansion was addressed in Volume II (*Project-Specific Siting and Construction Analyses*) of the *1999 SWEIS* (DOE 1999a) (see 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 to3,000 cubic meters) of waste per year, Zone 4 should be able to provide disposal capacity for 40 to 60 years (LANL 2005e).

I.4.10 Transportation

Motor vehicles are the primary means of transportation at LANL. Principal access routes to each of the MDAs and PRSs addressed in Section I.4.1.1 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 (Highway 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 State Route 502 in the Los Alamos Township.
33	MDAs D, E, K	State Route 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	State Route 4	
49	MDA AB	Frijoles Mesa Drive	Intersects with State Road 4 to the west.
50	MDA C	Pajarito Road	Passes through TA-50 and intersects with Highway 501 (East and West Jemez Roads) to the east and State Road 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 Highway 501 (East and West Jemez Roads) to the east and State Road 4 to the west.
73	Ashpile	East Road	

TA = technical area, MDA = material disposal area, SWMU = solid waste management unit.

Figure I–25 shows many of the principal transportation routes within LANL. Materials such as concrete or fill dirt could be delivered using State Road 4 to the west or Highway 502 to the east. Waste and materials moved within LANL would be transported mainly over Highway 501 (East and West Jemez Roads), Highway 502, State Road 4, and Pajarito Road. Much of the waste sent off site from LANL for treatment or disposal may be transported over Highway 502 to the east (**Figure I–26**). Highway 502 intersects with Route 30 in San Ildefonso. Route 30 passes north to Española. Highway 502 continues east, interesting with Highway 285/64. Highway 285/64 is routed north to Española and south to Santa Fe, where it intersects with I-25. A new Santa Fe bypass connects with Highway 285/64 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).

I.4.11 Environmental Justice

As summarized in Chapter 4, Section 4.7 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.

One probable waste transportation route from LANL heading east on New Mexico 502 and south toward I-25 passes through San Ildefonso, Pojoaque, Nambe, and Tesuque Pueblo lands (DOE 1999a).

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 2004a).

I.5 Environmental Consequences

The major options considered in this project-specific analysis 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 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 the main body 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. Such 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 white domes at Area G in TA-54 would remain until operations associated with the domes (such as transuranic waste storage) are completed and Area G is closed. 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.4 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 a small parcel of TA-21 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). Yet because capping will 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 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 36 to 81 acres (14.6 to 32.8 hectares) of land could be temporarily affected.

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 (52.6 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 up to 10 acres (4 hectares) 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 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 within different TAs, a much smaller area would be affected during any single year. The largest area (about 27 acres [10.8 hectares]) would be affected during FY 2011. 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 (52.6 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 MDA 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 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 Section H.2). Assuming 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 60 acres (24.3 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 70 acres (28.3 hectares) of land for bulk material storage. An additional 84 acres (34 hectares) may be needed to site several hazard identification, waste processing, or characterization facilities around LANL.

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 (52.6 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 containment structures similar to those used for transuranic waste recovery at TA-54. (The investigation, remediation, and restoration program at MDA B will be conducted under containment structures.) These structures 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 structures would be removed and the backfilled excavations revegetated. MDAs not exhumed under containment structures 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 (52.6 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 containment structures, and all air exhausted from these structures would be filtered.

Remediation of Other MDAs. 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 run-on 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 of crushed tuff would be needed through 2011.) The site containing the borrow pit covers 43 acres (17.0 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 acres (3.8 hectares) in size, while excavating 2,000,000 cubic yards (1,520,000 cubic meters) of tuff would create a 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. Note that in addition to fill, construction of the MDA covers through 2016 would require 440,000 to 460,000 cubic yards (330,000 to 350,000 cubic meters) of additional rock, gravel, topsoil, and other bulk materials from local sources.

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, which could occur similar to the MDA B investigation, remediation, and restoration program (see Section I.3.3.2.7), 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 project-specific analysis would be removed. After removal of the waste from the MDAs, roughly 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 obtained from local sources. Assuming that the backfill would be obtained from the TA-61 borrow pit, then operation of the pit would create a 33-foot (10-meter) hole 25 acres (10 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 remedition that are considered in this project-specific analysis.

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. Historical investigations have included those for 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 1999a).

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 was issued in 1997 for the Area G low-level radioactive waste disposal facility in TA-54 (LANL 1997a). 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 1999a).

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^{-3}	10
Composite analysis	All pathways	Cañada del Buey	5.8	30 to 100
Performance assessment	Groundwater protection	White Rock Pajarito Canyon	3.5×10^{-5}	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} [a]	30 to 100

[a] Projected dose from the groundwater pathway alone was 1.2×10^{-5} millirem in a year at the receptor exposure location, which is farther from the disposal area than that assumed for the performance assessment.

Source: LANL 1999a.

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. The analytical point of compliance for the performance assessment is the boundary of the operational (post-September 1988) disposal site. The analytical point of compliance of the composite analysis is the boundary of the area assumed to be controlled in the future (LANL 1997a).[70] 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

[70] *The dose (7.2×10^{-3} millirem per year) calculated for the composite analysis was almost all contributed from surface water pathways. Most of the dose was attributed to inhalation of resuspended contaminated sediments and ingestion of vegetables contaminated with sediment (by way of rain splash) (LANL 1999a).*

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 of the watershed and can range from several 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, points 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, Table 1).

(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, where hydrodynamic testing was performed at the bottoms of numerous deep shafts in 1960 and 1961, one area 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. It also developed cracks; estimates of leakage through the cracked pad range from 2.4 to 15 inches (60 to 388 millimeters) per year. Borehole data indicated elevated water contents to a depth of 18 meters (roughly 60 feet). Numerical simulations 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 (Birdsell et al. 1999, 2005). In 1998, the asphalt was removed and the site regraded and capped with an evapotranspiration cover. Since then, the upper 20 feet (6 meters) of soil beneath the cover appear to be drying slowly (Levitt et al. 2005, cited in 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 run-on 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 an alternative considered in future corrective measure evaluations perfomed under the Consent Order,[71] 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 1999a). 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

[71] *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.*

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 Information Program (EPA 2006).

One of the studies cited in the EPA *Alternative Cover Assessment Project Report* is the Alternative Landfill Cover Demonstration at Sandia National Laboratory 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 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).

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 disposal unit contents.

It was concluded that evopotranspiration 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 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 MDAs. Remedial actions conducted under the Consent Order will either improve groundwater quality or reduce risks to it from LANL MDAs. 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 off site. (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, such as that contemplated for MDA B, 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 (NOx), 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	4.8	8.0	6.6	0.047	0.53	0.19	0.19	0.19	0.19	0.19
CO	12	20	17	0.12	1.3	0.48	0.48	0.48	0.48	0.48
SO_x	0.31	0.52	0.43	0.0031	0.035	0.012	0.012	0.012	0.012	0.012
PM_{10}	0.33	0.56	0.46	0.0033	0.037	0.013	0.013	0.013	0.013	0.013
CO_2	190	330	270	1.9	22	7.7	7.7	7.7	7.7	7.7
Aldehydes	0.084	0.14	0.12	0.00083	0.0093	0.0033	0.0033	0.0033	0.0033	0.0033
TOCs	0.90	1.5	1.2	0.0089	0.10	0.036	0.036	0.036	0.036	0.036

CO_2 = carbon dioxide, CO = carbon monoxide, NO_x = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SO_x = sulfur oxides, 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 from the environmental restoration project (see Section 4.4 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 MDA G 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.

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	53	78	190	16	160	18	164	64
CO	51	59	130	200	470	40	410	46	410	160
SO_x	1.3	1.5	3.4	5.1	12	1.0	10	1.2	11	4.2
PM_{10}	1.4	1.6	3.7	5.4	13	1.1	11	1.3	11	4.5
CO_2	820	950	2,100	3,200	7,600	640	6,600	750	6,700	2,600
Aldehydes	0.35	0.41	0.92	1.4	3.3	0.28	2.8	0.32	2.9	1.1
TOCs	3.8	4.4	10	15	35	3.0	30	3.5	31	12
Maximum-Thickness Cap										
NO_x	25	28	70	120	270	20	220	26	230	88
CO	62	71	180	310	690	52	560	65	580	220
SO_x	1.6	1.8	4.5	8.0	18	1.3	14	1.7	15	5.7
PM_{10}	1.7	2.0	4.9	8.6	19	1.4	16	1.8	16	6.1
CO_2	1,000	1,100	2,800	5,000	11,000	830	9,100	1,000	9,300	3,600
Aldehydes	0.43	0.49	1.2	2.2	4.8	0.36	3.9	0.45	4.0	1.5
TOCs	4.7	5.3	13	23	52	3.9	42	4.8	43	17

CO_2 = carbon dioxide, CO = carbon monoxide, NO_x = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SO_x = sulfur oxides, TOCs = total organic compounds.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

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.

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–88 Projected Pollutant Releases to Air from Heavy Machinery Operation from Capping Material Disposal 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*
Material Disposal Area G										
Minimum-Thickness Cap										
NO_x					150		150		150	49
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	56	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	900	6.6				
Aldehydes			0.072	0.57	0.39	2.8×10^{-3}				
TOC			0.77	6.2	4.2	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				

CO_2 = carbon dioxide, CO = carbon monoxide, NO_x = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SO_x = sulfur oxides, TOC = 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.

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										
NOx	2.7	2.7	22	40	73	2.8	59	4.3	61	22
CO	6.9	6.9	56	100	180	7.1	150	11	150	54
SOx	0.18	0.18	1.4	2.6	4.8	0.18	3.8	0.28	3.9	1.4
PM_{10}	0.19	0.19	1.6	2.8	5.1	0.20	4.1	0.30	4.2	1.5
CO_2	110	110	900	1,600	3,000	110	2,400	180	2,500	880
Aldehydes	0.048	0.048	0.39	0.71	1.3	0.049	1.0	0.075	1.1	0.38
TOCs	0.52	0.52	4.2	7.6	14	0.53	11	0.81	11	4.1
Maximum Thickness Cap										
NOx	7.5	7.5	47	97	200	7.7	160	12	170	59
CO	19	19	120	240	510	19	410	30	420	150
Sox	0.49	0.49	3.0	6.3	13	0.50	11	0.76	11	3.8
PM_{10}	0.52	0.52	3.3	6.8	14	0.54	11	0.82	12	4.1
CO_2	300	300	1,900	3,900	8,200	310	6,600	480	6,800	2,400
Aldehydes	0.13	0.13	0.82	1.7	3.5	0.14	2.8	0.21	2.9	1.0
TOCs	1.4	1.4	8.8	18	38	1.5	31	2.2	31	11

CO_2 = carbon dioxide, CO = carbon monoxide, NOx = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SOx = sulfur oxides, 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 windspeed of 2.9 meters per second and an average moisture content of 3.4 percent was assumed.[72] Also, assuming that the

[72] *A moisture content of 3.4 percent was assumed from Table 13.2.4-1 of AP42. It is typical for exposed ground of western surface coal mines.*

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 [460 kilograms]) of PM_{10} would occur during FY 2011. Emissions of dust and particulates could be mitigated, however, by use of common dust control measures such as water sprays.

I.5.4.2.2 Noise

Site Investigations. Site investigations under the Consent Order would cause very small noise impacts of activities such as well installation.

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. Considering physical features, noise levels from this equipment could return to background levels within about 1,000 feet from the noise source (DOE 2004a).

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 off site, 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 New Mexico Route 4
- 4,984 vehicles per day on Pajarito Road near its intersection with New Mexico Route 4
- 12,185 vehicles per day on New Mexico Route 502 (East Road) west of its intersection with New Mexico Route 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.[73] 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 up to 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.

MDA and PRS Remediation. 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

[73] *This is unlikely because solid waste is normally sent directly to an offsite industrial landfill.*

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 containment structures (see below). The releases estimated in Table I–90 were for complete removal of all MDAs and other remediation activities conducted under the Removal Option. Releases estimated in Table I–91 are for complete removal of MDA G and combined MDAs A, B, T, and U. Partial removal of waste and contamination from MDAs, such as that contemplated for MDA B (see Section I.3.3.2.7), would result in reduced emissions.

Table I–90 Removal 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	27	33	2,100	3,000	2,600	2,500	2,600	2,600	2,500	470
CO	69	84	5,200	7,600	6,500	6,200	6,400	6,600	6,300	1,200
SO_x	1.8	2.2	130	200	170	160	170	170	160	31
PM_{10}	1.9	2.3	140	210	180	170	180	180	180	33
CO_2	1,100	1,400	83,000	120,000	110,000	100,000	100,000	110,000	100,000	19,000
Aldehydes	0.48	0.58	36	53	45	43	45	46	44	8.3
TOCs	5.1	6.3	390	570	490	470	480	490	470	89

CO_2 = carbon dioxide, CO = carbon monoxide, NO_x = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SO_x = sulfur oxides,
TOC = total organic compounds.
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										
NO_x			1,600	2,500	2,500	2,500	2,500	2,500	2,500	450
CO			4,000	6,200	6,200	6,200	6,200	6,200	6,200	1,100
SO_x			100	160	160	160	160	160	160	29
PM_{10}			110	170	170	170	170	170	170	31
CO_2			65,000	100,000	100,000	100,000	100,000	100,000	100,000	18,000
Aldehydes			28	43	43	43	43	43	43	7.9
TOCs			300	460	460	460	460	463	460	85
MDAs A, B, T, and U										
NO_x			310	410	110	0.10				
CO			780	1,000	270	0.25				
SO_x			20	26	6.9	$6.5x10^{-3}$				
PM_{10}			22	28	7.4	$7.0x10^{-3}$				
CO_2			13,000	17,000	4,300	4.1				
Aldehydes			5.4	7.1	1.9	$1.8x10^{-3}$				
TOCs			58	77	20	$1.9x10^{-2}$				

CO_2 = carbon dioxide, CO = carbon monoxide, NO_x = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SO_x = sulfur oxides, TOCs = total organic compounds.
Note: To convert tons to metric tons, multiply by 0.90718. Numbers have been rounded.

Based on the above projected releases, 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 containment structures.

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 containment structures (see Section I.5.6.3.2). Containment structures may not be needed for many MDAs, particularly the small ones, or for remediating other PRSs. Containment structures 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, (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.

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

Pollutant (tons)	*Fiscal Year*									
	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
NO_x	3.6	3.7	87	110	66	57	58	59	57	13
CO	9.0	9.4	220	290	170	140	150	150	140	33
SO_x	0.23	0.24	5.7	7.4	4.3	3.7	3.8	3.8	3.7	0.86
PM_{10}	0.25	0.26	6.1	8.0	4.6	3.9	4.1	4.1	4.0	0.93
CO_2	150	150	3,600	4,700	2,700	2,300	2,400	2,400	2,300	540
Aldehydes	0.063	0.065	1.5	2.0	1.2	0.99	1.0	1.0	1.00	0.23
TOCs	0.68	0.70	16	22	13	11	11	11	11	2.5

CO_2 = carbon dioxide, CO = carbon monoxide, NO_x = nitrogen oxides, PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 micrometers, SO_x = sulfur oxides, TOCs = total organic compounds.
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. Assuming no controls or mitigation measures, the largest release (580 pounds [260 kilograms] of

PM_{10}) would occur during FY 2010. Emissions of dust and particulate matter would be mitigated, however, by use of dust control measures such as water sprays.

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 23,700 shipments) would be during FY 2010. Shipments of backfill and topsoil following MDA removal would number 99,800 shipments over 10 years, or an average of 9,980 per year. Thus, the Removal Option could slightly 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 used to backfill the excavated MDAs came from the TA-61 borrow pit, about 95,500 one-way shipments of crushed tuff would transit East Jemez Road through FY 2016. This averages 9,550 per year (38 per working day). The largest number of shipments would occur during FY 2010, when about 21,000 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 46,000 two-way shipments, or roughly 180 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 ecological and biological resources were projected under the Expanded Operations Alternative. The No Action Option for this project-specific analysis represents a continuation of the 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 impact because the MDAs are generally grassy areas enclosed by fencing. 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 the 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.4.5.1), direct impacts on this species are not expected of remediation activities, including capping. This sensitive species would not likely be present because of the disturbed nature of the sites. Indirect impacts of noise on Mexican spotted owls from noise are possible where MDAs are in or near Areas of Environmental Interest. If activities were to take place during the breeding season (March 1 through August 31), owls could be disturbed and surveys would need to be undertaken to determine if they are present. If none are found, there would be no restriction on project activities. However, if they are present, restrictions could be implemented to ensure that noise and lighting limits are met (LANL 2000d). MDA D is located within the Area of Environmental Interest for the bald eagle; however, no underdeveloped habitat would be disturbed. If reasonable and prudent mitigation measures are taken to reduce noise levels, the bald eagle should not be adversely affected. As noted for terrestrial resources, once remedial actions are completed, the sites would provide habitat similar to that before the implementation of corrective measures.

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, which would eliminate wildlife habitat in the cleared areas.

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 MDS and PRSs. Impacts on ecological resources under the Removal Option would be similar to those described for the Capping Option. Habitat at the MDAs would be completely disrupted by the remediation actions. 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 short-term remedial actions would create a disruptive environment for local wildlife, 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 Section 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. From FY 2007 through FY 2016, the total worker dose using this procedure was estimated to be 0.010 person-rem, or a latent cancer fatality risk of 5.8×10^{-5}. From FY 2007 through FY 2011, the total worker dose was estimated to be 0.09 person-rem, or a latent cancer fatality risk of 5.5×10^{-5}. In addition, workers would receive radiation doses from proximity of the PRSs being addressed to other reduction sources at LANL. 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.

Intruder scenarios such as these are commonly addressed in performance assessments for low-level radioactive waste disposal facilities, including those performed for Area G in TA-54

(LANL 1997a). Impacts on potential future inadvertent intruders have also been addressed as part of a No Action Alternative for disposal of transuranic waste at WIPP. 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 Section I.3.6.4, for FY 2007 through FY 2016, the total additional worker dose ranged from about 7 to 11 person-rem, depending on whether a thin or thick cap is emplaced. This worker dose corresponds to a latent cancer fatality risk ranging from 4.5×10^{-3} to 6.4×10^{-3}. For FY 2007 through FY 2011, the total worker dose range from 3.3 to 4.8 person-rems, and the latent cancer fatality risk range from 2.0×10^{-3} to 2.9×10^{-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 MDA G.[74] 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 potential for dispersion of contaminated materials currently existing as hotspots in soil, and as brought to the surface from burrowing animals.

---

[74] 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 planned 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).

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 Additional 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.5.1.4.2.1. 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 Section I.3.6.4. Compared to the No Action Option, for FY 2007 through FY 2016, the total additional worker dose was estimated as 1,100 person-rem, resulting in a latent cancer fatality risk of 0.68. For FY 2007 through FY 2011, the total worker dose was estimated as 460 person-rem, resulting in a latent cancer fatality risk of 0.28. 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 fixed in place. Contamination at other PRSs would also be removed or fixed in place.

Site Investigations. The site investigations programs under the Consent Order should not affect public health.

Radiological Emissions from Remediation of MDAs and 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 this 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 (DSA) was issued in 2004 for nuclear environmental sites (LANL 2004o). The analysis performed for this DSA 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**.

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 2004o 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 1997a).
MDA B – For plutonium-239, assumed 6.22 curies from LANL 1999a, DOE 1999c, and LANL 2004o, and added an estimated 1.45 curies of plutonium-240. For plutonium-240 and other radionuclides, available information (Rogers 1977; LANL 1999a, 1991, 2004b) suggested their presence in the MDA but not their quantities. Inventories of these radionuclides were scaled from known inventories in MDA G (LANL 1997a).
MDA T – LANL 2004o.
MDA U – The current inventory is difficult to estimate because an unknown quantity of the originally disposed material was removed in 1985. The original inventory was estimated from available information (LANL 1991, 2004d). Some radionuclides were scaled from known inventories in MDA G (LANL 1997a). Two-thirds of the original inventory was assumed removed in 1985.
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 1997a).
MDA C – Radionuclide inventories were developed from data from LANL 1992c, LANL 2003a, Rogers 1977, and DOE 1999c.
MDA G – LANL 1997a.
Aggregate PRS – Scaled from known inventories of contaminated soil disposed of into MDA G (LANL 1997a).

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 containment structures. For those MDAs assumed to be exhumed without containment structures, 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.

Release of radionuclides from containment structures was modeled as a point source assuming a representative enclosure for all MDAs.[75] (Structures 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).

The heating, ventilating, and air conditioning system for the containment structure 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 heating, ventilating, and air conditioning 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

[75] *Additional engineering work would be needed to arrive at optimum numbers, sizes, configurations, and relocation schedules for the removal enclosures.*

(0.91-meter-diameter) stack. A 99.95 percent removal efficiency was assumed.[76] 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 containment structure 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. Their transfer could change the distance and direction to the MEI, and they would be transferred before the 2007 start date of this SWEIS.[77] 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 1997a). 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).[78] 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.

---

[76] *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.*

[77] *Regarding land transfer tracts, NMED determines remediation progress and status with input from LANL and DOE.*

[78] *Pit inventories from 1971 through September 1988 are provided in Table 3-8 of Appendix 2e of the 1997 LANL* Performance Assessment and Computer Analysis *for the Area G LLW site (LANL 1997a). 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] *(millirem per year)*	*Population Dose (person-rem per year)*
MDA A	1.8	0.0013 to 7.1	0.000097	0.00066
MDA B	2.4	0.062 to 50	0.0081	0.024
MDA T	2.0	0.064 to 310	0.0043	0.036
MDA U	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 available	Not available	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 a containment structure; the large dose is for removal assuming no use of a containment structure.

[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.

Note: Citations 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 a containment structure. If the MDA is exhumed without a containment structure, 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 containment structures (0.13 millirem per year). If removal of MDA U occurred without use of a containment structure, 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 is also exhumed without the use of a containment structure, the dose to the TA-21 MEI would exceed the 10-millirem public dose limit (7.1 millirem for MDA A plus 1.9 millirems for MDA U plus 1.5 millirem dose to TA-21 from operations at LANSCE).

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 contribute a portion to the LANL site-wide MEI. 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 containment structures because their contribution to the LANL site-wide MEI would be small. (Total doses to the LANL MEI from all sources are summarized in Chapter 5 of this 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 containment structures. All other large MDAs would be removed under containment structures. 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 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 short-term 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 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.

Secondary 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. 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 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 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, 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 13,000 employees (see Section I.4.9.1). Using the procedures outlined in Section I.4.6.3, total personnel hours were estimated through FY 2016 for removal of contaminated material as part of the No Action Option. This estimate is 43,800 person-hours through FY 2016 (41,800 person-hours through FY 2011). Utility usage (electricity, natural gas, water) would probably not be significantly affected by continuing environmental restoration project operations. Roughly 78,000 gallons 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. Because of the expected increase in remedial construction activities, this option would cause somewhat higher employment, personnel income, and other economic measures. Carrying out the Capping Option is projected to require roughly 920,000 to

1,200,000 person-hours through FY 2016 (440,000 to 590,000 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 46 to 61 workers per year.

Usage of electricity or natural gas would likely be only marginally increased compared to the No Action Option. Roughly 3 to 4 million gallons 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. The quantities of water that may be needed were not directly determined. However, as part of developing water projections for completion of the "Security-Driven Transportation Modification Project for Pajarito Road" (Appendix J), it was estimated that compaction of 1 acre (0.4 hectares) of land with 5 feet of fill would require roughly 267,500 gallons (1,012,000 liters) of water. Extrapolating from this estimate suggests that capping the MDAs could require roughly 30 million gallons (114 million liters) of water from FY 2007 through FY 2016, with the largest annual quantity of water (roughly 7 million gallons [27 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.

Carrying out the Removal Option is projected to require roughly 30 million person-hours through FY 2016 (12.8 million person-hours through FY 2011), assuming complete removal of waste from MDAs. Assuming 2,000 hours per year per worker, the Removal Option would require the full-time efforts of an average of 1,500 workers per year. This would increase population levels at LANL compared to the Capping Option.

Utility usage may be affected. Significant additional volumes of waste would be generated, which could overwhelm existing waste management capacity at LANL. 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 roughly 68 million gallons of liquid fuel (diesel and gasoline) through FY 2016. Water use through FY 2016 would be comparable to that under the Capping Option.

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 to be generated from LANL's environmental restoration project.

The expansion of Area G into Zone 4 would probably accommodate solid, 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 off site 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 off site 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 likely to be generated 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 could significantly impact the waste management infrastructure at LANL. 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 construction of additional and complex waste handling capacity. 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. Although these effects would be temporary, they could be relatively large. 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.

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 greatly exceed current plans for waste acceptance at Zone 4 of TA-54. The Zone 4 disposal capacity would also be used within a far shorter period of time than planned, requiring development of additional disposal capacity. Use of offsite disposal capacity would help alleviate these impacts, but the impact on onsite disposal capacity would still be significant.

The amount of transuranic waste that would be exumed from the MDAs is significant. WIPP 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 off site for treatment or disposal. In addition, the greatly increased personnel requirements for waste removal would, compared to existing levels, 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 off site and all transuranic wastes would be shipped to the Waste Isolation Pilot Plant.

[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 Envirocare 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 bore holes 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 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* [b]
	2009	*2010*	*2011*	*2012*	
Waste shipments	1	260	300	1	560
Soil and Other Materials					
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	
Maximum cap	13	93	59	0.4	

[a] Assuming two-way shipments—that is, trucks entering and leaving Technical Area 21 via DP Road.
[b] Shipments have been rounded to two significant figures.
[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. A New Mexico State safety project considering alternatives for this intersection is planned for FY 2006.

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 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 as set forth 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.

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 off site and all transuranic wastes would be shipped to the Waste Isolation Pilot Plant.
[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 Envirocare site in Utah.
Note: Numbers have been rounded.

Borrow Pit. Operation of the borrow pit in TA-61 should have no offsite impacts of material transport.

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 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 an even 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 Shipments of Waste and Bulk Materials into and out of Technical Area 21 [a]

Waste and Material Shipments	*Fiscal Year*				*Total Shipments*
	2009	*2010*	*2011*	*2012*	
Waste shipments	5,600	8,800	4,200	10	19,000
Soil and Other Materials					
Crushed tuff	4,700	7,400	3,500	10	16,000
Additional material	340	510	240	1	1,100
Total shipments	11,000	17,000	7,900	21	35,000
Total shipments per day [b]	42	67	32	Less than 1	

[a] Assuming two-way shipments—that is, trucks entering and leaving Technical Area 21 via DP Road.
[b] Assuming 250 working days per year.
Note: Because 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 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 as set forth 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	0.0013	2.2
FY 2007 through FY 2011	390	0.23	120	0.071	0.0006	1.2
Peak year (FY 2010)	170	0.10	54	0.032	0.00027	0.49

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 project-specific analysis 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 should have no offsite impacts of 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 off site and all transuranic wastes would be shipped to the Waste Isolation Pilot Plant.

[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 Envirocare 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 4–45 in Chapter 4 of this SWEIS shows average daily vehicle trips eastbound on New Mexico Highway 502 east of its intersection with New Mexico Route 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 Highway 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 off site 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 off site through these affected communities, there would be approximately 7,200 waste shipments, or 14,400 total truck trips via Highway 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 Highway 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 off site 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 off site through these affected communities, there would be approximately 110,000 waste shipments, or 220,000 total truck trips via Highway 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 23,700 shipments (47,400 total truck trips) in 2010, or approximately 190 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 190 truck trips per working day under the Removal Option would represent about 1 percent of the total traffic (17,865 vehicle trips) on Highway 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 project-specific analysis 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 2004a).

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 small 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.5.10.2.2 for the No Action Option and Section I.5.10.3.2 for the Capping Option.

In addition to the risks from waste (Section I.5.10.3.2) 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 in MDA H. 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.

Site-specific assessments would consider the potential for such risks and mitigative actions. But for purposes of this project-specific analysis, 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 containment structures 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 containment structure 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 a fire occurred at MDA B in 1948, there is no experience at LANL with explosions associated with MDA remediation or removal. 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). For this project-specific analysis, 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 2006b). The chosen accident scenario for this MDA is a fire that results in releases that breach the containment structure and the HEPA filters. The specific materials and quantities of chemicals and fire sources in the MDA are unknown 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 109 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 for 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 1997a). 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 1–6 was assumed, reflecting the assumption that no more than a single pit would be involved in the accident.[79]

MDA B was one of the earliest disposal sites at LANL and operated when radioactive material, particularly plutonium, was extremely scarce and expensive. The estimated plutonium inventory in MDA B (about 100 grams) may thus be a significant over-estimate. The distribution of radionuclide contamination in 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 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 greater 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.

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. 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 2004a).

---

[79] *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 Area 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
		Gold-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	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
		Gold-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		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	0.006	0.01		1	9.54×10^{-9}	1
		Americium-241	3.01	1	0.006	0.01		1	0.000181	1
		Tritium-3	116	1	0.006	0.01		1	0.00696	1
		Plutonium-238	4.15	1	0.006	0.01		1	0.000249	1
		Plutonium-239	3.10	1	0.006	0.01		1	0.000186	1
		Plutonium-240	0.671	1	0.006	0.01		1	0.0000403	1
		Plutonium-241	0.428	1	0.006	0.01		1	0.0000257	1

MDA	Accident Phase	Nuclide	MAR (Ci)	DR[a,b]	ARF[b]	RF[b]	ARR (/hr)[b]	LPF	ST-Ci	DEL T (min)
		Uranium-233	0.0211	1	0.006	0.01		1	1.27×10^{-6}	1
		Uranium-234	0.00712	1	0.006	0.01		1	4.27×10^{-7}	1
		Uranium-238	0.0687	1	0.006	0.01		1	4.12×10^{-6}	1
	Suspension	Actinium-227	0.000158	1		1	4.00×10^{-6}	1	1.52×10^{-8}	1440
		Americium-241	2.99	1		1	4.00×10^{-6}	1	0.000287	1440
		Tritium-3	115	1		1	4.00×10^{-6}	1	0.0111	1440
		Plutonium-238	4.13	1		1	4.00×10^{-6}	1	0.000396	1440
		Plutonium-239	3.08	1		1	4.00×10^{-6}	1	0.000296	1440
		Plutonium-240	0.667	1		1	4.00×10^{-6}	1	0.0000640	1440
		Plutonium-241	0.425	1		1	4.00×10^{-6}	1	0.0000408	1440
		Uranium-233	0.0210	1		1	4.00×10^{-6}	1	2.01×10^{-6}	1440
		Uranium-234	0.00708	1		1	4.00×10^{-6}	1	6.79×10^{-7}	1440
		Uranium-238	0.0683	1		1	4.00×10^{-6}	1	6.56×10^{-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 1994b).

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	55.2	0.0662	766	0.460	405	0.486
MDA B	1.26	0.000756	2.04	0.00122	0.280	0.000168

MDA = material disposal area.
[a] Increased risk of a latent cancer fatality (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.

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	0.000662	0.00460	0.00486
MDA B	7.56×10^{-6}	0.0000122	1.68×10^{-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.

Accidents Involving Release of Toxic Chemicals. A toxic chemical accident analysis for the MDAs was performed using the ALOHA code[80] 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 has 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 containment structure 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

[80] 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.

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 the Definitive Identification Facility (DIF) and surrounding storage and staging area (LANL 2006b). The DIF will be constructed and operated to support the investigation, remediation and restoration 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 2004c). 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 2004c).

[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 2004c).

[c] Based on a respirable release fraction of 6×10^{-5} of the total powder at risk and under thermal stress (DOE 1994b).

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.3.5.2.1 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 and the general construction industry. **Table I–108** presents similar risks 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 Project-Specific Analysis Options

Option	*Construction Industry*			*Overall DOE*		
	Recordable Injuries	*Lost Workdays*	*Fatalities*	*Recordable Injuries*	*Lost Workdays*	*Fatalities*
Fiscal Year 2007 through Fiscal Year 2016						
No Action	1.9	20	0.0045	0.42	2.5	0.000033
Capping						
Thin cap	39	420	0.095	8.7	52	0.00069
Thick cap	51	560	0.13	12	169	0.00091
Removal	1,300	14,000	3.1	290	1,700	0.023
Fiscal Year 2007 through Fiscal Year 2011						
No Action	1.8	19	0.0043	0.40	2.4	0.000031
Capping:						
Thin cap	19	200	0.046	4.2	25	0.00033
Thick cap	25	270	0.061	5.6	34	0.00044
Removal	540	5,900	1.3	120	730	0.0096

Note: Numbers have been rounded.

Table I–108 Industrial Accident Risks for Technical Area 61 Borrow Pit Operations

Option	Construction Industry			Overall DOE		
	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}	2.7	16	2.1×10^{-4}
Thick cap	31	340	7.7×10^{-2}	7.0	42	5.6×10^{-4}
Removal	21	230	5.2×10^{-2}	4.8	29	3.8×10^{-4}
Fiscal Year 2007 through Fiscal Year 2011						
Capping:						
Thin cap	5.8	63	1.4×10^{-2}	1.3	7.8	1.0×10^{-4}
Thick cap	15	160	3.6×10^{-2}	3.3	20	2.6×10^{-4}
Removal	11	120	2.8×10^{-2}	2.5	15	2.0×10^{-4}

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			Overall DOE		
	Recordable Injuries	Lost Workdays	Fatalities	Recordable Injuries	Lost Workdays	Fatalities
Fiscal Year 2007 through Fiscal Year 2016:						
MDA G	1,200	13,000	2.8	260	1,600	2.0×10^{-2}
MDAs A, B, T, and U	59	630	0.14	13	79	1.0×10^{-3}
Fiscal Year 2007 through Fiscal Year 2011:						
MDAs G	450	4,900	1.1	100	610	7.9×10^{-3}
MDA A, B, T, and U	59	640	0.14	13	79	1.0×10^{-3}

MDA = material disposal area.
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

AEAT (AEA Technology Engineering Services, Inc.), 2004, *Mobile Fluidic Tank Waste Retrieval Equipment for TA-21 Generals Tanks*, Draft, 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, Los Alamos National Laboratory, Los Alamos, New Mexico.

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.

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”, Vadose Zone Journal, Los Alamos, New Mexico.

BLM (U.S. Bureau of Land Management), 1986, *Visual Resource Contrast Rating*, BLM Handbook 8431-1, January 17.

BLS (U.S. Bureau of Labor Statistics), 2003, *Incidence Rates of Nonfatal Occupational Injuries and Illneses in 2003*, U.S. Department of Labor, Washington, DC.

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, Vol. 4, pp. 798–810.

Burris (Burris Disposal Service), 2005, Roll-Off Services, accessed on December 23, 2005, at www.burrisdisposal.com.

CPEO (Center for Public and Environmental Oversight), 2005, *Resonant Sonic Drilling*, summary technology description accessed from “Tech List” on December 12, 2005, at http://www.cpeo.org.

DCA (Damon Clark Associates), 2005, *Code of Practices for Dry Stack Concrete Block Retaining Walls*, accessed from “Products” on December 23, 2005, www.damonclark.co.za.

DOE (U.S. Department of Energy), 1993, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, DOE-STD-1021-93, Change Notice on January 1996, reaffirmed with Errata April 2002, Washington, DC, July.

DOE (U.S. Department of Energy), 1994, *Natural Phenomena Hazards Site Characterization Criteria*, DOE-STD-1022-94, Change Notice on January 1996, reaffirmed with Errata, April 2002, Washington, DC, March.

DOE (U.S. Department of Energy), 1994b, *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, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23*, Nuclear Safety Analysis Reports, DOE-STD-1027-97 (Change Notice No. 1 to DOE-STD-1027-92, December 1992), Washington, DC, September.

DOE (U.S. Department of Energy), 1998, *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*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 1999b, *Tanks Focus Area, Innovative Technology Summary Report – AEA Fluidic Pulse Jet Mixer,* DOE/EM-0447, Office of Environmental Management, August.

DOE (U.S. Department of Energy), 1999c, *Buried Transuranic-Contaminated Waste and Related Materials Database*, December 15.

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, New Mexico, October.

DOE (U.S. Department of Energy), 1999e, *DOE Standard Radiological Control Manual*, DOE-STD-1098-99, Washington, DC, July.

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 Analyses for the Department of Energy, National Nuclear Security Administration, Action Taken in Response to the Cerro Grande Fire at the Los Alamos National Laboratory,* Los Alamos New Mexico, DOE-SBA-3, 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.

DOE (U.S. Department of Energy), 2002a, *DOE Proposes Modification to Hazardous Waste Facility Permit: Remote-Handled Transuranic Waste Operations at WIPP*, Waste Isolation Pilot Plant Fact Sheet, available at http://www.wipp.energy.gov/rcradox/rfc/rhfactsheet.pdf, September 14.

DOE (U.S. Department of Energy), 2004a, *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), 2004b, *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), 2004c, *ERPGs and TEELs for Chemicals of Concern,* Rev. 20, DKC-04-003, April.

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, February 25, 2005, email from J. E. Orban, U.S. Department of Energy, to G. Roles, Science Applications International Corporation, Germantown, Maryland.

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.

DOE (U.S. Department of Energy), 2005c, *Cross-Cut Guidance on Environmental Requirements for DOE Real Property Transfers (Update),* DOE/EH-413/9712, Washington, DC, March.

DRI (Desert Research Institute), Albright, W.H., and C. H. Benson, 2002a, *Alternative Cover Assessment Program 2002 Annual Report*, Publication No. 41182, October.

DRI (Desert Research Institute), Albright, W.H., 2002b, *Alternative Center Assessment Project Phase I Report*, Publication No. 41183, October.

Duratek (Duratek Services, Inc.), 2005, Duratek Transport Cask Inventory, table accessed on December 20, 2005, from “Transportation Casks and Containers/HICs” at http://www.duratekinc.com.

Dwyer, S. F., 2001, *Finding a Better Landfill Cover,* Civil Engineering, January.

Envirocare (Envirocare of Utah, Inc.), 2003, *Bulk Waste Disposal and Treatment Facilities Waste Acceptance Criteria*, Rev. 4, April.

EPA (U.S. Environmental Protection Agency), 1995, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources,* AP 42, Fifth Edition, available at http://www.epa.gov/ttn/chief/ap42, January.

EPA (U.S. Environmental Protection Agency), 2006, *Mid-Atlantic Integrated Assessment, Appendix C, Glossary*,Office of Research and Development, EPA Region III, Philadelphia, Pennsylvania, available at http://www.epa.gov/maia/html/glossary.html, March 3.

FRTR (Federal Remediation Technologies Roundtable), 2005, *Remediation Technologies Screening Matrix and Reference Guide*, Version 4.0, available at http://www.frtr.gov/matrix2/top_page.html, accessed December 12, 2005.

Fugro (Fugro Geosciences, Inc.), 2005, Direct Push Technology (DPT) Sampling, available at: http://www.geo.fugro.com/services/geosciences/direct_push.asp. (accessed 12/9/2005).

Green, C., L. McWhirter, E. Paulsgrove, and J. Wood, 2005, *Wetlands Delineation Report*, Los Alamos National Laboratory, Los Alamos, New Mexico, U.S. Army Corps of Engineers, Albuquerque District, Albuquerque, New Mexico, October.

GWRTAC (Ground-Water Remediation Technologies Analysis Center), 2005, Remediation Technologies, accessed from www.gwrtac.org on 12/23/2005.

Hudak (Hudak, Paul F), 1996, *Hydrogeology Field Manual*, Department of Geography, University of North Texas, available at http://www.geog.unt.edu/hudak/wellmanual.html (accessed 6/3/2005).

ICON (ICON Environmental Services), 2005, Direct Push Technology, available at http://www.iconenv.com/directpush.html.

IES (Integrated Environmental Services), 2005, About Compressed Gases, accessed on 1/17/2006 from www.iescylinders.com/compressedgas.html.

INEEL (Idaho National Environmental and Engineering Laboratory), 2000, Porro, I., *Hydrologic Behavior of Two Engineered Barriers Following Extreme Wetting*, INEEL/EXT-2000-00602, Bechtel TWXT Idaho, LLC, September.

INEEL (Idaho National Environmental and Engineering Laboratory), 2002a, Zitnik, et al., *Preliminary Evaluation of Remedial Alternatives for the Subsurface Disposal Area*, INEEL/EXT-02-01258, Bechtel TWXT Idaho, LLC, December.

INEEL (Idaho National Environmental and Engineering Laboratory), 2002b, Sykes, Kira, *Evaluation of Soil and Buried Transuranic Waste Retrieval Technologies for Operable Unit 7-13/14*, INEEL/EXT-01-00281, Bechtel TWXT Idaho, LLC, December.

INEEL (Idaho National Environmental and Engineering Laboratory), 2002c, Armstrong, A.T., D.A. Arrenholz, and J.R. Weidner, *Evaluation of In Situ Grouting for Operable Unit 7–13/14, INEEL/EXT-01-0078*, Bechtel BWXT Idaho, LLC, December.

INEEL (Idaho National Environmental and Engineering Laboratory), 2002d, Schofield, Wayne, *Evaluation of Short-Term Risks for Operable Unit 7-13/14*, INEEL/EXT-02-00038, Revision 0, Bechtel BWXT Idaho, LLC, December.

Initiatives, 2001, Going *Natural with Passive Soil Vapor Extraction, in Initiatives Online*, Volume 8, Fall 2001, available at http://www.p2pays.org/ref/14/13958.htm (accessed 3/3/2005).

ITRC (Interstate Technology and Regulatory Council), 2003a, Technical Overview Using Case Studies of Alternative Landfill Technologies and Associated Regulatory Topics, March.

ITRC (Interstate Technology and Regulatory Council), 2003b, Technical and Regulatory Guidance 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 Traffic, September 1, 2004 – September 18, 2004 (Map), Los Alamos, New Mexico, November 18.

Kwicklis, E., Witkowski, M., Birdsell, K, Newman, B, and Walther, D., 2005, *Development of an Infiltration Map for the Los Alamos Area*, New Mexico, Vadose Zone Journal, v. 4, pp. 694-707.

LANL (Los Alamos National Laboratory), 1981, Walker, L. J., W. R. Hansen, D. C. Nelson, G. Maestas, W. J. Wenzel, F. A Guevara, J. L Warren, J. C. Rodgers, and J. M. Graf, Alternative Transuranic Waste Management Strategies at Los Alamos National Laboratory, LA-8982-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 1984, Nyhen, J. W, et al., *Distribution of Radionuclides and Water in Bandelier Tuff Beneath a Former Los Alamos Liquid Waste Disposal Site After 33 Years*, LA-10159-66-WM, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1986, Nyhen, J.W., T. E. Hakonson, and R. A. Lopez, *Corrective Measures Technology for Shallow Land Buried 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, Gerety, M., J. Nyhan, and R. Oliver, *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, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992b, *RFI Work Plan for Operable Unit 1144*, LA-UR-92-900, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992c, *RFI Work Plan for Operable Unit 1147*, LA-UR-92-969, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992d, *RFI Work Plan for Operable Unit 1079*, LA-UR-92-850, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992e, *RFI Work Plan for Operable Unit 1071*, LA-UR-92-810, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1992f, *RFI Work Plan for Operable Unit 1122*, LA-UR-92-925, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 1993a, *RFI Work Plan for Operable Unit 1086, LA-UR-92-3968*, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993b, *RFI Work Plan for Operable Unit 1111, LA-UR-93-2166*, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1993c, *RFI Work Plan for Operable Unit 1082 (TA-11, -16, -28, -37)*, LA-UR-93-1196, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993d, *RFI Work Plan for Operable Unit 1130 (TA-36, -68, -71)*, LA-UR-93-1152, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1993e, *RFI Work Plan for Operable Unit 1132 (TA-39), LA-UR-93-768*, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 1993f, *RFI for Operable Unit 1157 (TA-8, -9, -23, -69)*, LA-UR-93-1230, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993g, *RFI Work Plan for Operable Unit 1114, LA-UR-93-1000, Environmental Restoration Program*, Los Alamos, New Mexico, July.

LANL (Los Alamos National Laboratory), 1993h, Nyhen, J. W., and B. J. Drennon, *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), 1997a, *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*, ESH-20, 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, *Best Management Practices Report for Installation of Stabilization Measures at Potential Release Sites 49-001 (b, c, d, and g),* LA-UR-98-4170, Los Alamos, New Mexico, April.

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, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 1999g, *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), 1999i, E. M. Van Eeckhout, *Environmental Technology Cost-Savings Analysis Project Summary Viewgraphs*, LA-UR-99-2367, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2000a, Canepa, J. A. and T. Taylor, *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, Los Alamos, New Mexico, March.

LANL (Los Alamos National Laboratory), 2000d, *Threatened and Endangered Species Habitat Management Plan, Site Plans*, LA-UR-00-4747, Los Alamos, New Mexico, April.

LANL (Los Alamos National Laboratory), 2001a, *Veenis, Steven J. and Randy Johnson, 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, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2001b, *Supplemental Sampling and Analysis Plan for Potential Release Sites 73-001(a) and 73-001(d)*, LA-UR-01-3987, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2001c, *Information Sheet: Material Disposal Area P*, LA-UR-01-6778, ER2001-1002.

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, *Information Sheet: Airport Landfill*, ER2001-1002.

LANL (Los Alamos National Laboratory), 2001f, *Comprehensive Site Plan 2001*, Los Alamos, New Mexico, April 13.

LANL (Los Alamos National Laboratory), 2002a, *Information Sheet: Technical Area 21 Material Disposal Areas*, ER2002-0466, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), 2002b, Memorandum from B.A. Ramsey, Risk Reduction and Environmental Stewardship Division, to Ralph Erickson, Office of Los Alamos Site Operations, Department of Energy, "New Mexico Environmental Department (NMED) Draft Order, July 30.

LANL (Los Alamos National Laboratory), 2002c, *Information Sheet: 260 Outfall*, ER2002-0333.

LANL (Los Alamos National Laboratory), 2002d, *Voluntary Corrective Measures Plan for Solid Waste Management Unit 21-011(k) at Technical Area 21*, LA-UR-02-2218, ER2002-0253, Los Alamos, New Mexico, April.

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), 2002g, *Transuranic Waste Inspectable Storage Project (TWISP) Retrieval from Pads 1, 2, and 4 at Technical Area 54*, FWO-Solid Waste Operations, February.

LANL (Los Alamos National Laboratory), 2002h, 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), 2003a, *Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009 at Technical Area 50*, Revision 1, LA-UR-03-8201, Los Alamos, New Mexico, November 2003 (Updated January 2004).

LANL (Los Alamos National Laboratory), 2003b, *Historical Investigation Report for Area L*, ER2003-0766, December.

LANL (Los Alamos National Laboratory), 2003c, *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), 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, *MDA P Closure Certification Report*, LA-UR-03-8046, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2003g, *Waste Volume Forecast*, Rev. 0, LA-UR-03-4009, Los Alamos, New Mexico, June. (Appendix G to LANL 2004i, 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), 2003h, *Interim Measure Completion Report for the NTISV Hot Demonstration at SWMU 21-018(a)-00 (MDA V)*, LA-UR-03-6494, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003i, *Los Alamos National Laboratory Technical Area 54 Part B Permit Renewal Application*, Rev. 3.0, Attachment G: "Container Management," LA-UR-03-3579, Los Alamos, New Mexico, June.

LANL (Los Alamos National Laboratory), 2003k, Booth, Steven, *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), 2003l, *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-04-5862, Ecology Group, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2003m, *Voluntary Corrective Measure (VCM) Completion Report for Solid Waste Management Unit 21-011(c) at Technical Area 21*, LA-UR-03-7293, Los Alamos, New Mexico, October.

LANL (Los Alamos National Laboratory), 2003n, *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), 2003o, *The General's Tanks Characterization Activities Documented Safety Analysis*, LA-UR-03-6570, Los Alamos, New Mexico, October.

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, *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), 2004c, "Historical Investigation Report," Appendix B to *Investigation Work Plan for Material Disposal Area G, Solid Waste Management 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, *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), 2004e, *Phase III RCRA Facility Investigation Report for Consolidated SWMU 16-021(c)-99 (Revised)*, ERE2004-0521, Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004f, *Proposed Remediation of MDA V Within TA-21, NEPA Categorical Exclusio*n, LAN-05-001, October 4.

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, *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), 2004j, Booth, Steven, *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), 2004m, *Waste Volume Forecast*, Revision 1, LA-UR-04-6682, Prepared by C. Bachmeier (Infrastructure, Facilities, and Construction) and J. Scott (Abaxial Technology, Inc.), Los Alamos, New Mexico, September.

LANL (Los Alamos National Laboratory), 2004n, *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), 2004o, *Documented Safety Analysis for Surveillance and Maintenance of Nuclear Environmental Sites at Los Alamos National Laboratory*, LA-UR-04-7508, Los Alamos, New Mexico, November.

LANL (Los Alamos National Laboratory), 2005a, PRS Data Base for LANL, Unpublished, Word file dated January 24.

LANL (Los Alamos National Laboratory), 2005b, Newman, Darryl, 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), 2005c, Snodgrass, Roger, Airport Landfill Plan Progresses, Lamonitor.com, the *Online News Source for Los Alamos*, June 6.

LANL (Los Alamos National Laboratory), 2005e, Stanford, Tony and Ken Hargis, *Radioactive Waste Operations at Area G*, LA-UR-05-3190, PowerPoint slides, Los Alamos, New Mexico, May 3.

LANL (Los Alamos National Laboratory), 2005f, Booth, Steven, *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), 2005g, *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, NEPA Categorical Exclusion, February 8.

LANL (Los Alamos National Laboratory), 2005i, *Status Report for Integrated Closure Activities at Technical Area 54*, DIV-REPORT-0202, R.0, Los Alamos, New Mexico, July 7.

LANL (Los Alamos National Laboratory), 2005k, *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), 2005m, *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), 2005n, *Aggregate Areas List; Maps of TAs, SWMUs/AOCs*, LA-UR-05-6234, Los Alamos, New Mexico, August.

LANL (Los Alamos National Laboratory), 2005o, *Pueblo Canyon Aggregate Area Investigation Work Plan*, LA-UR-05-2366, Los Alamos, New Mexico, May.

LANL (Los Alamos National Laboratory), 2005p, *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), 2005q, *SWEIS Yearbook – 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), 2005s, *Facility Integration Program*, LA-UR-05-5601, Los Alamos, New Mexico, July 26.

LANL (Los Alamos National Laboratory), 2005t, *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), 2005u, *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), 2005v, *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, *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.

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*, Vol. 4, pp. 789-797.

LLNL (Lawrence Livermore National Laboratory), 2002, Pruneda, C. and A. Bilstrom, *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 from *Division of Pollution Prevention and Environmental Assistance (DPPEA),* website search on 12/12/2005 from http://www.p2pays.org.

Newman, B. D., 1996, *Vadose Zone Water Movement at Area G, Los Alamos National Laboratory, TA-54: Interpretation Based on Chloride and Stable Isotope Profiles,* LA-UR-96-4682, Los Alamos National Laboratory, Los Alamos, New Mexico,

NFESC (Naval Facilities Engineering Services Center), 2005, Vertical Cutoff Wall, from Technologies button at Vertical Cutoff Wall Technology Web page, available at http://enviro.nfesc.navy.mil/scripts/WebObjects.exe/erbweb.woa/2/wa/default?wosid=kg5PgvsoqkwMY8esEKS7Cg#slide_show_end. (accessed 12/9/2005).

NFS RPS (Nuclear Fuel Services Radiation Protection Systems), 2005, *Perma-Con® Turnkey Containment Systems,* available at http://www.nfsrps.com/docs/pcon.pdf (accessed 12/9/2005).

NMED (New Mexico Environmental Department), 2000, *Solid Waste in New Mexico, 2000 Annual Report,* December 1.

NMED (New Mexico Environmental 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 the University of California for the Los Alamos National Laboratory, Los Alamos, New Mexico,* Santa Fe, New Mexico, September.

NMED (New Mexico Environmental Department), 2005, Compliance Order on Consent, Proceeding Under the New Mexico Hazardous Waste Act (Section 74-9-D), the New Mexico Solid Waste Act (Section 74.9.36(D)), March 1.

NNSA (National Nuclear Security Administration), 2003, *Environmental Impact Statement for the Chemistry and Metallurgy Research Building Replacement Project at Los Alamos National Laboratory*, 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, Office of Nuclear Material Safety and Safeguards, 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, Restrepo, L, *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 National Laboratory, Oak Ridge, Tennessee, January.

Pfeil, J.J., A.L. Leavitt, M.E. Wilks, S. Azevedo, L. Hemensay, K. Glesener, and J.M. Barker, 2001, *Mines, Mills and Quarries in New Mexico in 2001*, New Mexico Energy, Minerals and Natural Resources Department and New Mexico Institute of Mining and Technology.

Pope, Paul; Naomi Becker; Ed Van Eeckhout; Cheryl Rofer; Nancy David; and John Irvine, 2000, *Environmental Site Characterization Utilizing Aerial Photographs and Satellite Imagery: Three Sites at Los Alamos National Laboratory*, New Mexico, LA-UR-00-3781, Presented at Spectrum 2000, Chattanooga, Tennessee, September 28.

PNNL (Pacific, Northwest National Laboratory), Buck, J.W., et al, 1997, Analysis of the Long-Term Impacts of TRU Waste Remaining at Generation/Storage Sites for No Action Alternatives, PNNL-11251, Battelle Memorial Institute.

RAE (Rogers and Associates Engineering Company, Inc.), 1997, Shuman, R, Radioactive Waste Inventory for the TA-54, Area G Performance Assessment and Composite Analysis, Prepared for Los Alamos National Laboratory by RAE, Salt Lake City, Utah, March. (Appendix of LANL, 1997a, Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G, LA-UR-97-85, Los Alamos, New Mexico, March.

Reade (Reade Advanced Materials), 2005, Weight per cubic Foot and Specific Gravity, accessed on 12/30/2005 via Useful Particle Briefings link from Reade Advanced Material Supersite (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 (Rogers, Margaret Anne), 1977, History and Environmental Setting of LASL Near-Surface 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.

Sandia (Sandia National Laboratories), 2003a, Chemical Waste Landfill Excavation Voluntary Corrective Measure Final Report, Environmental Restoration Project, Albuquerque, New Mexico, April.

Sandia (Sandia National Laboratories), 2003b, Peace, Jerry L. and Timothy J. Goering, *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, Prepared by Daniel B. Stevens, and Associates, Inc., for Shaw Environmental, Inc. of Los Alamos, New Mexico, January 18.

TH (TH Drilling Services, Ltd. Services), 2005, available at http://www.thdrilling.com/services.htm (accessed 6/13/2005).

USGS (U.S. Geological Survey), 2003, USGS and New Mexico Bureau of Mines and Mineral Resources, *The Mineral Industry of New Mexico*, from Minerals Yearbook for 2003.

Waugh, W. J., G. M. Smith, D. Beraman-Tabbert, and D. R. Metzler, 2001, Evolution of Cover Systems for the Uranium Mill Tailings Remedial Action Project, USA, from *Mine Water and the Environment*, V.20, pp190-197.

WCS (Waste Control Specialists, LLC), 2005, Services, accessed on 12/14/2005 from www.westexes.com.

WERC (Waste-Management Education and Research Consortium), 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, available from http://www.wipp.energy.gov/fctshts/TRUwastecontainers.pdf (accessed 12/9/2005).

WSDOE (Washington State Department of Ecology), 2005, History of the Northwest Interstate Compact, accessed on 12/14/2005 from www.ecy.wa.gov/ecyhome.html, Waste Management Programs/Commercial Low-Level Radioactive Waste.

WSRC (Westinghouse Savannah River Company), 1997, Riha, B., Miscellaneous Chemical Basin Treatability Study: Analysis of Passive Soil Vapor Extraction Wells (PSVE),WSRC-TR-97-00415, Rev. 1, Aiken, South Carolina.

WSRC (Westinghouse Savannah River Company), 2000, Riha, B.D., J. Rossabi, and W.K. Hyde, Metallurgical Laboratory (MetLab) Treatability Study: An Analysis of Passive Soil Vapor Extraction Wells (PSVE), June 2000 Update, WSRC-TR-2000-00182, Aiken, South Carolina.

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 *Draft 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) documentation. 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 to upgrade physical protection in the area of the Pajarito Corridor West. This would involve restricting vehicular 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 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 acting as an alternative to underground testing. While the computing capacity of the Metropolis Center is currently between 30 and 50 teraops (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 teraops. 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 teraops, with the possibility that a future operating level of approximately 200 teraops 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 for storage. 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, the 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, DOE's recovery mission was expanded, thereby necessitating the management of an additional number and type of sealed sources. While DOE 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. 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.

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 TAs 48 and 63. Under this planned approach, vehicular 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 utilize transit systems in order 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.

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 vehicular traffic in the vicinity of the core area of LANL, including the main administrative and technical area at TA-3.

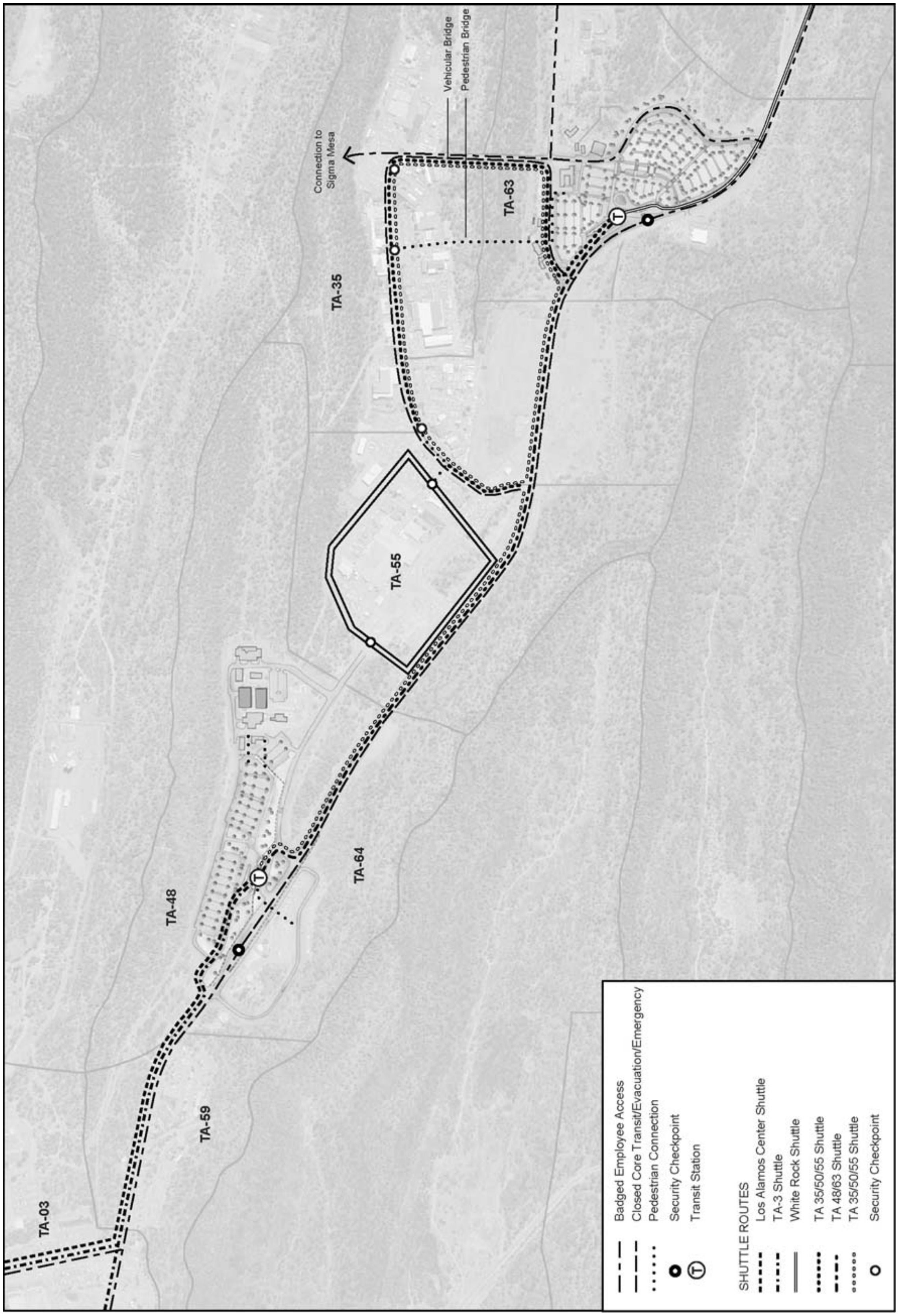


Figure J–2 Proposed Pajarito Corridor West Security-Driven Transportation Plan

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 (CMR) 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 55 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, funded through 2011, 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 CMR 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. Vehicular 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 2006). 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 in 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.

- 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.

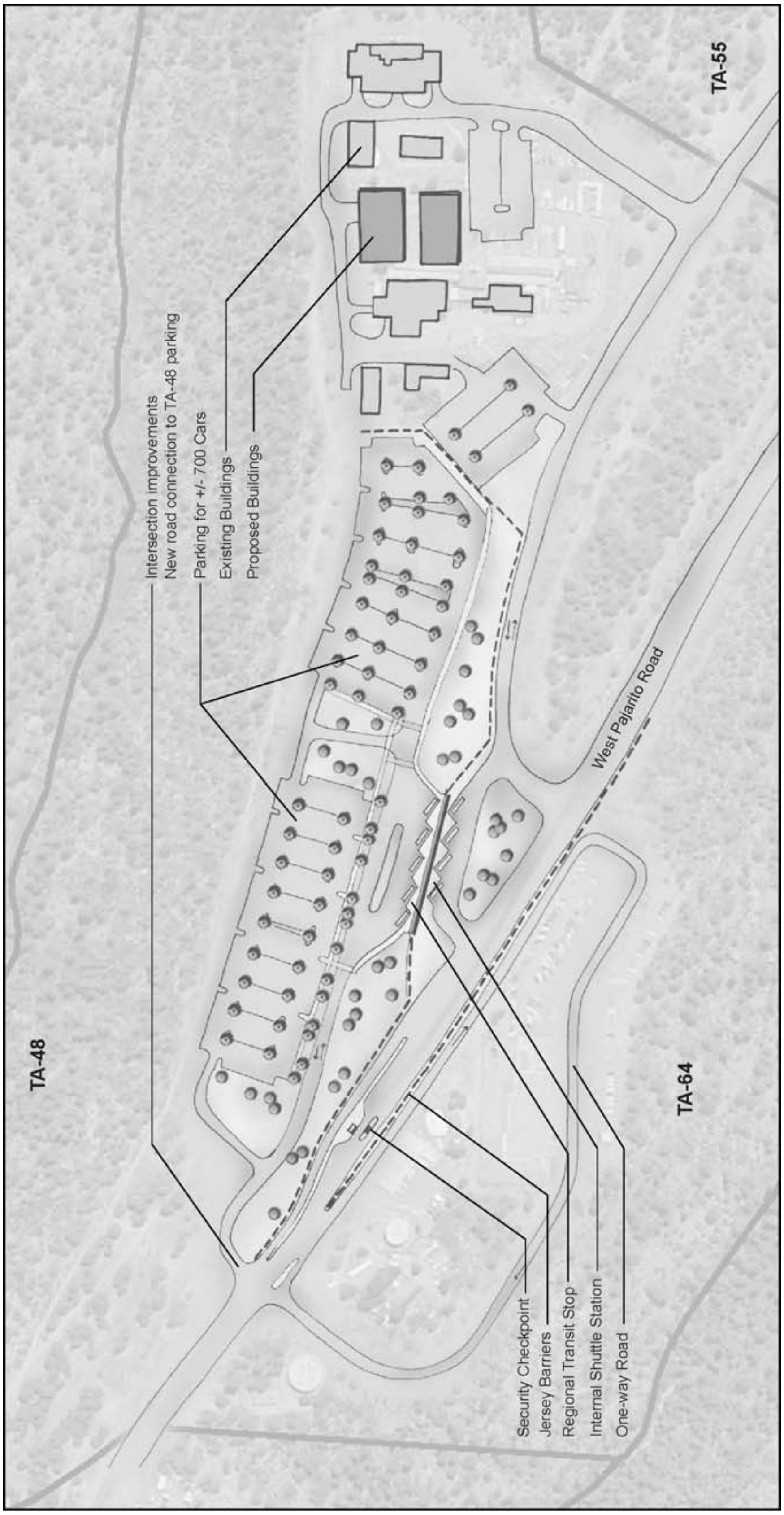


Figure J–3 Proposed Technical Area 48 Security-Driven Transportation Modifications

- 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 utilized 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.

- 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.

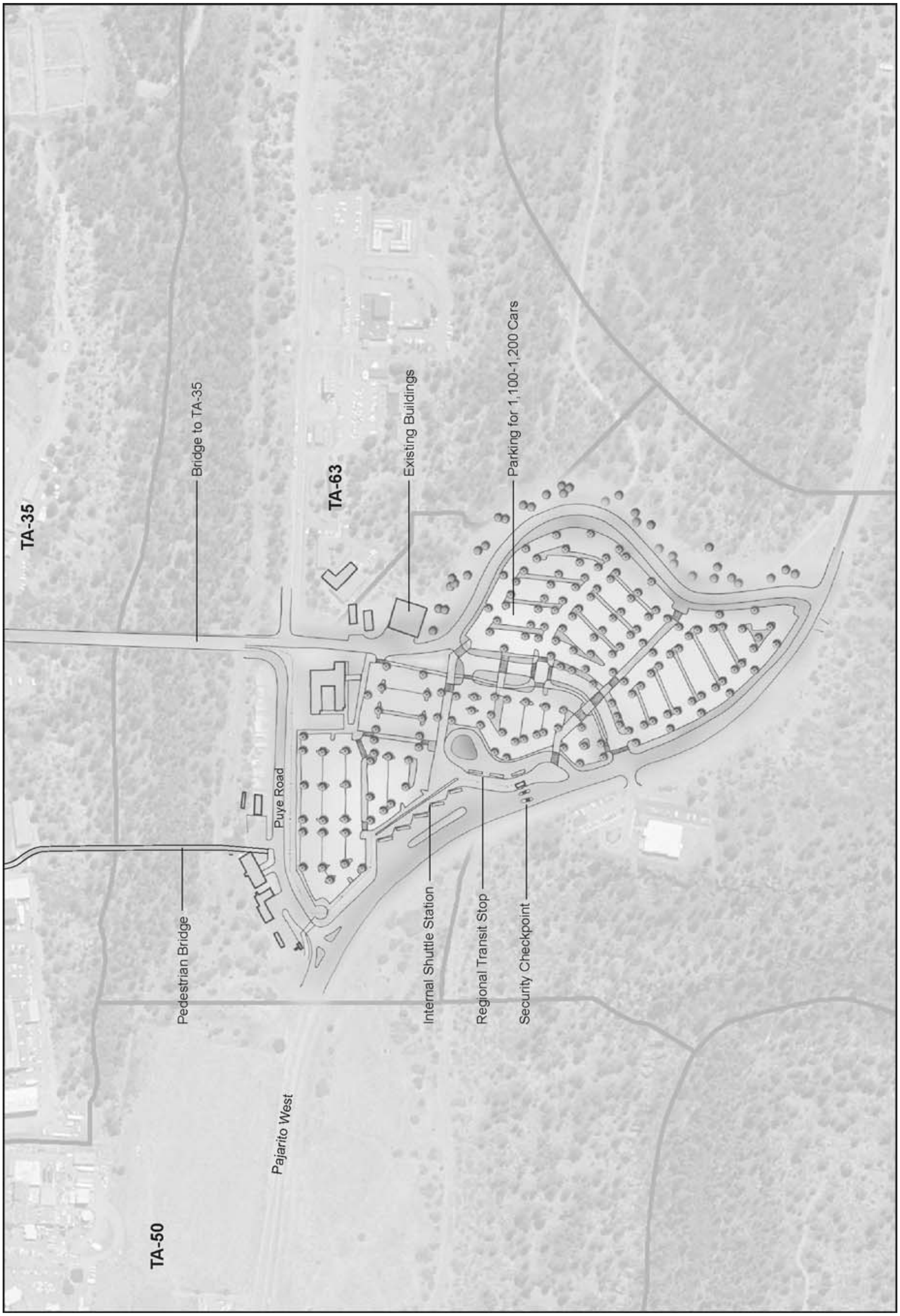


Figure J–4 Proposed Technical Area 35 and Technical Area 63 Security-Driven Transportation Modifications

- 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 2006). A 126-foot (38-meter) by 78-foot (24-meter) detention 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 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 would be constructed to connect the road crossing the bridge to a road extended east from TA-3. A new two-lane paved road approximately 3,750 feet (1,140 meters) long proceeding westward through TA-60 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.

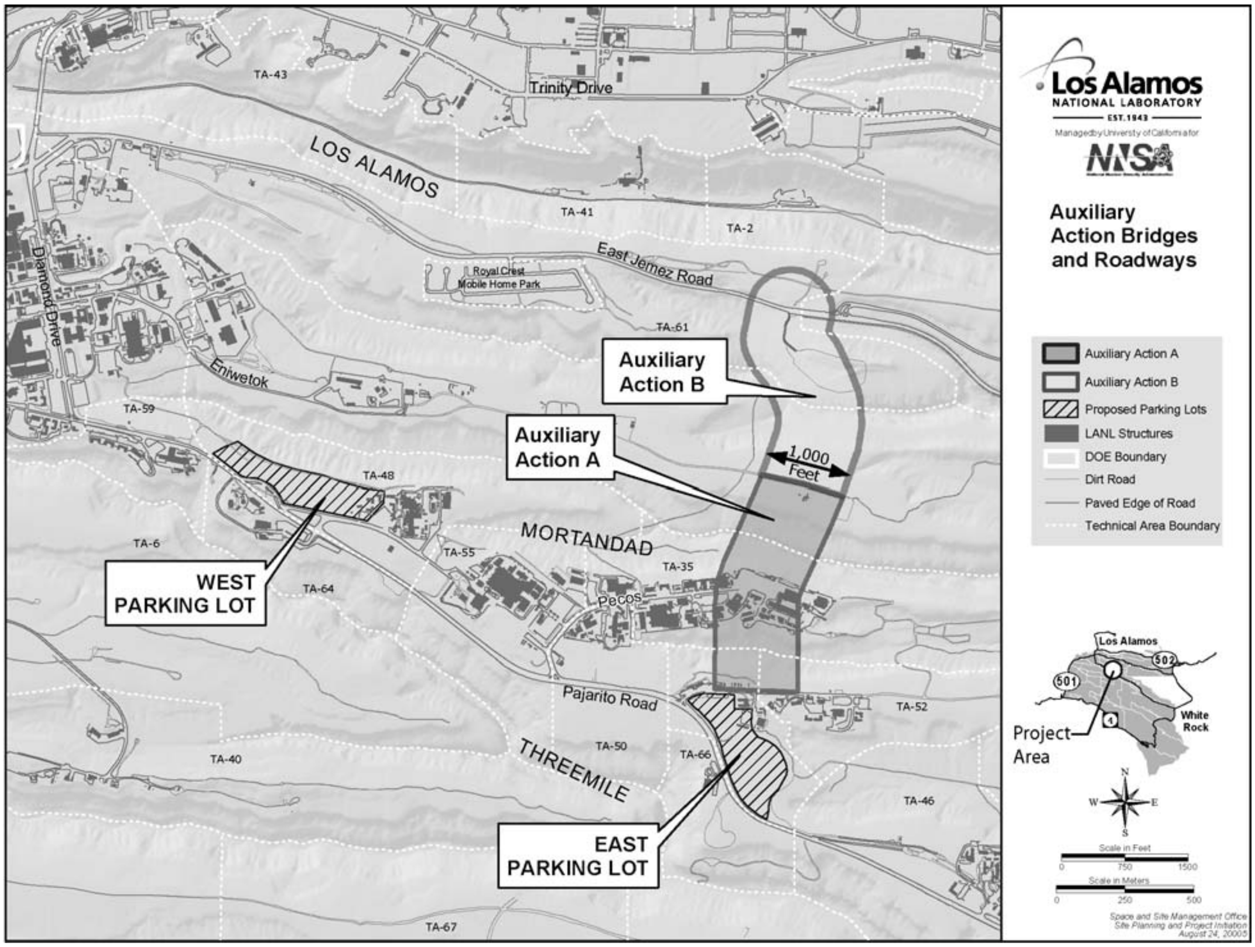


Figure J–6 General Locations of the Auxiliary Action Bridges and Roadways to Technical Area 60 and Technical Area 61

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. 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 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. This approach provides a conservative estimate of the doses associated with an accident involving storage of sealed sources since 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 overestimate the radiological impacts of an accident. This conservative approach is used because the Off-Site Source Recover Project does not know how many of each type of source it 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.

- *Human Health* – There would be no change in practices or procedures associated with radiation exposure or the chemical environment.
- *Socioeconomics* – It is not anticipated that socioeconomic impacts would occur as a consequence of the Proposed Project.
- *Environmental Justice* – No disproportionately high and adverse environmental impacts on minority and low-income populations would be anticipated to occur.
- *Facility Accidents* – There would be no facility accidents, as the Proposed Project is not related to facility operations.

J.1.3.1 No Action Option

As there would be no change in the existing transportation network and no change to practices or procedures under the No Action option, 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.

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 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, currently 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, currently 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 2004b). The generalized land use categories within which TA-61 is located are depicted in Chapter 4, Figure 4.1-3, of this 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. Although land for the proposed parking area in TA-48 is vacant, that in TA-63 has 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 is 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 located 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 branch of Mortandad Canyon would noticeably add to the built-up appearance of the area.

Construction of the two parking lots would disturb a total of approximately 30 acres (12.1 hectares) of open and forested land, as would a section of the road crossing the eastern portion of TA-35. 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 located 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 2004c). Although it is not anticipated 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 disturb approximately 238,000 cubic yards (182,000 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, 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 should 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 should be seeded or managed as appropriate to prevent erosion and loss of the resource. In addition, care should 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.

There are a number of potential release sites 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. Approximately 50,000 cubic yards (38,000 cubic meters) of gravel, 25,000 cubic yards (19,000 cubic meters) of asphalt, and 7,600 cubic yards (5,800 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 (RLWTF) 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 RLWTF has steadily decreased since the *1999 SWEIS*. 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 very good. Most samples are within normal ranges or at concentrations far below regulatory standards or risk-based advisory levels (LANL 2004b). Current releases into Mortandad Canyon have introduced cesium-137, americium-241, plutonium-238, plutonium-239, and plutonium-240 into surface waters. Radioactivity in Mortandad Canyon surface water at locations below the RLWTF outfall was at or near the DOE Derived Concentration Guide levels for public exposure. This water is not used as a drinking source and flows do not extend offsite. Perchlorate was not detected in surface water samples in 2002, when the detection limit was 4 micrograms per liter. There was one exception: a sample from Sandia Canyon below the LANL powerplant showed detectable levels of perchlorate. Followup samples of the powerplant effluent contained no detectable perchlorate concentrations; the source of the perchlorate remains unknown (LANL 2004b).

Effluent discharges have affected perched alluvial groundwater in Mortandad Canyon. Most notably, radionuclide constituents in effluents discharged to Mortandad Canyon from the RLWTF at TA-50 have exceeded the DOE Derived Concentration Guides and have created a localized area of alluvial groundwater with plutonium-238, plutonium-239, plutonium-240, and americium-241 measured above the 4-millirem DOE Derived Concentration Guides for drinking water (LANL 2004b). Nitrate also contained in the effluent has caused alluvial groundwater concentrations to exceed the New Mexico groundwater standard and (U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level of 10 milligrams per liter.

In past years, the levels of tritium, strontium-90, and gross beta in alluvial groundwater in Mortandad Canyon usually have exceeded EPA drinking water criteria. In 2001, strontium-90 exceeded the EPA Maximum Contaminant Level in two alluvial monitoring wells in Mortandad Canyon and was also detected in surface water in the canyon. None of the other monitored radiochemical parameters exceeded either the DOE Derived Concentration Guides or EPA Maximum Contaminant Levels. During 2001, nitrate concentrations in alluvial groundwater were below the New Mexico groundwater standard and EPA Maximum Contaminant Level, except for one downstream well in Mortandad Canyon. Two wells in Mortandad Canyon also exceeded the New Mexico standard of 1.6 milligrams per liter for fluoride. Perchlorate, a nonradiological contaminant (with a provisional drinking water standard of 0.018 milligrams per liter) was detected in groundwater in every alluvial groundwater well sampled in Mortandad Canyon, with a maximum concentration of 0.22 milligrams per liter. The perchlorate source is the RLWTF effluent; however, a treatment system was installed in 2001 at the RLWTF to remove perchlorate from the facility's effluent (LANL 2004b). Since March 31, 2002, the perchlorate concentrations in RLWTF effluent have been reduced to below the detection limit of 1 part per billion (LANL 2004b).

Minimal impacts to surface water should occur during the construction of the Proposed Project. Adverse impacts from constructing the additional parking lots, intersections, and roads required for this Proposed Project would be minimized by the implementation of best management practices described in construction storm water pollution prevention plans. 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 for linear transportation projects, as 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 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 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 AS 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 2000a).

Several wetlands occur within the Pajarito Corridor West, including four in TA-48 and one in TA-55. Three of the four wetlands located 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 less than 0.1 acre (0.04 hectares) in size. The wetland located within TA-55 is within a branch of Pajarito Canyon and is located between TA-55 and TA-48; it is 1.2 acres (0.48 hectares) in size. This wetland is dominated by cattails (Army Corps of Engineers 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; Army Corps of Engineers 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), and the area consists of open field and ponderosa pine forest. The parking lot at TA-63 would total approximately 19 acres (7.7 hectares); the area currently consists 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 in the 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. Although the parking lot in TA-63, the road across the eastern edge of TA-63, and the pedestrian and vehicle bridges fall within Areas of Environmental Interest buffer zones, none of these areas are within core zones. However, construction has the potential to disturb the Mexican spotted owl due to excess noise or light. If construction were to take place during the breeding season (March 1 through August 31) Mexican spotted owls could be disturbed and surveys would need to be undertaken to determine if they were present or not. If none were found, there would be no restrictions on construction activities. However, if they were present, restrictions could be implemented to ensure that noise and lighting limits were met (LANL 2000a).

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 4.8.3, 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.

Infrastructure

Within the proposed project area, 115 kilovolt and 13.2 kilovolt 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 3.2 million gallons (12 million liters) of liquid fuels (diesel and gasoline) would be consumed for site work (mainly by heavy equipment) and 210,000 gallons (795,000 liters) for 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 million gallons (61 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-48, TA-55, TA-50, and TA-35 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. It is anticipated that approximately 630 tons (530 metric tons) (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-45, TA-55, TA-50, and TA-35. 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. 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 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 20,700 cubic yards (15,800 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 what actions would need to be taken 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.

Since 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 1,600 cubic yards (1,200 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 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.

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 would pass through portions of the core and buffer zones of the Sandia-Mortandad Mexican spotted owl Areas of Environmental Interest. Thus, the potential exists to impact Mexican spotted owls both directly (within the core zone) and indirectly (within both the core and buffer zones). Since construction during the breeding season (March 1 through August 31) could disturb Mexican spotted owls, surveys would be required to determine whether they were present or not. If a nest were discovered, restrictions on activities could be required. Further, construction activities within the core zone could be restricted if they occurred within 1,300 feet (400 meters) of the nest site and would require Section 7 consultation with the U.S. Fish and Wildlife Service. This process would necessitate the preparation of a biological assessment by DOE for the purpose of analyzing potential effects of the project on the Mexican spotted owl and its habitat. This would be followed by the issuance of a biological opinion on the project by the U.S. Fish and Wildlife Service, which could propose reasonable and prudent alternatives to the proposed project. Provided Mexican spotted owls were not found within the Areas of Environmental Interest, there would be no restrictions on construction activities (LANL 2000a).

Construction of a two-lane bridge across Mortandad Canyon is also a part of this auxiliary action. While the bridge has yet to be designed, the approaches and piers would result in the loss of some ponderosa pine forest. Although the acreage lost would be minimal, direct and indirect impacts to wildlife, such as described above for the new road, would be expected during the construction phase of the project. Although piers could be needed within the canyon, they 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. Impacts to the Mexican spotted owl from construction would require surveys and possible restrictions similar to those described above. Following construction of the bridge, both its presence and traffic-generated noise have the potential to impact core zone habitat and prevent Mexican spotted owls from using the area in the future. Thus, this aspect of the project also would be considered during consultation with the U.S. Fish and Wildlife Service.

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 4.8.3, 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.

Infrastructure

Utility resource requirements to support Auxiliary Action A are expected to have a negligible impact on site infrastructure. Approximately 284,000 gallons (1 million liters) of liquid fuel (diesel and gasoline) would be consumed for site work, mainly heavy equipment, and 86,000 gallons (326,000 liters) for the construction of new structures. In addition, it is anticipated that approximate 1.7 million gallons (6.4 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. It is anticipated that approximately 80 tons (73 metric tons) (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 5,800 cubic yards (4,400 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 1,600 cubic yards (1,200 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, 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.

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 approximately 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 pass through the core zone of the Sandia-Mortandad Canyon Mexican spotted owl Areas of Environmental Interest. Thus, the potential exists to impact Mexican spotted owls both directly (within the core zone) and indirectly (within both the core and buffer zones). Since construction during the breeding season (March 1 through August 31) could disturb Mexican spotted owls, surveys would be required to determine if they were present. If a nest were discovered, restrictions on activities, such as meeting noise and light requirements, would be implemented. Further, all construction activities within the core zone could be restricted if they occurred within 1,300 feet (400 meters) of the nest site, and Section 7 consultation with the U.S. Fish and Wildlife Service would be required. Provided Mexican spotted owls were not found within the Areas of Environmental Interest, there would be no restrictions on construction activities (LANL 2000a). Following construction of the bridge, both its presence and traffic generated noise have the potential to impact core zone habitat and prevent Mexican spotted owls from using the area in the future. As noted above for the bridge across Mortandad Canyon, this would be considered during Section 7 consultation with the U.S. Fish and Wildlife Service.

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.

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 131,000 gallons (496,000 million liters) of fuel (diesel and gasoline) would be consumed for site work, and 86,000 gallons (326,000 liters) for the construction of structures. In addition, it is anticipated that approximately 920,000 gallons (3.5 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. It is anticipated that approximately 55 tons (50 metric tons) (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 a brief 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, 2006).

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 teraops (30 to 50 trillion floating point operations per second) (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 teraops 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 teraops. 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 teraops, with the 50- and 100-teraops 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.

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 teraops. However, with the Metropolis Center presently operating near that 50-teraops level, DOE 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

DOE'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, DOE 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, DOE needs to increase its existing computer system capability. At LANL's Metropolis Center, a capability of at least 100 teraops is essential for effectively running these high-fidelity, full system weapon simulations. It is estimated that in the future, an operating level of approximately 200 teraops 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-teraops level analyzed in the *SCC EA*. Computing capacity would not be expanded beyond that level, and DOE would not attain the long-term goal of at least 100 teraops 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, DOE would expand the computing capabilities of the Metropolis Center at TA-3 to support, at a minimum, a 100-teraops capability, and approximately 200 teraops 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-teraops 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 2006).

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-acre (144-hectare) boundaries. 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, environmental justice, cultural resources, socioeconomics, transportation, waste management, and facility accidents.

J.2.3.1 No Action Option

Under the No Action Option, NNSA would operate the Metropolis Center only up to the 50-teraops 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 site capacity.

As shown in Table J–4, the *SCC EA* evaluated water usage of 63 million gallons (239 million liters) per year and electrical consumption of 7.1 megawatt per year for operating a 50 teraops platform. Due to continued computer design efficiencies, current water usage for operating the Metropolis Center is about 19 million gallons (72 million liters) per year and electricity consumption is about 5 megawatts per year (LANL 2006).

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]	*LANL System Usage (2004)* [c]	*LANL System Capacity (2004)* [c]
Water (million gallons per year)	63.1	19	51	1,382	1,806
Electricity *Energy* (megawatt-hours per year)	62,196	43,800 [d]	131,400 [d]	540,821	1,314,600
Peak Load (megawatts)	7.1	6 [e]	18 [e]	86	150
Workers	300	350	350	13,261 [f]	Not applicable

[a] DOE 1998a.
[b] LANL 2006.
[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.
[d] Megawatt platform × estimated 8,760 hours per year.
[e] Megawatt platform × estimated 1.2 peak loading factor.
[f] LANL 2005a.
Note: To convert gallons to liters, multiply by 3.7853.

Although the *SCC EA* and associated FONSI indicated that operating the Metropolis Center at up to 50 teraops 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 process water needs, has not been able to effectively meet the Metropolis Center's water requirements, much of this water has been, and is expected to continue to be, supplied through groundwater.

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). In fiscal year 2004, LANL used approximately 346 million gallons (1,310 million liters) of water, of which 19 million gallons (72 million liters) were attributable to the Metropolis Center (LANL 2005a). LANL site water use and capacity compared to the Proposed Project and alternatives is presented in Table J–4.

Groundwater in the Los Alamos area occurs as perched groundwater near the surface in shallow canyon bottom alluvium and at deeper levels in the main (regional) aquifer. All groundwater underlying LANL and the vicinity having a total dissolved solids concentration of 10,000 milligrams per liter or less is considered a potential source of water supply for domestic or other beneficial use. Surface water within LANL boundaries is not a source of municipal, industrial, or irrigation water.

Under the Proposed Project, DOE 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 effective in supplying the Metropolis Center, most of this process 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 200 teraops (LANL 2006). Because each new generation of computing capability machinery continues to be designed with increased computational speed and enhanced efficiency in cooling water requirements, it is anticipated that the net cooling water requirements for the Metropolis Center would be less, should the Sanitary Effluent Recycling Facility be used as planned (LANL 2006).

Electric

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, DOE 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 is scheduled to become operational in June 2006. Generally, onsite electricity production is used to fill the difference between peak loads and the electric power import capability (LANL 2004c, 2005a, 2006).

As shown in Table J–4, electric power availability from the local Pool is now estimated at 1,314,600 megawatt-hours (reflecting the lower thermal rating of 150 megawatts for 8,760 hours per year on the existing transmission system). In fiscal year 2004, LANL and other Los Alamos County users combined for a Power Pool total electric energy consumption of 540,821 megawatt-hours of electricity. The fiscal year 2004 peak load usage was about 69 megawatts for LANL and about 16 megawatts for the rest of the county (LANL 2004b). The estimated peak load capacity is 150 megawatts (LANL 2005a).

Under the Proposed Project, DOE would expand the computing capabilities of the Metropolis Center at TA-3 to support a 100-teraops 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 200 teraops (LANL 2006). 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 teraops should increase significantly while the amount of required electrical power stabilizes at less than 15 megawatts (LANL 2006).

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[1] having a wider range of isotopes than analyzed in previous NEPA documents. The Off-Site Source Recovery Project has the responsibility to identify, recover, and store excess and unwanted sealed sources in cooperation with the 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

[1] 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 835). Sealed sources are typically small.

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 the NRC. Since 1999, the Off-Site Source Recovery Project has successfully managed actinide-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 (DOE 2004b), the previous mission of the Off-Site Source Recovery Project was expanded. 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, 10 *Code of Federal Regulations* (CFR) 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 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 organizations and facilities where appropriate, and LANL facilities would be utilized when commercial storage is 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.

Recognizing the public danger posed by excess and unwanted radioactive sealed sources, Congress addressed their disposition in 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 61.[2] This waste is

[2] 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 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 16.55, Class C limits are established for these isotopes that are commonly found in sealed surfaces: alpha-emitting transuranic isotopes having half-lives exceeding five years; strontium-90; and cesium-137.

commonly called Greater-than-Class-C waste. Sealed sources that are declared excess may be determined to be Greater-than-Class-C waste because they exceed the Class C concentration limits due to the quantity of radioactive material and their small physical size. It has been estimated that 21,000 Greater-than-Class-C sealed sources within the commercial sector will become excess and need to be managed in the Off-Site Source Recovery Project.[3]

From 1979 to 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. Approximately 1,100 neutron-generating and other sealed sources were recovered from regulated licensees, DOE sites, and other Governmental agencies and sent to LANL. At LANL, these sealed sources were opened, their radioactive contents chemically separated, and the radioactive products and wastes stored separately.

In the early 1990s, DOE 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. Facing the potential recovery of several thousand 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 the DOE's *Environmental Assessment for the Radioactive Source Recovery Program* (DOE 1995) issued December 20, 1995.

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* is 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 the impacts analysis for the CMR Building, the Plutonium Facility complex, and Area G at TA-54.

In 2000, NNSA prepared the *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 (DOE 2000). 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), sealed sources would be packaged in multi-functional shielded containers (at the origination point or

Class C limits are also established for these isotopes that are not commonly found in sealed sources: carbon-14, nickel-59 and -63, niobium-94, technetium-99, iodine-129, plutonium-241, and curium-242.

[3] *In this appendix, sources containing isotopes in quantities that could exceed Class C concentrations, if disposed as waste, are called Greater-than-Class-C sealed sources.*

consolidated at a licensed commercial facility under contract to DOE) and shipped directly to LANL for storage as waste items. Except for those containers of defense-related sealed sources that would be eligible for shipment to WIPP, this waste has no disposal path. The waste containers are placed in storage and held until an appropriate waste disposal facility becomes available.

In response to the events of September 11, 2001, the 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[4] 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 Project would result in a small amount of Greater-Than-Class C low-level 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 the 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 waste was not projected to exceed the *1999 SWEIS* projections for low-level 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 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 having Class C concentration limits. The 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. Attempts are underway to identify the numbers and types of sources involved in the expanded scope, similar to the estimate of 21,000 made for actinide-bearing sources.

---

[4] *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.*

At this point, sufficient information is not available to predict the total number of sources to be managed. The Off-Site Source Recovery Project intends to use commercial organizations and facilities where appropriate, and LANL facilities when commercial storage was not appropriate to fulfill the national security mission of the Off-Site Source Recovery Project.

Purpose and Need

The NRC 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 certain actinide-bearing sealed sources for recycling actinide materials or for storage as waste until a disposal method is determined. Six strontium-90 radioisotope thermoelectric generators sealed sources were received and stored as waste with no disposal path. The Off-Site Source Recovery Project has now been tasked with managing an additional number and type of sealed sources. The Off-Site Source Recovery Project would use commercial organizations and facilities where appropriate, and LANL facilities when commercial storage was not appropriate to fulfill the national security mission of the Off-Site Source Recovery Project.

J.3.2 Options Descriptions

J.3.2.1 No Action Option

Under the No Action Option, LANL would continue to receive and store Greater-Than-Class C actinide-bearing sealed sources at the previous rate of 10,000 curies per year or 100,000 curies for 10 years. 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 CMR Building, TA-18 or TA-55.

Sealed sources containing actinides (specifically isotopes that would make them meet the definition of transuranic waste) that DOE has determined were generated as part of defense activities are eligible for disposal at WIPP. The Off-Site Source Recovery Project also expects to continue to receive sealed sources containing transuranic isotopes that are not designated defense waste and are not eligible for disposal at WIPP; they are currently without a disposal path. The projected annual volumes for the duration of the Off-Site Source Recovery Project are shown in **Table J–5**. The total volume of actinide sources with no disposal path is expected to be approximately 260 cubic yards (200 cubic meters).

Table J–5 Projected Annual Volumes of Waste with No Disposal Path for Duration of the Off-Site Source Recovery Project

Fiscal Year	*Volume (cubic yards)*
2005	52
2006	16
2007	10
2008	7
2009	3
2010	1

Note: To convert cubic yards to cubic meters, multiply by 0.77.
Source: LANL 2004e.

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 Greater-Than-Class C actinide-bearing sealed sources that are currently received by the Off-Site Source Recovery Project. **Table J–6** gives the additional sources registered as of August 2005.

Table J–6 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 2004e, 2006.

Management of the sealed sources containing additional nuclides, if directed to LANL, would follow the same approach used for sealed 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 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, sources would be managed to minimize impacts on existing and planned NNSA operations within the facilities used to support 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 contain high activity or need special handling would be transported to Wing 9 of the CMR Building, removed from packages, and stored in the floor holes. 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 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 the pipe overpack container.

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 2005b). The SM-30 warehouse at TA-3 is LANL's main general warehouse; it can store limited quantities of hazardous chemicals. 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.
- *Environmental Justice* – No disproportionate impacts to minority or low-income communities are anticipated.
- *Cultural Resources* – Storage would be in developed areas with no identified cultural resources.
- *Socioeconomics* – No additional full-time equivalent employees would be expected.
- *Transportation* – Sealed sources are packaged to DOT specifications and would not require road closures. Due to their small size, a large shipping campaign would not be necessary for shipping sealed sources.
- *Environmental Restoration* – Future closure of Area G and management of remaining waste is addressed in Appendices H and I, respectively.

Waste management and human health are discussed in more detail in the following section, because many of these additional sealed sources would be stored at LANL as waste with no disposal path.

J.3.3.1 No Action Option

Waste Management

Public Law 99-240 of 1985 assigned the Federal government the responsibility for disposal of low-level radioactive wastes exceeding Class C limits, as established by 10 CFR 61.55, that result from activities licensed by NRC or Agreement States. The Act also directed that all radioactive waste exceeding Class C limits and resulting from NRC-licensed activities must be disposed of in a facility licensed by NRC. A large fraction of the sources recovered by the Off-Site Source Recovery Project result from these licensed activities. Until DOE identifies a disposal location consistent with these statutory requirements, much of the material recovered by the Off-Site Source Recovery Project will remain without a defined disposal pathway.

Originally the Off-Site Source Recovery Project and its predecessor organization received sealed sources on a case-by-case basis and processed them to recycle the actinide material. Any waste generated was stored for eventual disposal at WIPP or some other disposal facility. Later this program was no longer feasible and the sealed sources were recovered and stored as waste until a disposal path could be determined. 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 August 2005, 30 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–7 lists the anticipated volume of actinide-bearing sources that have been received or are expected to be received by 2010 that have no disposal path. 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 radioisotope thermoelectric generators are being stored pending shipment to the Nevada Test Site for disposal. **Table J–8** shows the location of the Greater-Than-Class-C actinide wastes currently stored at LANL.

Table J–7 Anticipated Volume of Greater-Than-Class C Actinide Waste with No Disposal Path over the Life of the Project

Source Type	*Typical Activity (curies/each)*	*Number of Sources*	*Anticipated Packaging (number per drum)*	*Number of Drums* [a]	*Total Volume* [a] *(cubic yards)*
Americium-241 Calibration Sources	0.005	3,960	330	12	3.1
Americium-241 Medical Sources	0.1	**Unknown**	**Unknown**	**Unknown**	**Unknown**
Plutonium-238 Medical Sources	8	1,440	6	240	62
Americium-241 Be Well Logging Sources	3	3,870	10	387	101
Plutonium-238 Be Well Logging Sources	10	204	3	68	18
Americium-241 Be General Neutron Sources	1	1,800	30	60	16
Americium-241 Be and Cesium-137 Portable Gauge Sources	0.045/0.01	1,200	100	12	3.1
Americium-241 Be Portable Gauge Sources	0.045	400	200	2	0.5
Americium-241 Fixed Gauges	0.124	2,040	85	24	6.2
Americium-241 XRF Sources	0.18	2,112	88	24	6.2
Totals	NA	17,346	NA	869	216.1

Be = beryllium, XRF = x-ray fluorescence.
[a] LANL 2004e. Final package volume and number of drums will vary based on actual packaging efficiencies.
Note: To convert cubic yards to cubic meters, multiply by 0.76456.

Table J–8 Currently Stored Material with No Disposal Path

LANL Facility	*Number of 55-Gallon Drums*	*Total Number of Sealed Sources*	*Types of Sources Classified as Waste with No Disposal Path*
Area G, TA-54 aboveground	721	9,591	Plutonium-238, americium-241
Area G, TA-54 retrievable shaft	0	4	Strontium-90 radioisotope thermoelectric generators
Area G, TA-54 aboveground	0	2	Strontium-90 radioisotope thermoelectric generators
Wing 9, CMR Building	1	22	Americium-241, plutonium-238

TA = technical area, CMR = Chemistry and Metallurgy Research.

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

Waste Management

Under the Proposed Project, the Off-Site Source Recovery Project would accept sealed Greater-Than-Class-C sealed sources containing any concentrations of the same isotopes as Greater-

Than-Class-C sources, and sealed sources containing certain additional isotopes. The current inventory of existing sources is shown in Table J–6. Most of these sealed sources are expected to be managed outside LANL, but it may be necessary to receive and store some of them at TA-54 or the CMR Building.

Sealed sources that contain high activity or needed special handling would be transported to Wing 9 of the CMR Building, removed from packages, and safely stored, these may be moved to the Radiological Sciences Institute at TA-48 after closure of the CMR Building (see Section G.3). Most of the sources are expected to 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 sources could be stored in a retrievable configuration in shafts. Any sources containing radium-226, curium-244, and californium-252, if stored at LANL, would likely be stored in the pipe overpack container described in previous analyses.

Human Health Impacts

Normal Operations 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 to occur 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 during normal operations.

The *Environmental Assessment for the Radioactive Source Recovery Program* (DOE 1995) provided an estimate of the CMR Wing 9 Hot Cell involved worker dose for all activities associated with each neutron sealed source to be 2.3 millirem. At 100 sources per year, the worker dose would be equivalent to the historical average worker dose at the CMR 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 a latent cancer fatality in this group of workers of 0.01, or 1 chance in 100.

Accident Health Impacts

As a result of the planning for expanding the project, specific limits on activity of sealed sources to be stored and managed at the TA-54, Area G and Wing 9 of the CMR Building were established (LANL 2006). These limits are based on equivalence to plutonium-239-equivalent-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 2006.
[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 2006.

LANL evaluated 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 2004d). 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 direct 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 capability (ORNL 1990). ZYLIND accounts for dose buildup factors and shielding effects. Direct 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**.

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 2004d.

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 2004d.

Cobalt-60 was found to result in 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; direct external radiation exposure at these distances was less important. Cesium-137 resulted in maximum exposure to the surrounding population because of its associated 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.

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 direct external radiation dose to the 50-mile (80-kilometer) radius population is small since 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 direct exposure to external radiation based on a factor of 1,000 to 10,000 lower source term of neutron emitters curium-244 and californium-252 as compared to gamma emitters cobalt-60, cesium-137, and iridium-192.

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.

Based on the CMR 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[5]. This accident has a frequency of 2.4×10^{-4} (1 chance in 4,200) per year (plume energy of 2.4 megawatts and 30-minute duration) 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, leak path factor as for TA-54, Area G, but using the material at risk for Wing 9 of the CMR Building, **Table J–14** delineates the airborne release and direct radiation source terms assuming that one shipping container with 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 CMR Building or TA-48, a proposed future location for hot cell operations (see Appendix G).

[5] *Wing 9 of the CMR 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 as discussed. The accident analysis for materials stored in Wing 9 was performed for the current CMR Building location in TA-3 as well as for a location in TA-48.*

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

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.

Results of the sealed source accident analysis are presented for two different facilities, Wing 9 of the CMR Building and TA-54 Area G, where sealed sources are planned to be handled, stored, and transported. The Wing 9 of the CMR 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 direct exposure to radiation 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, since 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 direct 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. Direct 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.

The nearest public access to the CMR Building, Diamond Drive, which is approximately 164 feet (50 meters) from the CMR 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 CMR Building at TA-3, and Wing 9 of the CMR Building 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, rem = roentgen equivalent man, 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 of the three accident scenarios analyzed involving sealed sources result in a risk of a latent cancer fatality during the lifetime of a noninvolved worker or maximally exposed individual 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 latent cancer fatality 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 strontium-90 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 dome, and Wing 9 of the CMR 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

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 at the Los Alamos National laboratory*, 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, 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, Los Alamos Site Office, National Nuclear Security Administration, Albuquerque, New Mexico, January.

DOE (U.S. Department of Energy), 2004b, Memorandum to Ralph Erickson, Manager, Los Alamos Site Operations, from Paul 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 (KBR SHAW LATA), 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 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), 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, *Environmental Surveillance at Los Alamos during 2003*, LA-14162-ENV, Los Alamos, New Mexico, September.

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, *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), 2004e, "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), 2005a, *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), 2005b, *Status Report for Integrated Closure Activities at Technical Area 54*, LA-UR-05-6767, (NWIS DIV-REPORT-0202), R.0., Los Alamos, New Mexico, July 7.

LANL (Los Alamos National Laboratory), 2006, *Los Alamos National Laboratory Site-Wide Environmental Impact Statement Information Document*, Data Call Materials, Los Alamos, New Mexico.

ORNL (Oak Ridge National Laboratory), 1990, *An Interactive Point Kernel Program for Photon Dose Rate Prediction of Cylindrical Source/Shield Arrangements*, 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 wastes 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*, Part 20 [10 CFR 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 or rail. 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 (0.21-cubic-meter) drum or standard waste box, is commonly used to transport radioactive materials with higher concentrations or amounts of radioactivity than Strong and Tight, 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 71 ("Packaging and Transportation of Radioactive Material"), 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 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 was 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). 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.

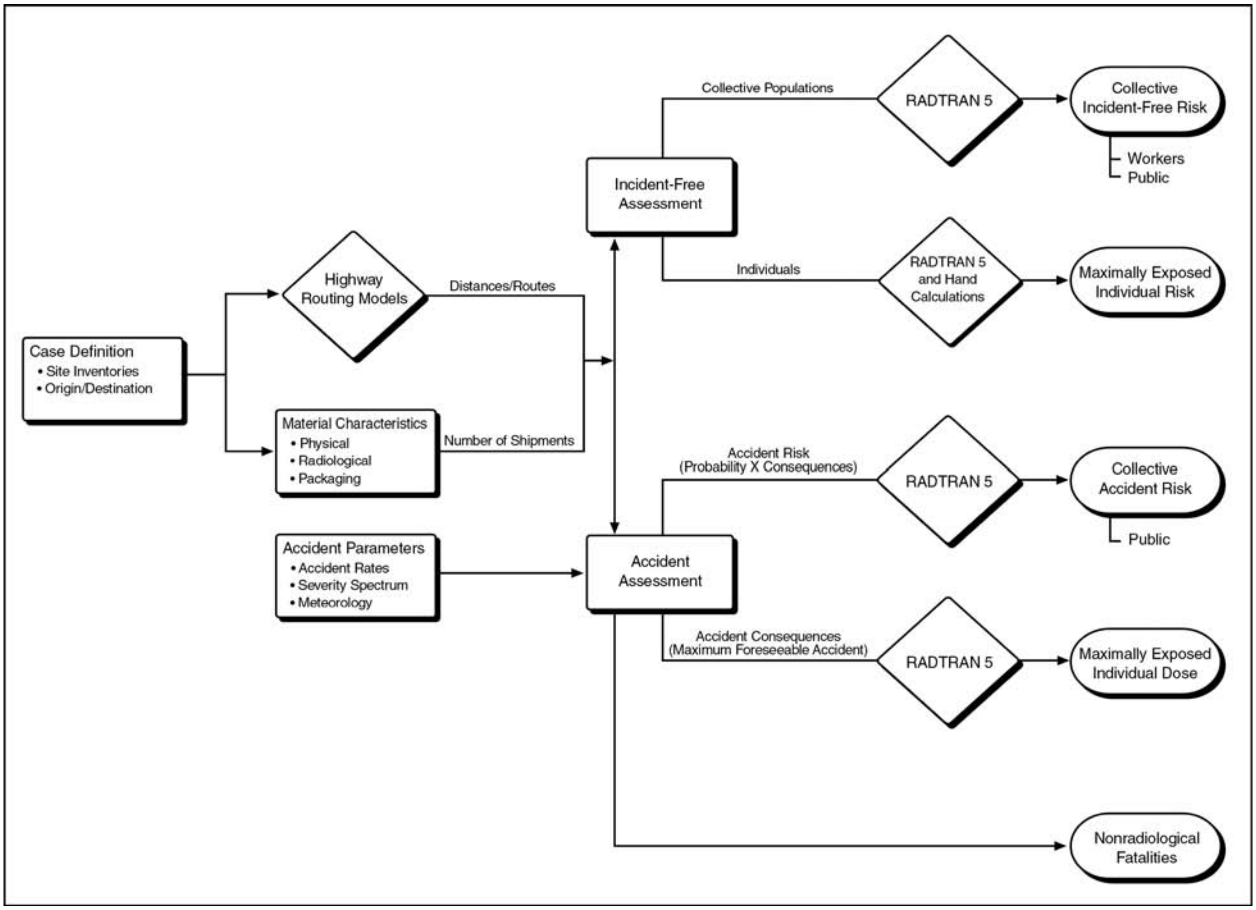


Figure K–1 Transportation Risk Assessment

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-freights are 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 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;
- Savannah River Site in Aiken, South Carolina;
- Nevada Test Site in Mercury, Nevada;
- Envirocare 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
	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), WIPP = Waste Isolation Pilot Plant.
[a] The estimated number of persons residing within 0.5 miles (800 meters) along the transportation route.
[b] Envirocare is a representative commercial disposal facility.
[c] Pass through Santa Fe bypass (S-599) to I-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**.

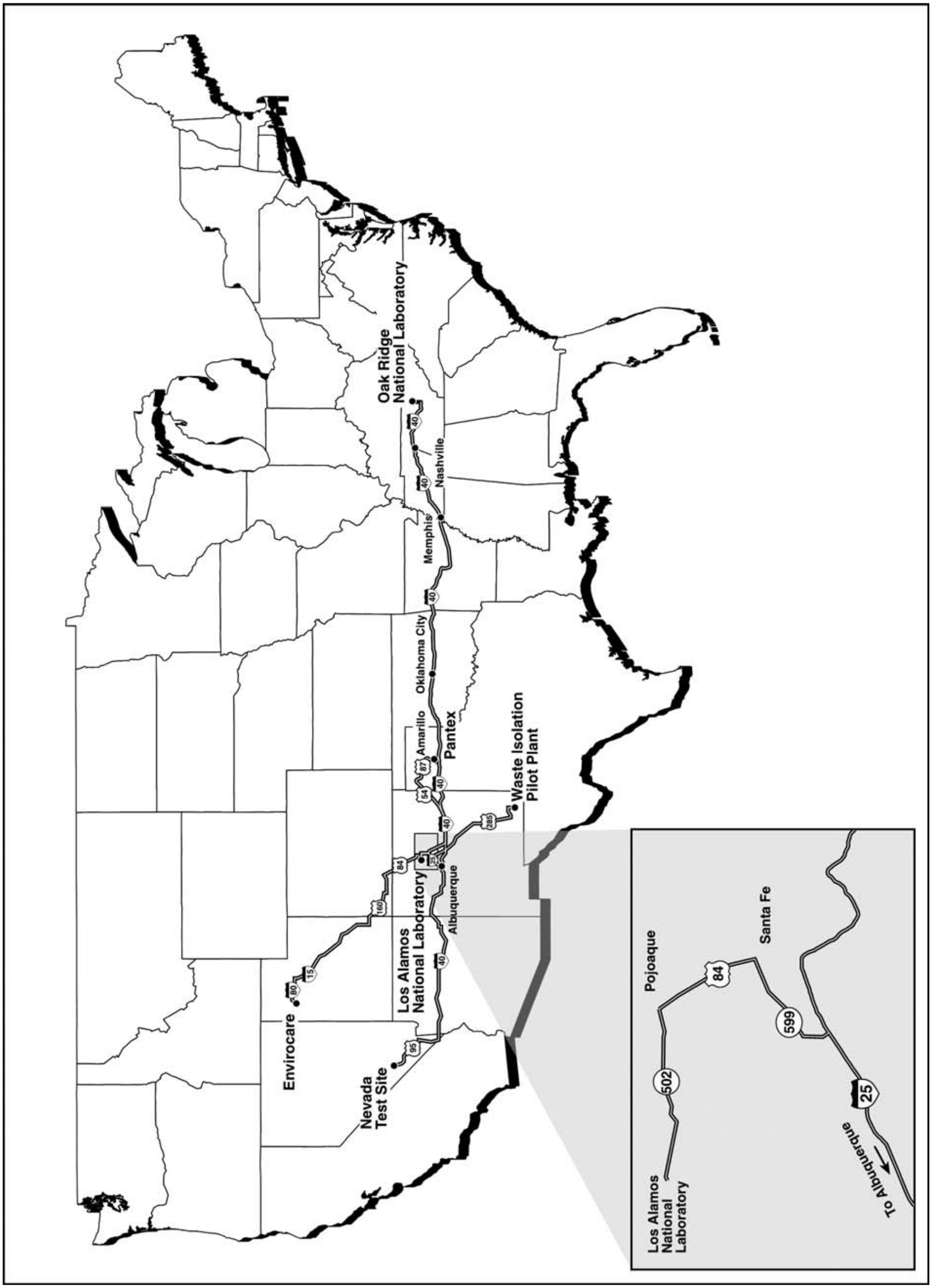


Figure K–2 Analyzed Truck Routes

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 and FL containers	0.13 and 0.32	168	10 to 20 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
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 [d]

[a] To convert cubic meters to cubic feet, multiply by 35.315; liters to gallons, multiply by 0.26417.
[b] To convert kilograms to pounds, multiply by 2.2046. Container mass includes the mass of the container shell, its internal packaging, and the materials within.
[c] Remote-handled low-level radioactive wastes are packaged in 55-gallons (208-liter) drums and transported in Type B shipping casks.
[d] Depending on the waste density, 60 to 80 drums could be shipped per truck.
Note: Construction debris and hazardous wastes would be shipped to a local offsite location.

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 material transports include those that are used in nuclear weapons and the production of mixed oxide fuel.

For the purposes of analysis, it was assumed that all low-level radioactive waste would be disposed at LANL, a DOE site (the Nevada Test Site, in Nevada), or a commercial site (Envirocare, 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 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. For rail shipments, the crew consists of workers in close proximity to the shipping containers during inspection or classification of railcars. The general population is composed of the persons residing within 0.50 miles (800 meters) of the truck or rail routes (off-link), persons sharing the road or railway (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 and escorts 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 lateral, edge of the vehicle, it would be transported in a Type A or Type B shielded shipping cask or container.

---

[1] *Based on the Transport Index definition provided in 10 CFR 71.43 and 49 CFR 173.410.*

Waste container dose rate, or its Transport Index, is dependent 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).

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 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, radiological consequences were calculated in each population zone for an accident having 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, Claus, and Blower 1994), was 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 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 average weather condition.

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 fractions 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 that it could take to minimize the risk or potential consequences of radiological sabotage. Acts of sabotage and terrorism have been evaluated for spent nuclear fuel and high-level radioactive waste shipments (DOE 1996, 2002a). The spectrum of accidents considered range from direct attack on the cask from afar to hijacking and exploding the shipping 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 weapons used). The sabotage event was assumed to occur in an urbanized area. The accident was assumed to involve a rail-sized cask containing high-level waste. DOE's evaluation of sabotage of a rail-size cask containing spent nuclear fuel in the *Environmental Impact Statement for a Geological Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Yucca Mountain EIS)* calculated an MEI dose (at 460 feet [140 meters]) of 40 rem. This dose increased the risk of a fatal cancer to the MEI by 2 percent (DOE 2002a). This estimate of risk bounds the risks from an act of sabotage or terrorism involving the radioactive material transported under all alternatives in this 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). 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 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 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.

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.

Table K–3 Risk Factors per Truck Shipment of Radioactive Material

		Incident-Free				*Accident*	
Waste Materials	***Transport Destination***	***Crew Dose (person-rem)***	***Crew Risk (LCF)***	***Population Dose (person rem)***	***Population Risk (LCF)***	***Radiological Risk (LCF)***	***Nonradiological 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	6.42×10^{-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}	1.89×10^{-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}	7.69×10^{-11}	1.73×10^{-6}
PuO_2	SRS	0.00985	4.71×10^{-6}	0.00542	3.25×10^{-6}	4.35×10^{-8}	8.08×10^{-6}

LCF = latent cancer fatality, rem = roentgen equivalent man, 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, SNM = special nuclear material, PuO_2 = plutonium dioxide (polished), SRS = Savannah River Site.

[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 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.

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.

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)	Nonradiological 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		0.000298	1.79×10^{-7}	0.000336	2.02×10^{-7}	4.93×10^{-12}	4.17×10^{-8}
PuO_2		0.000901	5.40×10^{-8}	0.0000602	3.61×10^{-8}	2.89×10^{-10}	4.17×10^{-8}
LLW (B) [a]	Pojoaque to Santa Fe [f]	0.000517	3.10×10^{-7}	0.000154	9.22v× 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		0.000500	3.00×10^{-7}	0.000552	3.31×10^{-7}	1.45×10^{-11}	1.40×10^{-7}
PuO_2		0.000151	9.05×10^{-8}	0.0000988	5.93×10^{-8}	8.49×10^{-10}	1.40×10^{-7}

LCF = latent cancer fatality, rem = roentgen equivalent man, 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 (polished).

[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 *Code of Federal Regulations* (CFR) 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] Shipments pass through the Santa Fe bypass (S-599) to I-25.

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 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* (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-freights. 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, 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 the analyses purposes in this SWEIS, the destinations were limited to those that would be greatly affected, namely 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. The 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 operational waste, the TA-18 decommissioning and demolition activities, and baseline remediation of MDA activities. For the remediation options for MDAs, see Appendix I.

Table K–6 shows the risks of transporting radioactive waste under each alternative. 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–5 Estimates of the Number of Radioactive Shipments Under Each Alternative

	Number of Shipments										
	Radioactive Materials									*Miscellaneous*	
Alternative	*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	784	8,517	300	0	190	1,317	600	0	950	10,764
Reduced Operation	624	784	7,283	300	0	190	1,317	600	0	938	11,764
Expanded Operation [f]	1,436 - 49,940	9,465	9,050	3,390 - 36,493	191 - 851	295 - 9,011	2,185 - 4,824	600	10	2,811 - 4,779	36,451 - 42,543

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 strong and tight, drums or Type A, B-25 boxes.

[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 61 waste classification. This waste is generated during MDA waste retrieval, and from decontamination and demolishing of some of the buildings.

[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.

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. 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–6 Risks of Transporting Radioactive Materials Under Each Alternative

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]
No Action									
LANL to Pojoaque	NTS	12,332	0.77	4.53	0.0027	1.55	0.00093	3.6×10^{-6}	0.0087
Pojoaque to Santa Fe		12,332	0.97	7.59	0.0046	2.54	0.00153	5.8×10^{-6}	0.0110
Total		12,332	28.72	146.7	0.088	49.3	0.0296	0.000156	0.282
LANL to Pojoaque	Commercial	12,332	0.77	4.53	0.0027	1.55	0.00093	3.6×10^{-6}	0.0087
Pojoaque to Santa Fe		2,360 [c]	0.19	3.07	0.00184	1.21	0.00073	2.1×10^{-7}	0.0017
Total		12,332	25.25	129.4	0.0776	44.3	0.0266	0.000132	0.244
Reduced Operations									
LANL to Pojoaque	NTS	11,098	0.69	4.15	0.00249	1.44	0.00086	3.1×10^{-6}	0.0082
Pojoaque to Santa Fe		11,098	0.88	6.95	0.0042	2.35	0.0014	5.0×10^{-6}	0.010
Total		11,098	25.63	131.3	0.079	44.4	0.0267	0.000136	0.251
LANL to Pojoaque	Commercial	11,098	0.69	4.15	0.00249	1.44	0.00086	3.1×10^{-6}	0.0082
Pojoaque to Santa Fe		2,360 [c]	0.19	3.07	0.00184	1.21	0.00073	2.1×10^{-7}	0.0022
Total		11,098	22.60	116.2	0.070	40.2	0.024	0.000115	0.218
Expanded Operations (with MDA Removal Option)									
LANL to Pojoaque	NTS	120,244	7.48	25.07	0.0150	7.62	0.00457	0.000031	0.088
Pojoaque to Santa Fe		120,244	9.50	42.01	0.0252	12.48	0.0075	0.000046	0.112
Total		120,244	294.17	884.2	0.530	271.3	0.163	0.00156	2.93
LANL to Pojoaque	Commercial	120,244	7.48	25.07	0.0150	7.62	0.00457	0.000031	0.088
Pojoaque to Santa Fe		42,954 [c]	3.39	29.37	0.0176	9.09	0.0055	0.000023	0.040
Total		120,244	267.32	745.3	0.447	258.6	0.0155	0.00134	2.64
Expanded Operations (with MDA Cap and Remediation Option)									
LANL to Pojoaque	NTS	26,622	1.66	7.17	0.0043	2.32	0.0014	5.3×10^{-6}	0.0195
Pojoaque to Santa Fe		26,622	2.10	12.02	0.0072	3.80	0.0023	8.3×10^{-6}	0.025
Total		26,622	63.52	229.8	0.138	73.6	0.044	0.00023	0.63
LANL to Pojoaque	Commercial	26,622	1.66	7.17	0.0043	2.32	0.0014	5.3×10^{-6}	0.0195
Pojoaque to Santa Fe		6,552 [c]	0.52	6.66	0.0040	2.28	0.00137	2.2×10^{-6}	0.0061
Total		26,622	56.55	208.6	0.125	67.9	0.041	0.00020	0.55

rem = roentgen equivalent man, 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, and Pantex 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, 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.

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

rem = roentgen equivalent man.
[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, if all radioactive materials were to be shipped via this route, would be about 36 millirem. 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 120,250 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 of 2 hours and ground contamination of 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 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	1.7×10^{-7}	310	0.186	0.0062	3.7×10^{-6}
Reduced Operations	CH-TRU	1.7×10^{-7}	310	0.186	0.0062	3.7×10^{-6}
Expanded Operations, MDA Removal Option	CH-TRU	4.9×10^{-7}	310	0.186	0.0062	3.7×10^{-6}
Expanded Operations, MDA Capping Option	CH-TRU	2.5×10^{-7}	310	0.186	0.0062	3.7×10^{-6}

rem = roentgen equivalent man, LCF = latent cancer fatality, CH-TRU = contact-handled transuranic waste, MDA = material disposal area.

[a] Unless otherwise noted, 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).

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	5.66×10^6	0.64	0.070
Expanded Operations			
With MDA Capping	24.61×10^6	2.78	0.29
With MDA Removal	28.20×10^6	3.19	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 120,250 truck shipments of radioactive materials would be transported to the Nevada Test Site, WIPP, Pantex, and Savannah River Site.

- The lowest risk to the public would be under the Reduced Operations Alternative and a commercial site disposal option, with about 11,100 truck shipments of radioactive materials.

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) 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 the 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 369,200 person-rem (222 LCFs) for the period 1943 through 2047 (104 years). The total general population collective dose was also estimated to be about 338,600 person-rem (203 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 estimated to result from radioactive material transportation over the period between 1943 and 2047 is 203. Over this same period (104 years), approximately 31 million people would die from cancer, based on 300,000 cancer fatalities per year. It should be noted that the estimated number of transportation-related LCFs would be indistinguishable from other LCFs, and the transportation-related LCFs would be 0.0014 percent of the total number of LCFs.

Table K–10 Cumulative Transportation-related Radiological Collective Doses and Latent Cancer Fatalities (1943 to 2047)

Category	*Collective Worker Dose (person-rem)*	*Collective General Population Dose (person-rem)*
Transportation Impacts in this SWEIS [a]	884 [a]	271 [a]
Other Nuclear Material Shipments		
Historical	330	230
Reasonably foreseeable	21,000	45,000
General transportation (1943 to 2033)	310,000	260,000
General transportation (1943 to 2047)	330,000	290,000
Yucca Mountain EIS (maximum transport) (up to 2047)	17,000	3,000
Total collective dose (up to 2047)	369,214	338,601
Total latent cancer fatalities	222	203

rem = roentgen equivalent man.
[a] Maximum values from Tables K–6 for transports from 2007 through 2016.
Source: DOE 2002a.

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 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

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.

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*, 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.

Neuhauser, K. S., F. L. Kanipe, and R. R. 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 Impact 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 Shipping 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 (10 *Code of Federal Regulations* [CFR] 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. 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 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 fire breaks 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.

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.

Environmental Restoration and Waste Management

LANL staff routinely conducts short-term, low-cost environmental actions to reduce risk to human health or the environment from the release or threat of release of hazardous substances. 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.

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.

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, and include plutonium-239 and plutonium-242, depleted uranium-238, thorium compounds, high-temperature superconductors, and other metals and semiconductors.

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.

Geology and Geochemistry Research

Basic and applied geology and geochemistry research studies are conducted on rock, concrete, soil, and other geological samples. A number of different activities are conducted, including electron probe microanalysis, infrared spectroscopy, optical microscopy, scanning electron microscopy, wet chemistry analyses, x-ray diffractometry, and acoustical studies. This research is used to quantitatively analyze elements, measure vibrational spectra, determine homogenization and freezing temperatures, determine vibration signals, and a number of other purposes. A variety of equipment (such as electron microprobes, infrared spectrometers, optical microscopes, gas chromatographs, oscilloscopes, and others) and materials are used to conduct the research.

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.

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.

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 wave lengths, 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.

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.

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 that 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.

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.

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.

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.

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.

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 improves evaluation of the sample.

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.

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.

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.

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 (lidar) systems.

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, volt meters, arbitrary function generators, image monitors, optical light sources, high-voltage power supplies, charge-coupled device cameras, commercial image intensifiers, and lasers.

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.

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.

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]

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.

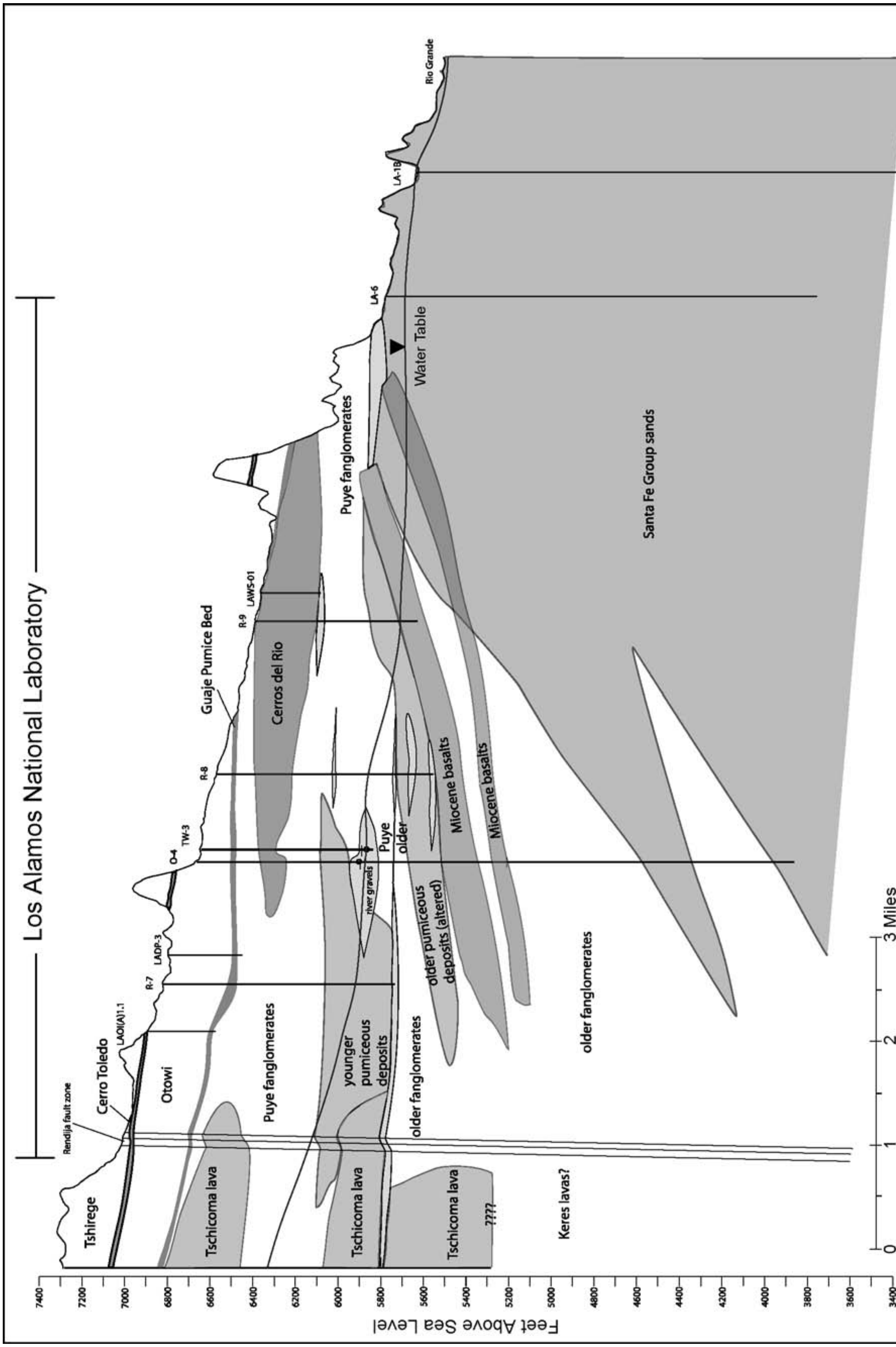
Certified by:

Signature

Timothy G. George
Name

President
Time Solutions Corporation

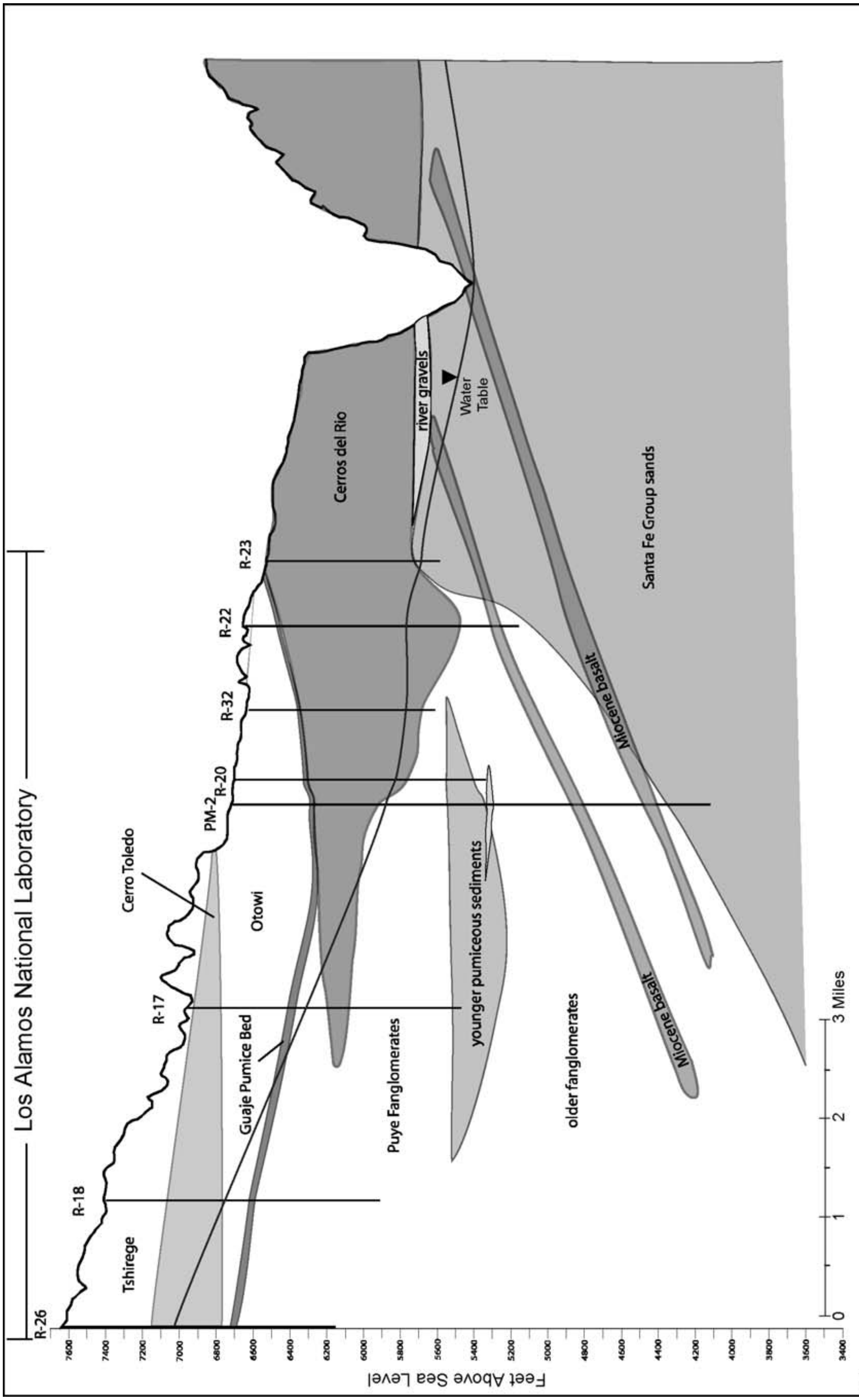
June 2005
Date



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.

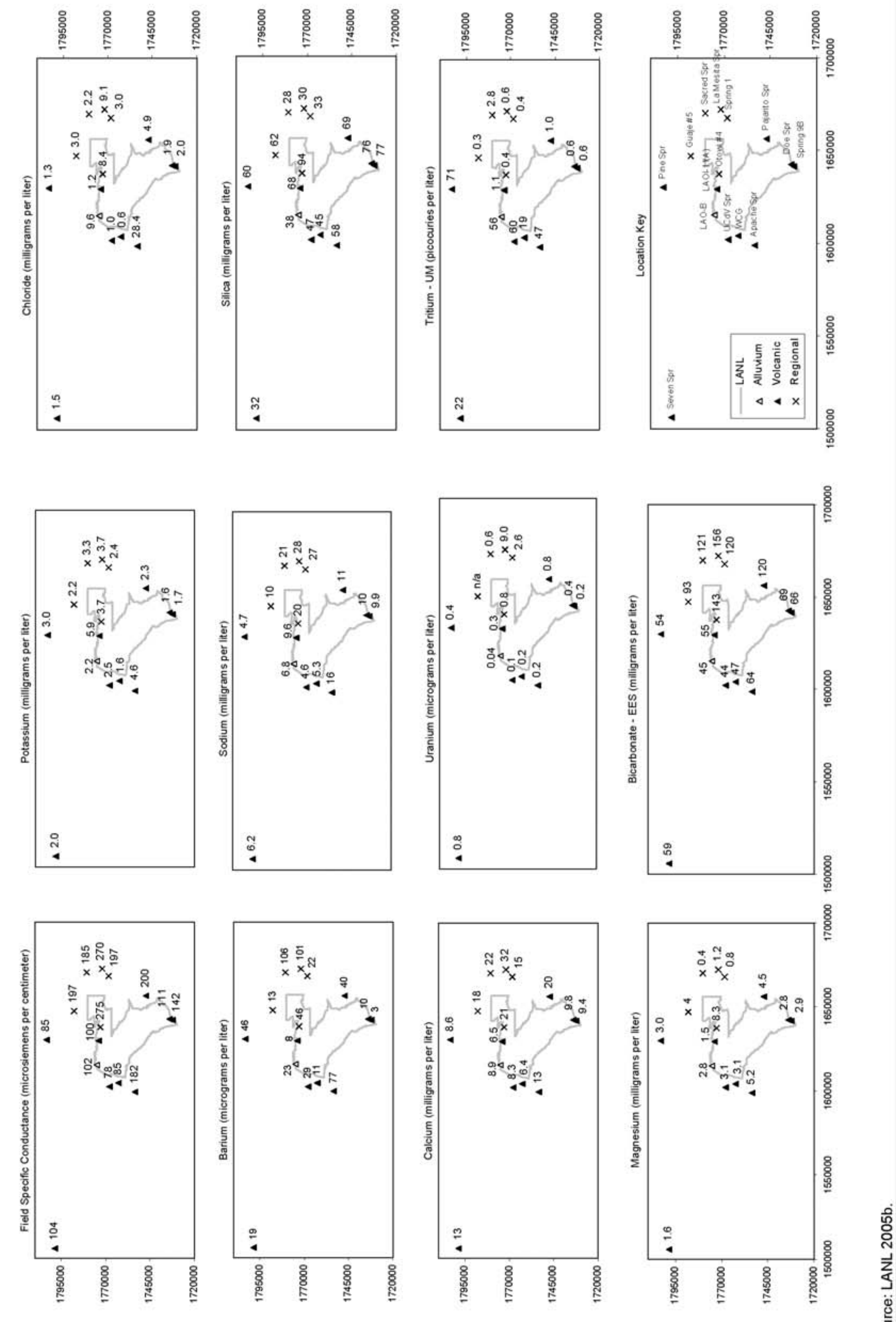
Figure E–7 Conceptual Cross-Section Across the Pajarito Plateau Along Los Alamos Canyon



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



Source: LANL 2005b.

Figure E–9 Average Spatial Distribution (n=6) for Key Analytes in Los Alamos National Laboratory Background Wells and Springs

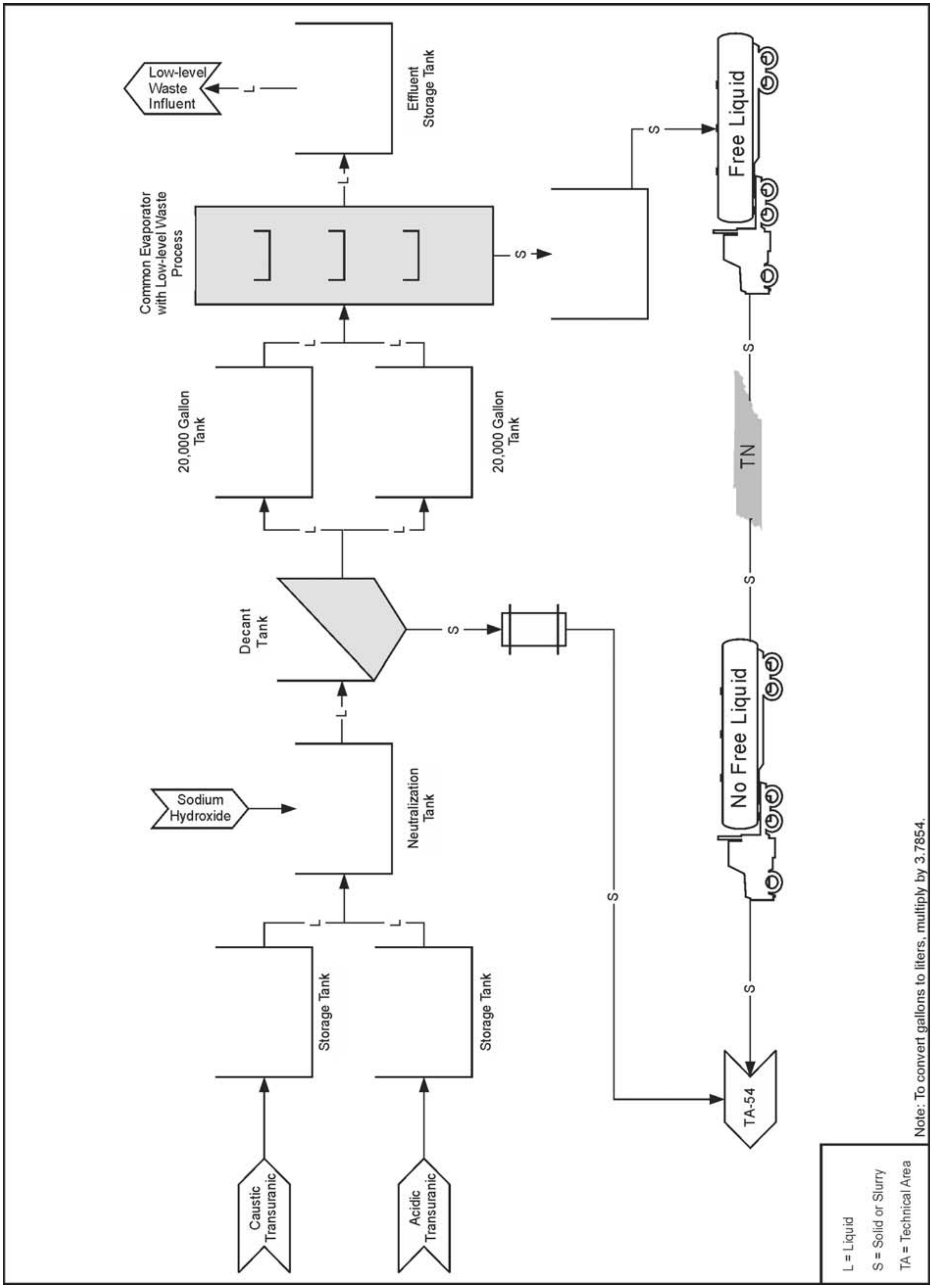


Figure G–5 Existing Treatment Processes for Transuranic Waste

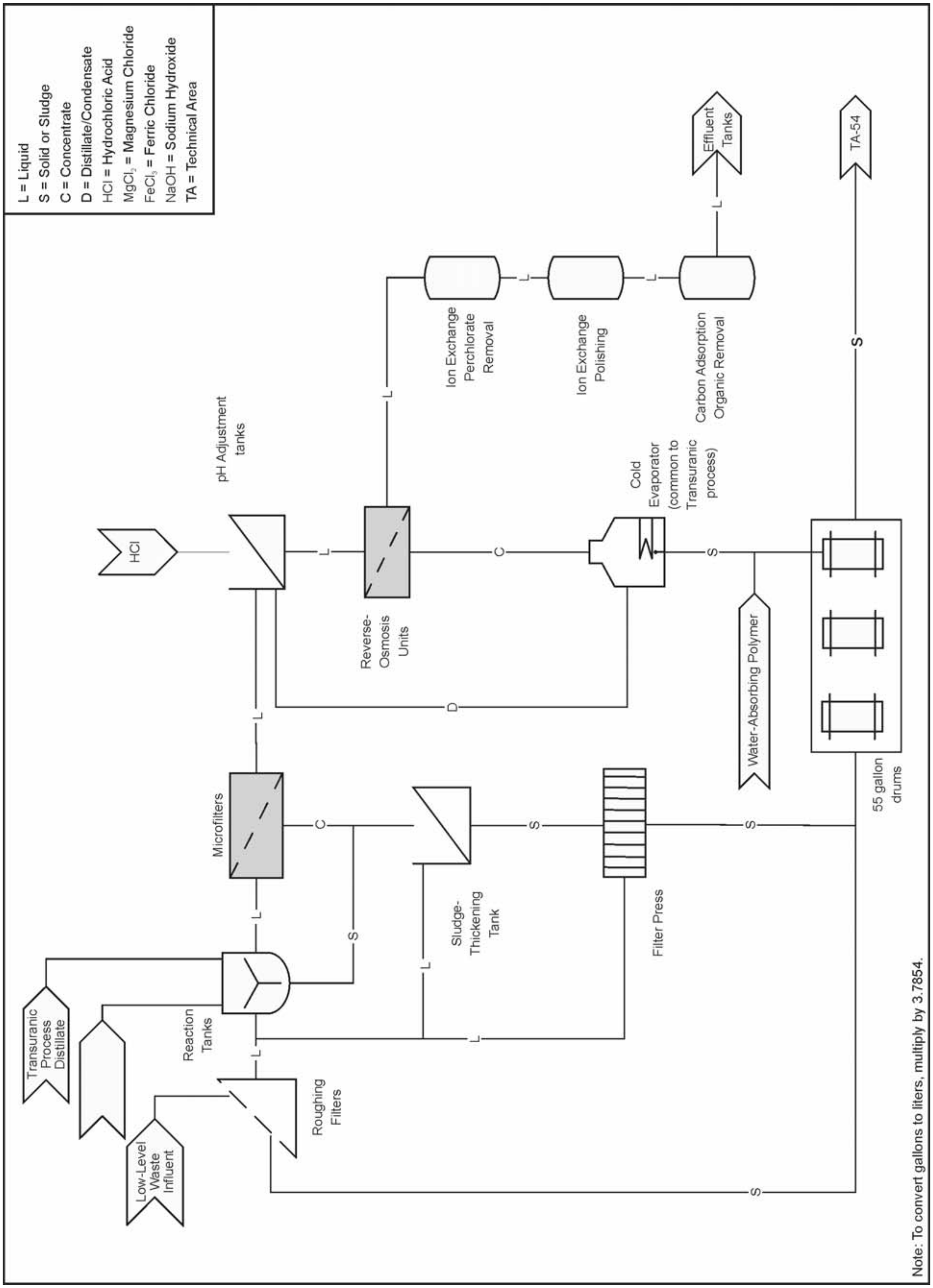


Figure G–7 Proposed Low-Level Radioactive Waste Treatment Process

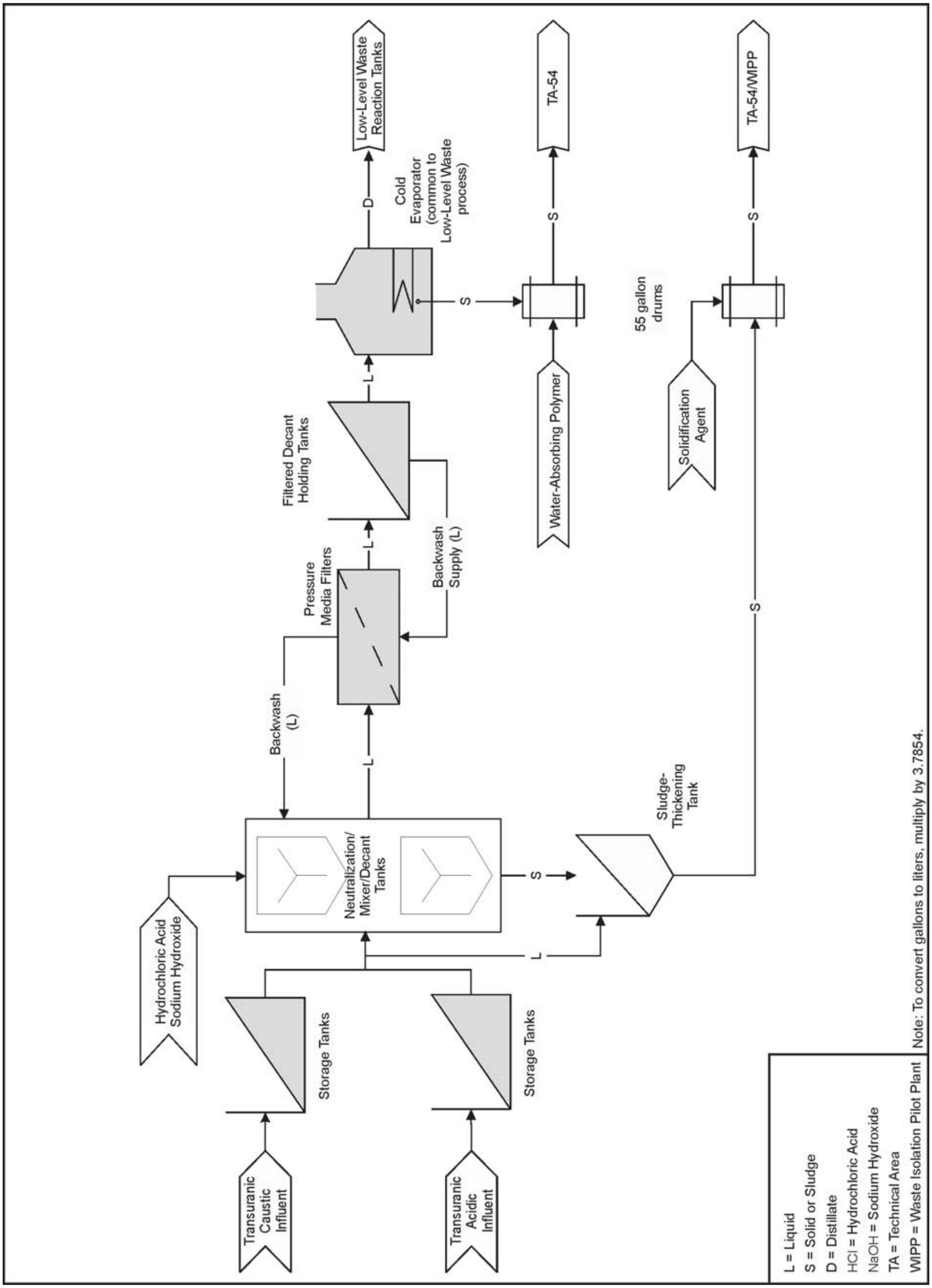
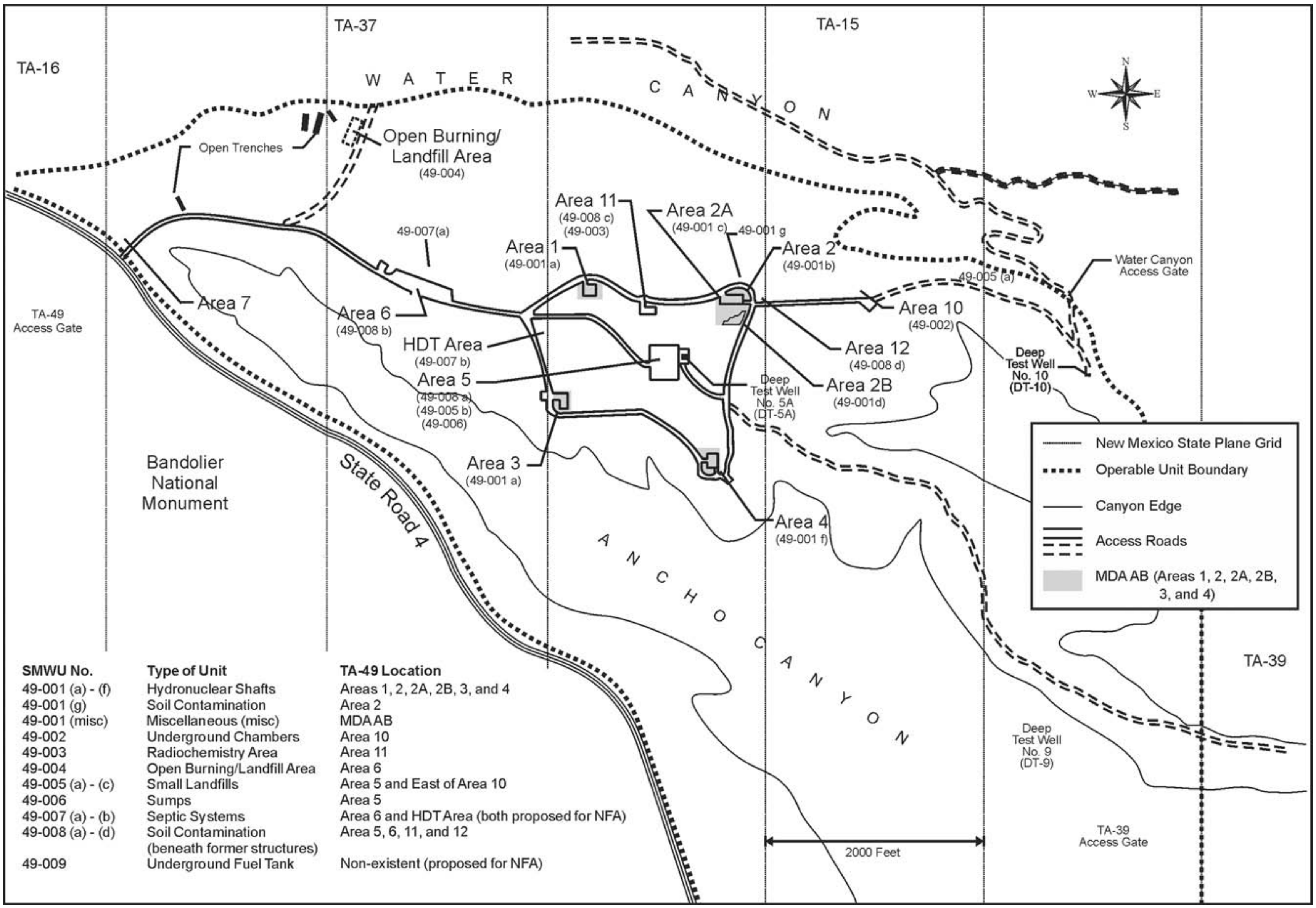
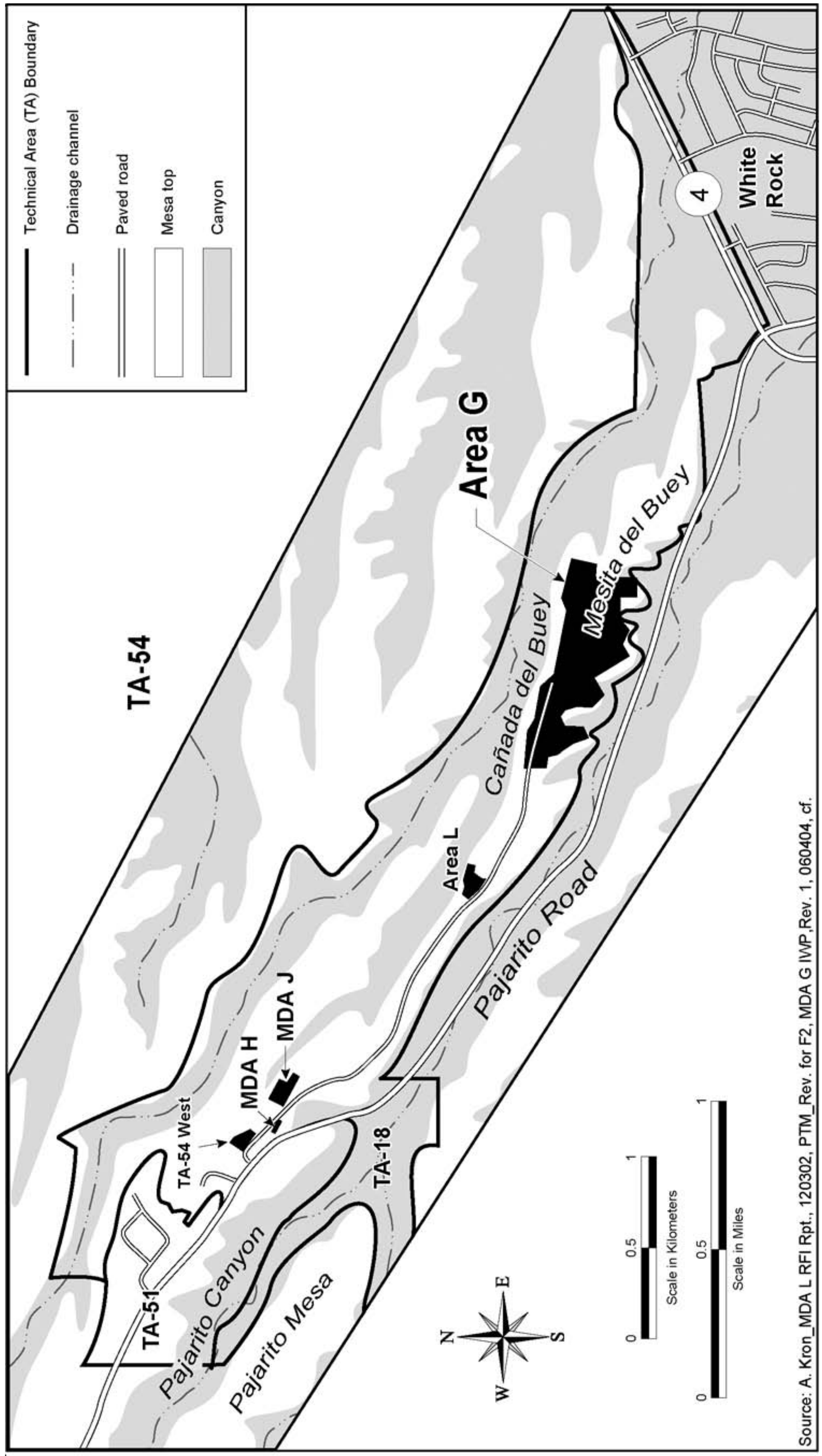


Figure G–8 Proposed Transuranic Waste Treatment Process



SMWU No.	Type of Unit	TA-49 Location
49-001 (a) - (f)	Hydronuclear Shafts	Areas 1, 2, 2A, 2B, 3, and 4
49-001 (g)	Soil Contamination	Area 2
49-001 (misc)	Miscellaneous (misc)	MDA AB
49-002	Underground Chambers	Area 10
49-003	Radiochemistry Area	Area 11
49-004	Open Burning/Landfill Area	Area 6
49-005 (a) - (c)	Small Landfills	Area 5 and East of Area 10
49-006	Sumps	Area 5
49-007 (a) - (b)	Septic Systems	Area 6 and HDT Area (both proposed for NFA)
49-008 (a) - (d)	Soil Contamination (beneath former structures)	Area 5, 6, 11, and 12
49-009	Underground Fuel Tank	Non-existent (proposed for NFA)

Figure I–12 Technical Area 49 Shaft Areas and Other Solid Waste Management Units



Source: A. Kron_MDA L RFI Rpt., 120302, PTM_Rev. for F2, MDA G IWP,Rev. 1, 060404, cf.

Figure I–14 Material Disposal Area Locations of Technical Area-54

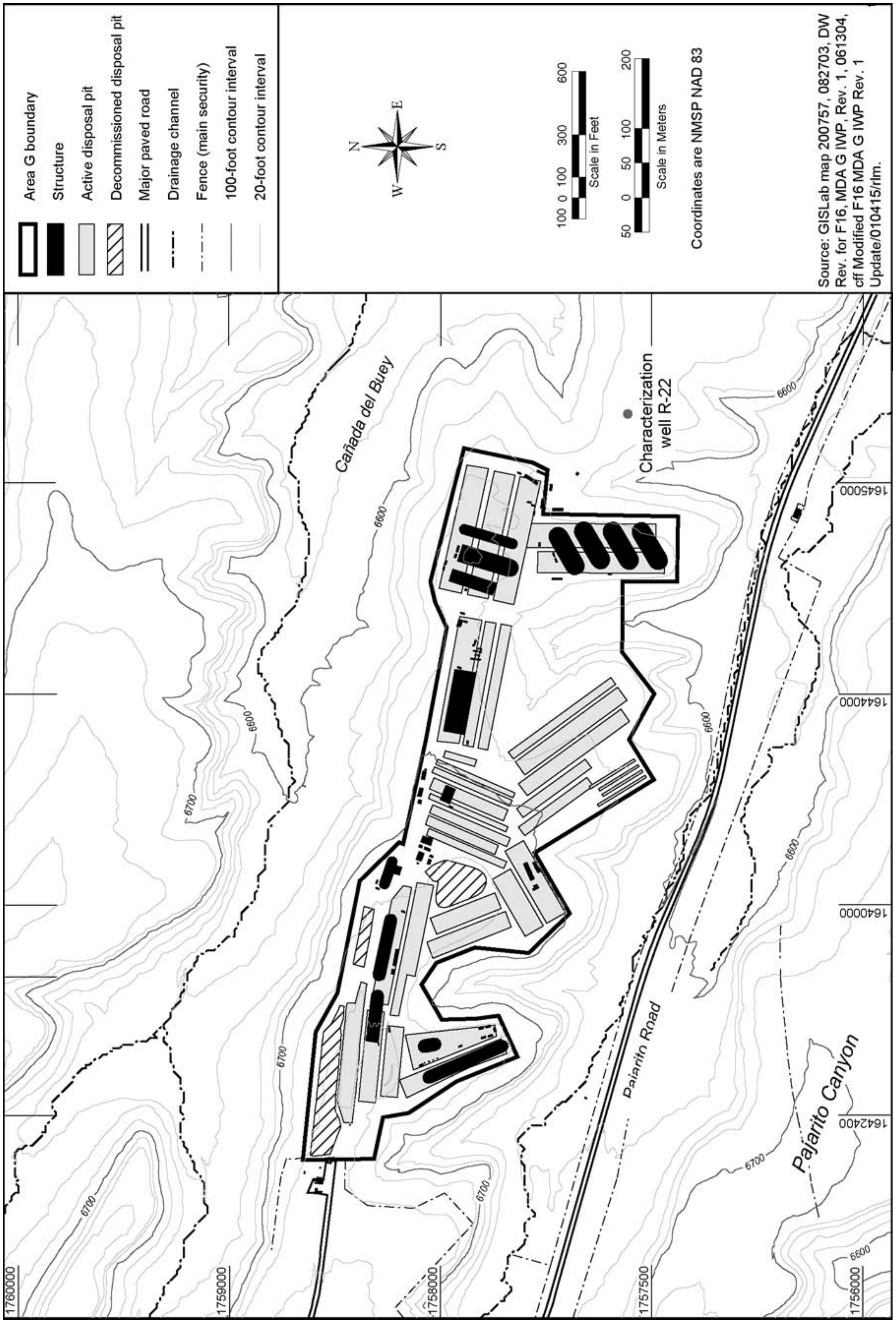


Figure I–15 Waste Management Areas within Area G of Technical Area-54

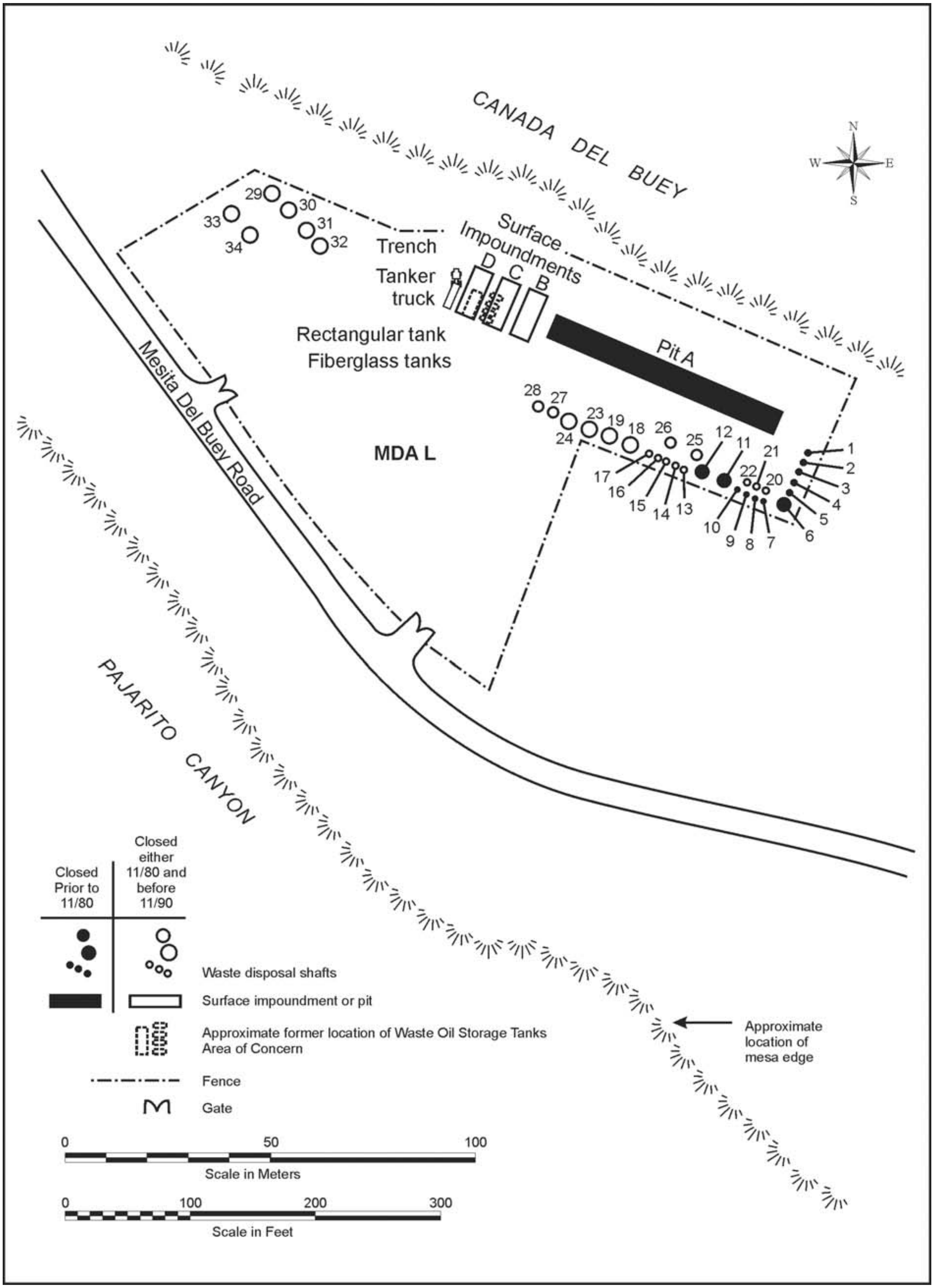


Figure I–16 Material Disposal Area L Inactive Waste Unit Locations

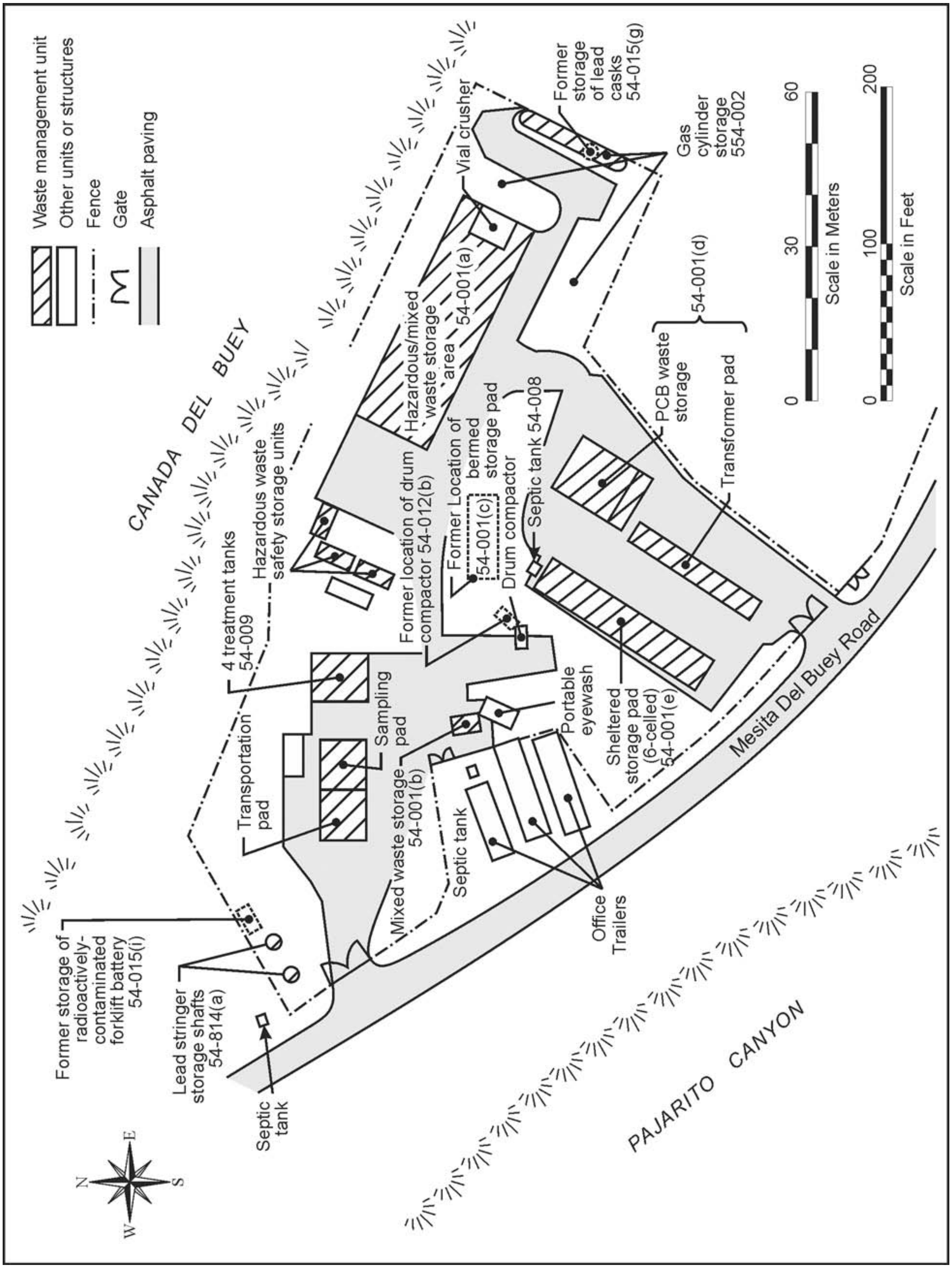


Figure I–17 Material Disposal Area L Operational Waste Management Units

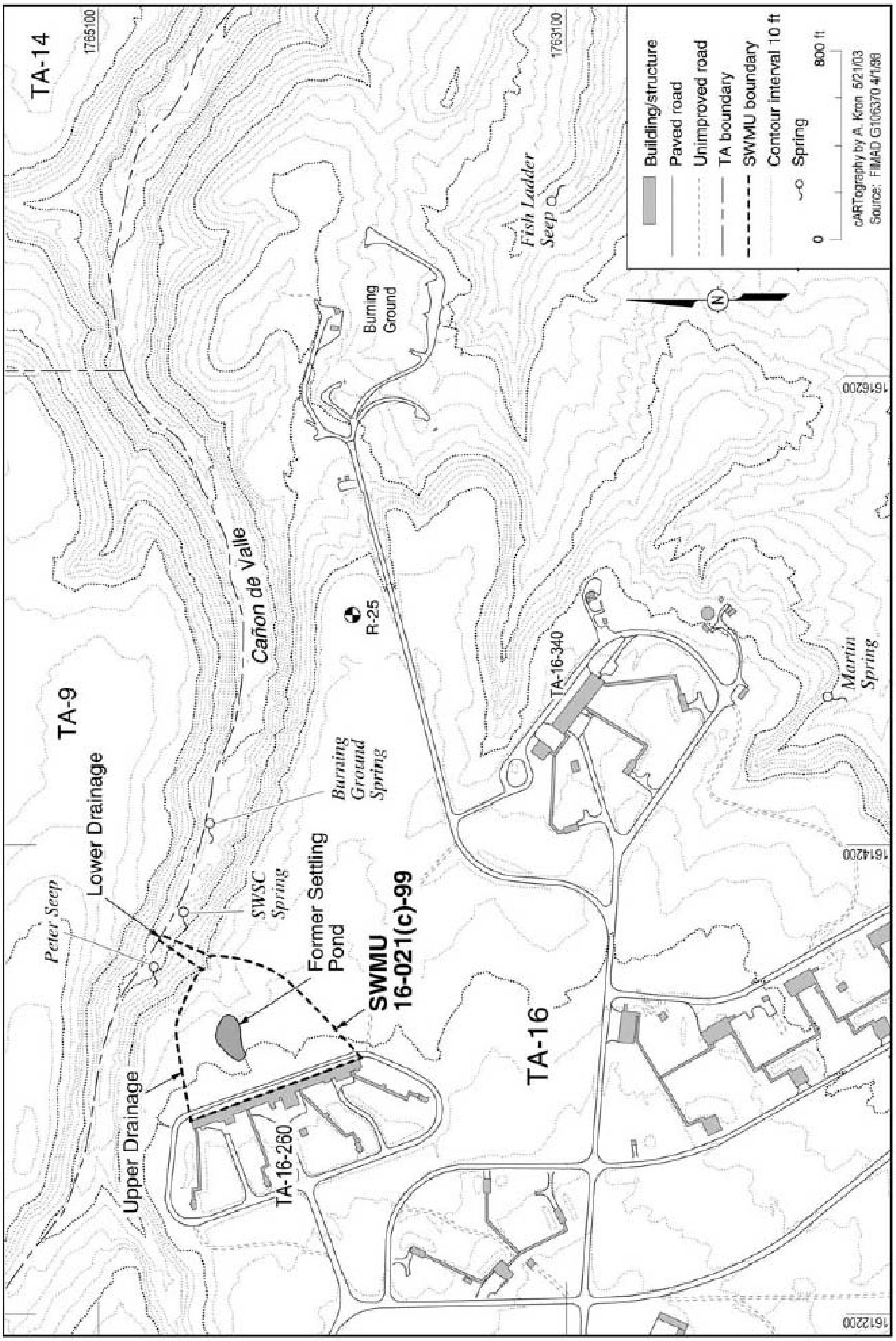


Figure I–18 260 Outfall Within Technical Area-16

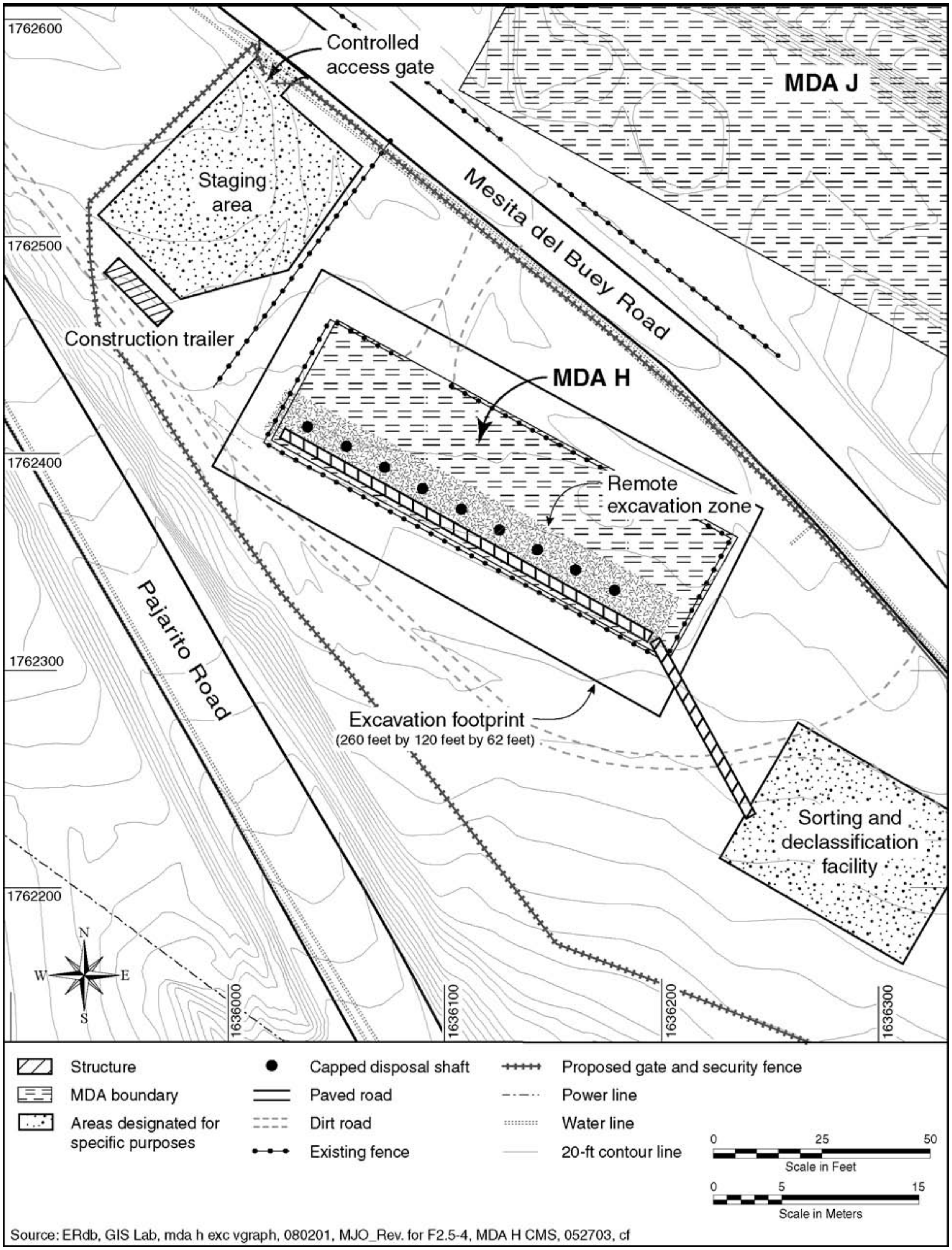


Figure I–19 Closeup View of Conceptual Site Changes to Facilitate Complete Excavation and Removal Corrective Measure Option

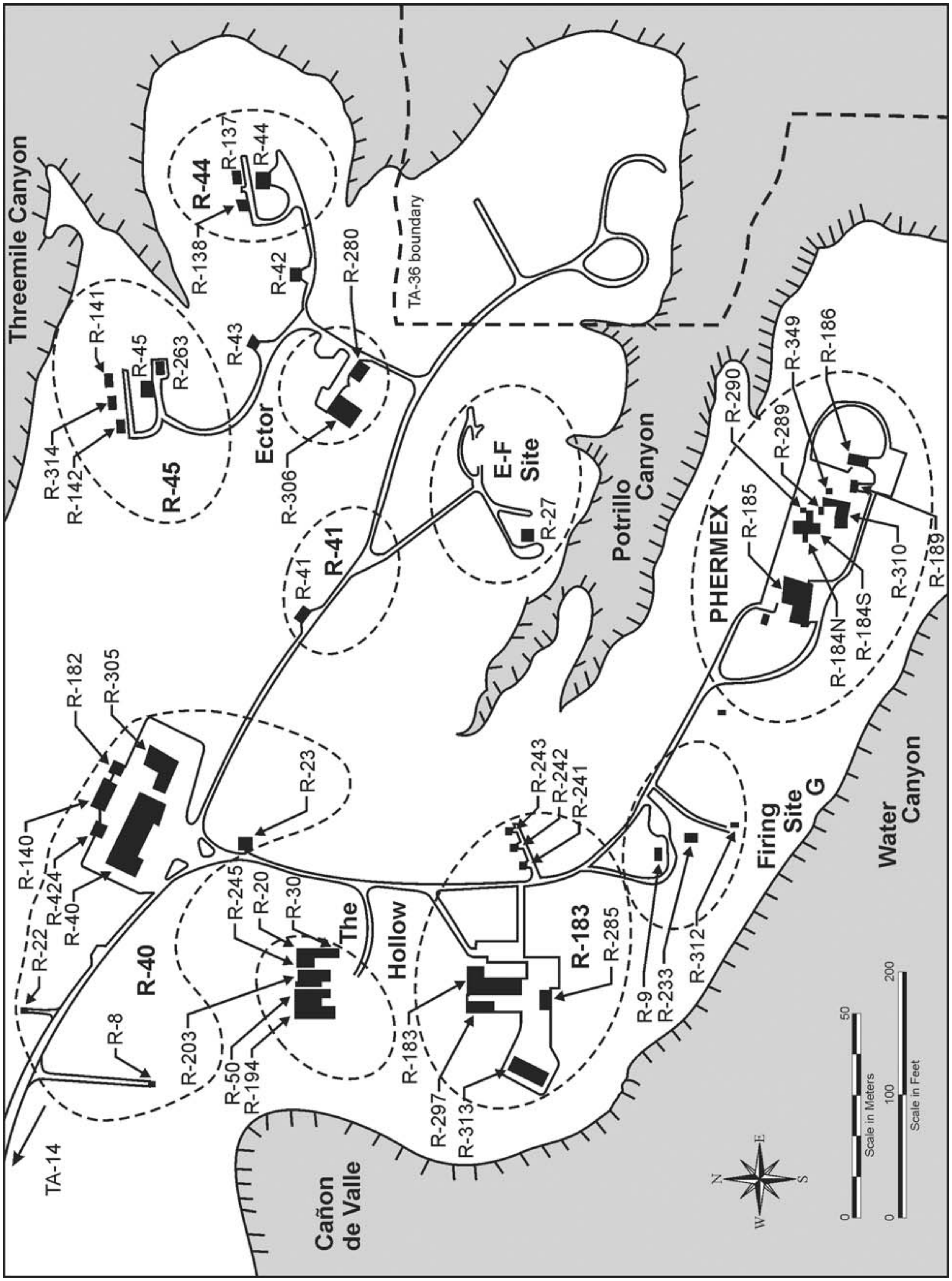


Figure I–2 Technical Area 15 Firing Sites and Other Facilities

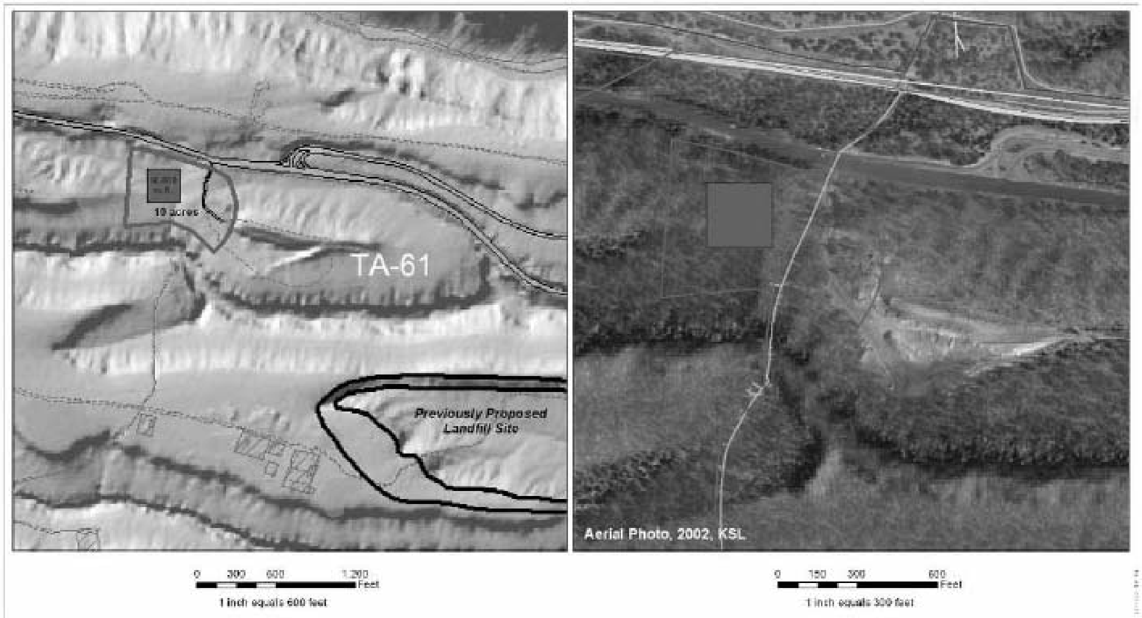


Figure I–22 Aerial Illustrations of Borrow Pit

Figure I–23 View to the East from within the Technical Area 61 Borrow Pit

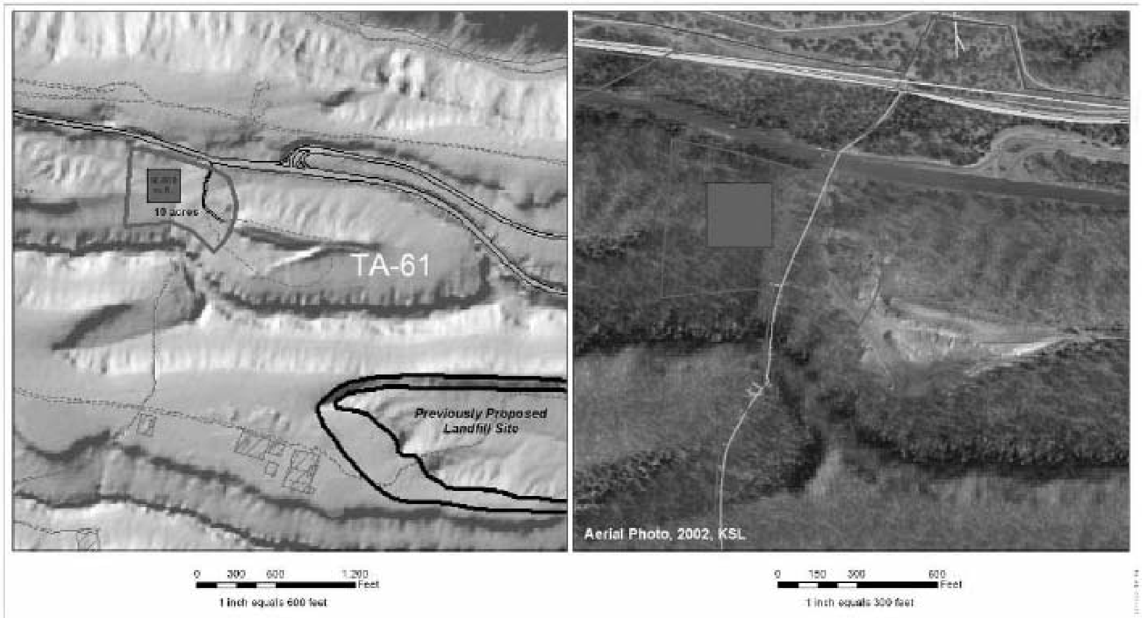


Figure I–22 Aerial Illustrations of Borrow Pit

Figure I–23 View to the East from within the Technical Area 61 Borrow Pit

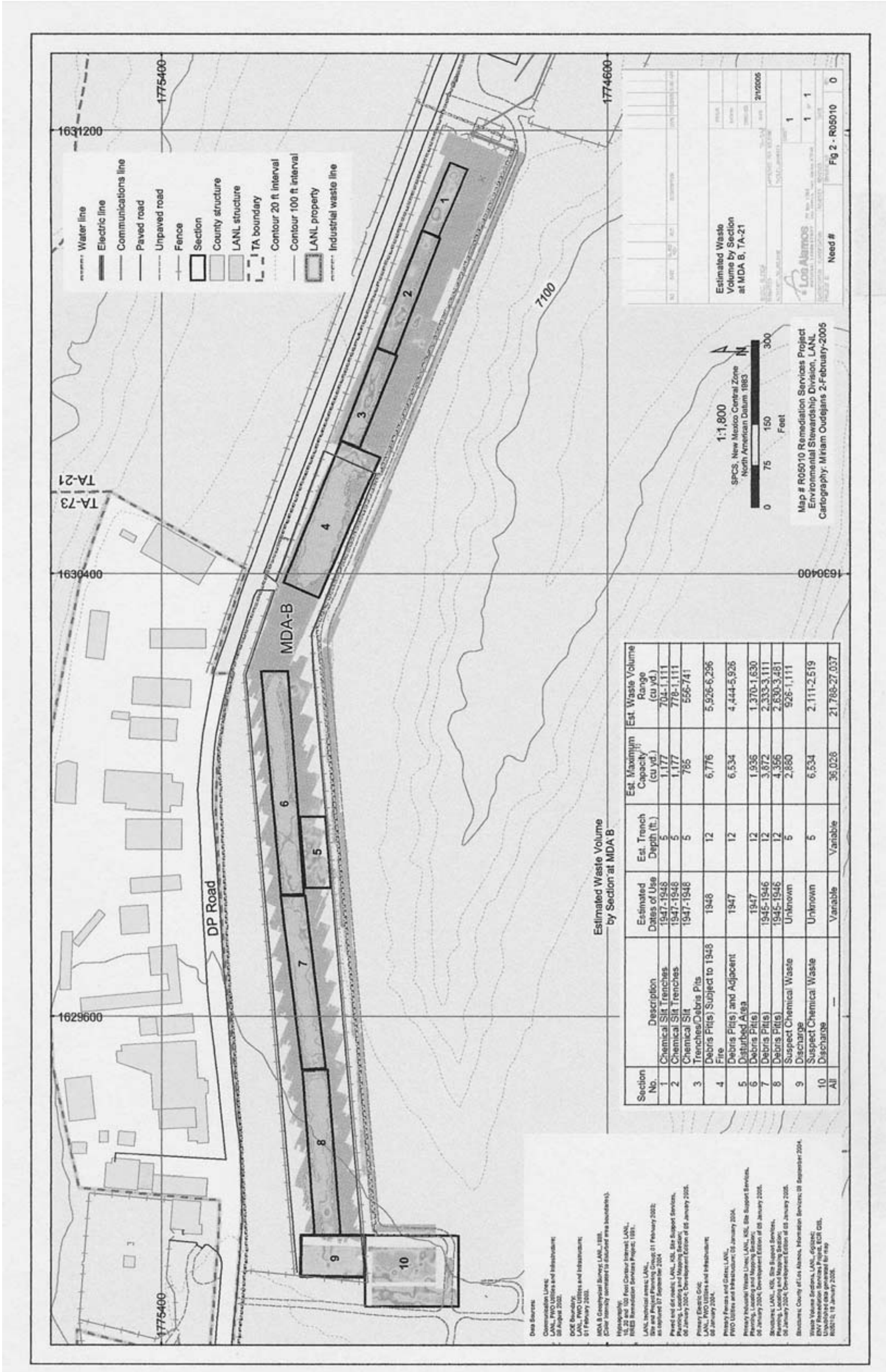


Figure I–24 Material Disposal Area B Investigative Sections

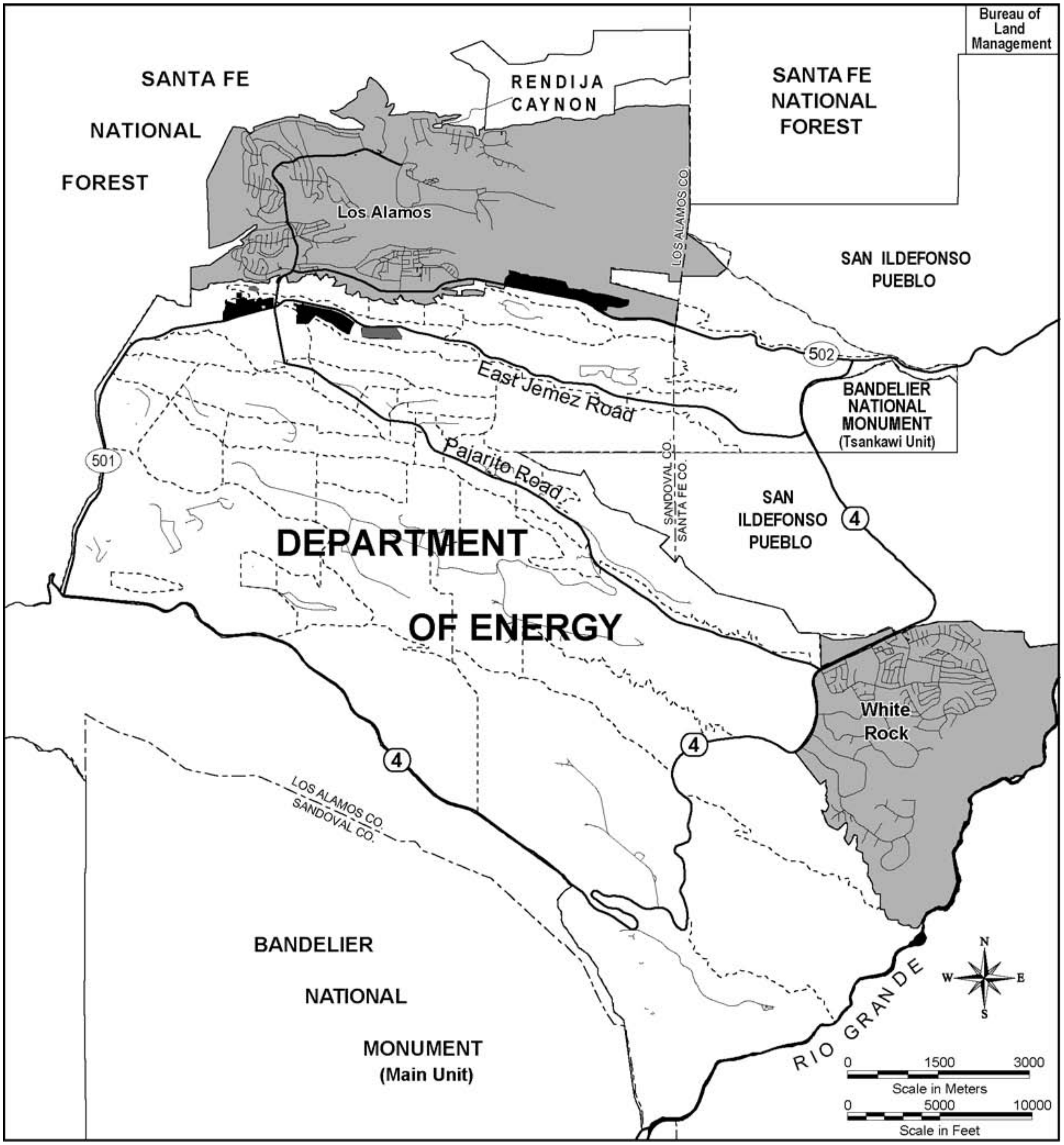


Figure I–25 Major Transportation Routes within Los Alamos National Laboratory

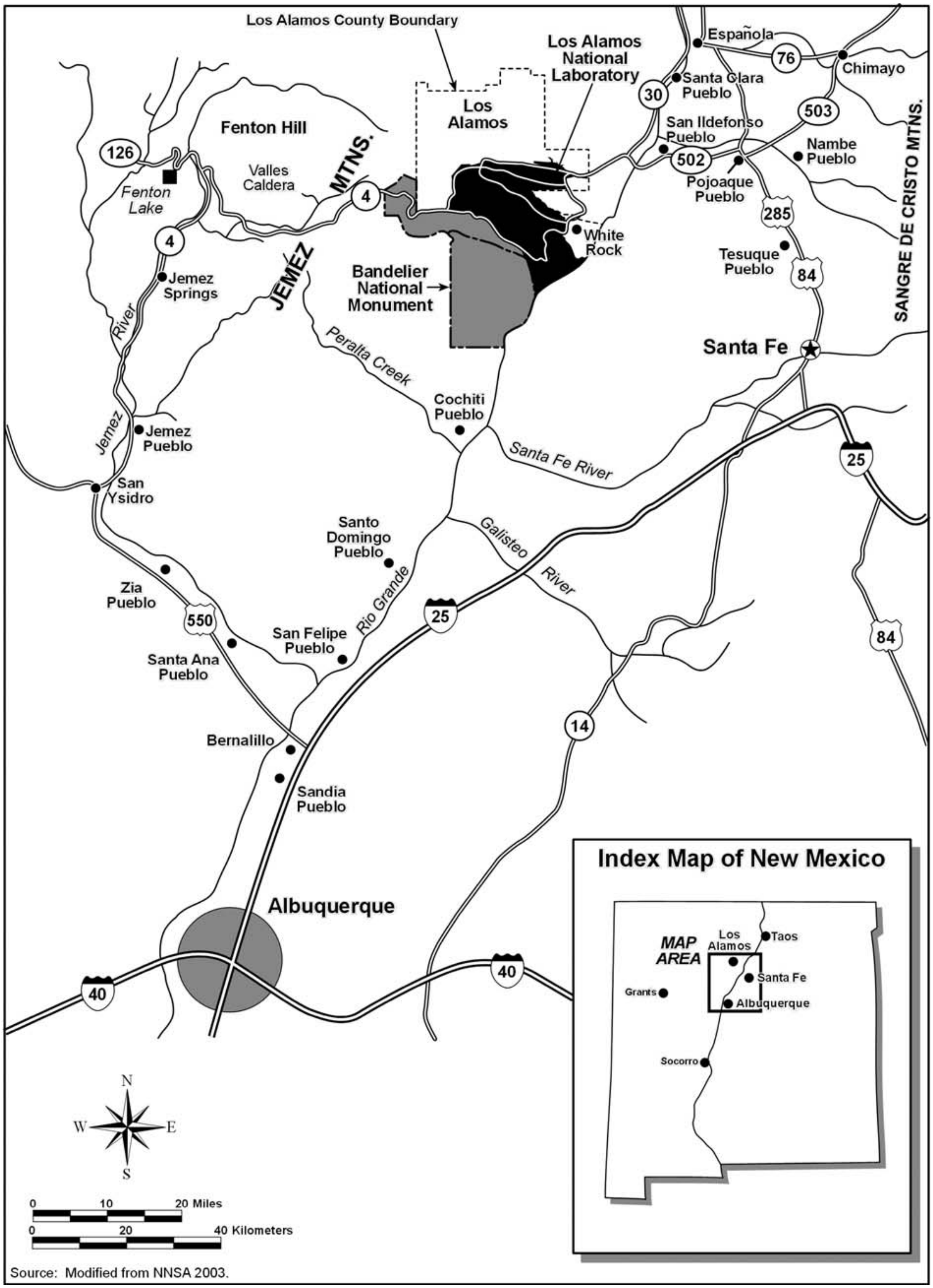


Figure I–26 Major Transportation Routes Outside of Los Alamos National Laboratory

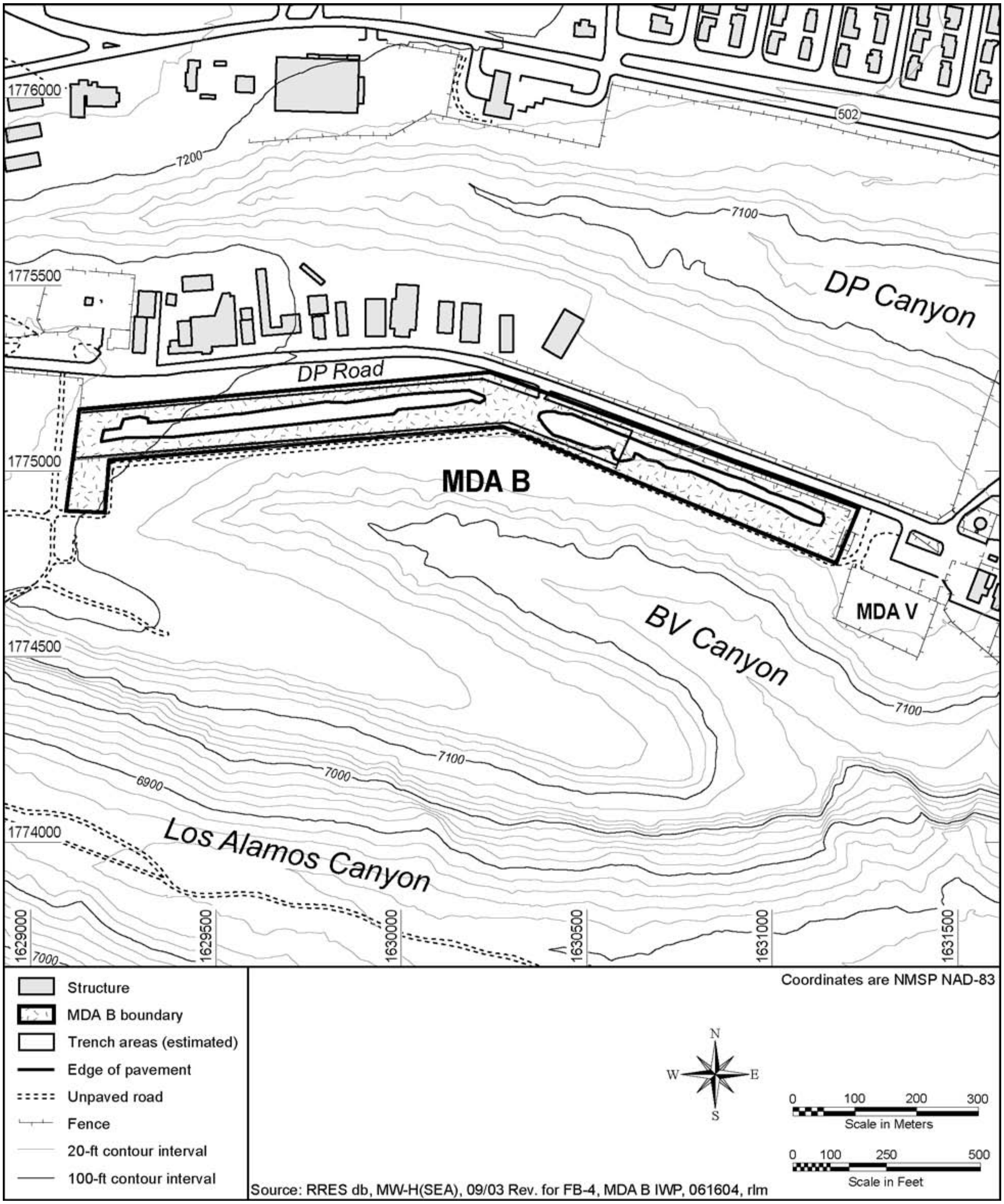


Figure I–7 Material Disposal Area B Base Map Showing Estimated Disposal Trench Locations